ABSTRACT

THE FUTURE OF THE URBAN STREET IN THE UNITED STATES: VISIONS OF ALTERNATIVE MOBILITIES IN THE TWENTY-FIRST CENTURY

by
Esther Zipori

This dissertation is concerned with the present and future of urban streets in the United States. The goal is to document and analyze current visions, policies, and strategies related to the form and use of American urban streets. The dissertation examines current mobility trends and offers a framework for organizing visions of the future of urban streets, evaluating them through three lenses: safety, comfort, and delight: assessing physical conditions in accordance with livability standards toward sustainable development. At the same time, it demonstrates the way 12 scenarios (NACTO Blueprint for Autonomous Urbanism, Sidewalk Labs: Quayside Project, Public Square by FXCollaborative, AIANY Future Street, The National Complete Street Coalition, Vision Zero, Smart Columbus, Waymo by Alphabet, The Hyperloop, Tesla “Autopilot,” Ford City of Tomorrow, SOM City of Tomorrow) have intentionally or unintentionally influenced contemporary use of American urban streets. Ultimately, the study shows that while sustainable alternative mobilities continue to emerge, the dominance of the automobility system has led to a stagnation of sustainable urban street development in the United States.

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"There is no point is using the word 'impossible' to describe something that has clearly happened." – Douglas Adams, Dirk Gently's Holistic Detective Agency

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LIST OF ACRONYMS

ADAS	Advanced Driver Assistance Systems
AI	Artificial Intelligence
AT	Autonomous Technology
AV	Autonomous Vehicles
AVS	Autonomous Vehicles Shuttle
BTS	Bureau of Transportation Statistics
CEO	Chief Executive Officer
CES	Consumer Technology Association
CFO	Chief Financial Officer
CIO	Chief Information Officer
CNU	The Congress for New Urbanism
COO	Chief Operating Officer
CTO	Chief Technology Officer
CVE	Connected Vehicle Environment
DARPA	Defense Advanced Research Project Agency
DOT	Department of Transportation
EVSE	Electric Vehicle Supply Equipment
FHWA	The Federal Highway Administration
FTA	Federal Transit Administration
GHG	Green House Gas Emissions
GHSA	Governors Highway Safety Association
GPS	Global Positioning System
LiDAR	Light Detection and Ranging Systems
LOS	Level of Service
MaaS	Mobility as a Service
MPH	Miles per Hour
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
NACTO	The National Association of City Transportation Officials
NHTSA	National Highway Traffic Safety Administration
NIMBY	Not in My Back Yard
NTSB	The National Transportation Safety Board
R&D	Research and Development
RFP	Request for Proposal
SAE	The Society of Automotive Engineers
SF	Science Fiction
SOV	Single Occupancy Vehicles
TC	Transportation Commission
TCD	Traffic Control Devices
TNC	Transportation Network Companies
USDOT	United States Department of Transportation
USPS	United States Postal Service
VMT	Vehicle Miles Traveled
YIMBY	Yes in My Back Yard

CHAPTER 1

INTRODUCTION

This dissertation is concerned with the American urban street and the push-and-pull that has occurred on it since the beginning of the twenty-first century. I am particularly interested in the relationship between various interventions and sustainable development. The key question I seek to answer is, what are the dominant visions of the future of the urban street? Literature concerned with mobile sustainable transitions has reached a consensus on its nature as a transition toward low-carbon streets. Yet, in the United States, the focus has remained on the car. This study adds to the automobile-system literature as a critical lens of urban systems analysis while providing a snapshot of the current conditions of the American urban street. I argue that the urban street is the most valuable real estate available to cities in the transition toward sustainable built environments.

The urban street is more than the pavement on which a car resides. It is for this very reason that the tendency to be auto-centric in examining American streets is flawed. Streets include sidewalks, curbs, and dedicated lanes, e.g., bus, bicycle, and high-occupancy vehicle lanes; they comprise the network of modern urban life. This study is concerned with the future of the urban street in the United States. Specifically, it aims to depict American urban street conditions and the existing cultural visions that influence urban street development. With the growing climate crisis and more localized issues surrounding the American urban street, the question this study is concerned with is to understand better where the future of the American urban street is heading; towards an automobile-based space or toward a post-automobility transition?

The primary research questions in this dissertation are: what are the visions for the future of the American urban street? What are the current formal conditions of the American urban street? How are those conditions being used? Building on the extensive literature on urban interventions and sustainability, this study aims to add to the ongoing discussion of defining and implementing sustainable urban street development.

I developed the research design, data collection, and analysis process through the weaving of two schools of thought. First, I draw on the role of the automobile and what John Urry defined as the automobility system, and second, the use of utopia in crafting the study methodology. The automobility perspective stipulates systems view where interlocking features reinforce and correct each other.[1] It also specifies a mobility vantage point. I turn to mobility transitions research, where mobility is conceptualized as individual freedom and a collective good.[2] This is where I integrate the use of the future, and utopia, as methods. Using Fredric Jameson's description of utopia as a place or an attempt to represent a place that forecasts a future.[3] As an analytical method, it is reading utopian clues and traces in the landscape of reality, "a theorization and interpretation of unconscious utopian investment in realities large and small."[4] In a world facing a climate crisis, I argue that a utopian place can be measured based on its sustainable features (or lack thereof).

[1] John Urry, "The 'System' of Automobility," *Theory, Culture, and Society* 21, no. 4 (2004): 26-27, 36; Steffen Böhm, Campbell Jones, Chris Land, and Matthew Paterson, *Against Automobility* (Malden, MA: Blackwell, 2006), 5.

[2] Anna Nikolaeva, Peter Adey, Tim Cresswell, Jane Yeonjae Lee, Andre Nóvoa, and Cristina Temenos, "Commoning Mobility: Toward a New Politics of Mobility Transitions," *Transactions of the Institute of British Geographers* 44, no. 2 (2019), 348-349.

[3] Fredric Jameson, "Utopia as Method" in *Utopia/Dystopia: Conditions of Historical Possibility*, ed. Michael D. Gordin, Helen Tilley, and Gyan Parkash (Princeton University Press, 2010), 21-22.

[4] Jameson, *Utopia/Dystopia*, 26.

For the public, the street serves as a space for getting from one place to another, but it is also a place for staying: on the sidewalk, we stop to look at shop windows, wait for a bus, or eat a delicious taco. The tension between the roadway and the sidewalk is made more difficult as new forms of movement emerge with no clear distinction as to which part of the street space they belong. There is more happening on the urban street than ever before, with various stakeholders demanding the redistribution of available space. While roadways and private vehicles still dominate most streets, cyclists, scooterists, data-collection sensors, drones (in the air and on the ground), pedestrians, autonomous vehicles (AVs), and delivery trucks have had an increasing presence since before COVID-19.

The street cannot be anything other than a public space.[5] It organizes the city by providing a context of cultural, social, and infrastructural importance: but in many cases, it is not considered synonymous with public space. Public spaces in a city are considered to be plazas and parks, places that have been organized to contain people separated from all other forms of activity except the activity of being in a public space. But the space that connects all these public spaces – the urban street – is not considered a social public space because it has been swallowed by the notion that the street and the roadway are one and the same. This becomes even more obvious when reviewing contemporary visions for the future that continually default to car-centered urban movement.

Henri Lefebvre, a French Marxist philosopher and sociologist, distinguished between abstract space and social lived-in spaces. Examining the theory of social space and the struggle for the meaning of space, he argued that geographical space is fundamentally social, a product of lived experiences. Streets are “representation of space”

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[5] Spiro Kostof, *The City Assembled: The Elements of Urban Form through History* (Boston: Little, Brown, 1992), 194.

as well as "spaces of representation," Essentially, both experienced space and conceptualized space.[6] To understand places, the relationship between the structures of the social space and the physical space needs to be analyzed.[7] In physical space, the inequality of power takes the form of the relationship between the distribution of goods and services and the distribution of agents. This means that the occupation of specific sites within physical spaces expresses certain social positions. Space is not the result of social action but an expression of social power. Social power can be described by what Lefebvre termed the "right to the city": a right that "cannot be conceived of as a simple visiting right or as a return to traditional cities. It can only be formulated as a transformed and renewed right to urban life."[8] It is the right of urban society not to be excluded. In the modern contemporary city and globalized urbanization people exercising their *right to the city* bring urban vitality to the urban street.[9]

David Harvey questions the right to the city by confronting the right itself as an object of struggle.[10] He argues that the kind of city we want cannot be divorced from the question of what kind of social relations we seek or what aesthetic values we hold. The right to the city is more than a right of individual or group access to a resource embodied in the city—it is a right to change and reinvent the city.[11] Harvey describes the urban conditions under capitalism "in which the inalienable rights to private property and the

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[6] Henri Lefebvre, *The Production of Space* (Oxford, UK: Blackwell, 1991), 245-246.
[7] Tim Cresswell, *Place: A Short Introduction* (Malden, MA: Blackwell, 2004), 1-15.
[8] Henri Lefebvre, "Right to the City," in *Writing on Cities*, eds. Elenore Kofman and Elizabeth Lebas (Oxford: Blackwell, 1968), 147-159.
[9] David Harvey, "The Right to the City in New Left Review," in *The City Reader Sixth Edition*, eds. by Richard T. LeGates and Frederic Stout (London and New York: Routledge, 2008), 270-78.
[10] David Harvey, *Rebel Cities: From the Right to the City to the Urban Revolution* (London and New York: Verso, 2013), xv.
[11] Harvey, *Rebel Cities*, 4.

profit rate trumps any other conception of inalienable rights."[12] This condition has created an ongoing debate on the nature of urban space. Between the creation of new urban commons for active democratic participation to privatized space.[13]

These debates over the right to the urban street continued to play out during the COVID-19 pandemic. The issues focused on four primary categories of alternative mobility scenarios: urban interventions, events, services, and objects. Each of these categories, while also existing as focal points of debate before the pandemic, were more pronounced during the height of COVID-19 and therefore accelerated the implementation of alternative mobility scenarios. It was, ironically, an opportunity. However, the process of making spaces for people walking and riding bicycles reverted to pre-COVID-19 stagnation as the pandemic ran its course.

The health crisis compressed and condensed urban street transitions that had been underway in North America and played them out on the street. A living lab like no other, the pandemic showed the public a glimpse of non-car mobility alternatives in urban places. The early months of the pandemic saw the emergence of an open public conversation about the nature of public space and the potential of non-car space through newspaper opinion articles and online discussions. Dan Rather, a well-known former American news anchor, tweeted that "Maybe when this is all over, we can widen the sidewalks,"[14] receiving many positive responses with people sharing a host of urban places made car-free during the pandemic and expressing their love and support.

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[12] David Harvey, The Right to the City, *International Journal of Urban and Regional Research*, Vol 27.4, December 2003, 940-941.
[13] Harvey, *Rebel Cities*, 67.
[14] Dan Rather (@DanRather), Twitter, April 2, 2020, 1:16 PM. https://twitter.com/DanRather/status/1245761993039962117.

The changes discussed in this chapter did not come with any systematic reformatting of urban spaces. No policies were introduced to improve transit systems or access to them permanently. A study from Vanderbilt University modeled possible scenarios for a host of cities based on pre-pandemic traffic patterns. The rebound scenarios addressed in the survey considered that 25% of transit users would drive their cars; instead, 50% of transit users would drive, 75% of transit users would drive instead, or all transit users would drive instead. Showing a range of possibilities, the researchers concluded that all American cities have added traffic hours per day and are at high risk for extreme return of traffic unless other alternatives (transit, microtransit) are resumed in step with car traffic.[15] Between June and July 2020, the New York State Motor Vehicle Commission processed 73,933 original car registrations, an 18% increase over the 62,507 registrations of 2019,[16] another sign for the "Carmageddon" facing cities as life in the United States returned to pre-COVID-19 activities. This is not surprising considering the profound relationship between Americans and private cars. In the early days of the pandemic, a resurgence in the discussion of Suburb vs. City took place. Early contraction rates were higher in densely populated cities, and with that came the general assumption that suburban residents were better suited to stay healthy. A *Boston Globe* article titled "Social Distancing Revives America's Suburban Instincts" began with the observation that "The global pandemic is breathing new life into the American dream – our love of driving alone, of suburbs and wide-open space, big-box stores and big streets, and oversize single-family

[15] Yue Hu, Will Barbour, Samitha Samaranayake, and Dan Work, "The Rebound – How Covid-19 Could Lead to Worse Traffic," *Medium*, April 29, 2020, https://medium.com/@barbourww/the-rebound-how-covid-19-could-lead-to-worse-traffic-cb245a5b1da2.
[16] Foster Kamer, "The Great Gotham Vroom Boom of 2020," *New York Times*, August 12, 2020, https://www.nytimes.com/2020/08/12/style/car-buying-new-york-coronavirus.html.

homes."[17] This is a condition that cannot be maintained in a world amid a climate crisis, not something the Boson Globe acknowledges.

This dissertation is a qualitative research study conducted using uncontrolled scenarios to study the current and future conditions of the American urban street. Data were collected over multiple points between 2017 and 2021 through an adapted snowball method. I drew from future studies, architectural design practice, and urban planning to develop the research design. In future studies, the future is typically studied in terms of alternative paths.[18] A similar process exists in architectural design and urban planning practice, fields concerned with creating the sequence of actions that will lead to a specific goal.[19] As Andrew Isserman wrote in "Dare to Plan: An Essay on the Role of the Future in Planning Practice and Education," planners are experts in the study of change—past, present, and future.[20] In urban design, visual analysis is supplemented by a critical assessment of the relationships between the various actors involved.[21] I take a critical automobility perspective approach in my visual examination of each scenario.

Scenarios are alternative narratives about the future that assist in identifying alternative evolutions of specific trends.[22] Scenarios usually include an image of the future, a snapshot that consists of the flow of events that lead to those future conditions.[23] I adopt

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[17] Anthony Flint, "Social Distancing Revives America's Suburban Instincts," *Boston Globe*, March 16, 2020, https://www.bostonglobe.com/2020/03/16/arts/social-distancing-revives-americas-suburban-instincts/.
[18] Wendell Bell, *Foundations of Futures Studies, Volume 1: History, Purposes and Knowledge* (New York: Routledge, 2003), 103.
[19] Sam Cole, "Dare to Dream: Bringing Futures into Planning," *APA Journal* 67, no 4 (2001): 373-374.
[20] Andrew Isserman, "Dare to Plan: An Essay on the Role of the Future in Planning Practice and Education," *The Town Planning Review* 85, no. 1 (2014): 9-10.
[21] Gerrit Schwalbach, *Basic Urban Analysis* (Basel: Birkhäuser, 2009),13.
[22] Neil MacDonald, "Futures and Culture," *Futures*, 44, no. 4 (2012): 277.
[23] Gilberto Gallopin, Al Hammond, Paul Raskin, and Rob Swart, *Branch Points: Global Scenarios and Human Choice* (Stockholm: Stockholm Environment Institute, 1997), 5.

a broad definition of scenarios drawing on three frameworks: the multi-level perspective (MLP); Simon Marvin and Steven Graham's conceptualization of urban systems as networked infrastructure made of objects and actors; and Tim Creswell's description of mobility as a constellation of mobility—physical movement, meanings, and lived experience. As a result, a scenario is a policy, an event, an object, a pilot, or an image.

First, the MLP is a sociotechnical system perspective based on the theory that any organization (or part of a system) is made from sub-systems of procedures, goals, cultures, infrastructure, technology, and people. The levels of the MLP—landscape, regimes, and niches—provide a scaled analytical tool. The socio-technical landscape offers a broader context, including the structure of society at the time, political and social values, concerns, and beliefs. The regime refers to the space in which existing technologies and regulations, infrastructure, user patterns, and culture align, including the social groups and actors that reproduce and maintain the system. The regime is a deep structural set of rules and coordinates that guide the actor's action and perception, making it difficult to break away from it. The last level of the MLP, niches, are the innovations that emerge within the regime but deviate from it. To be more accurate, niche-based innovation occurs outside of the regime, though it can be coopted or taken up over time by the regime. Niches act as seeds for systematic change through real-time experimentation and demonstration.[24]

Second, Tim Creswell proposes that in studying movement, six facets need to be considered: the starting point, speed, rhythm, routing, experience, and friction. He further argues that these six facets of mobility provide accounts of the dominant "sense of

[24] Frank W. Geels, "The Multi-Level Perspective on Sustainability Transitions: Responses to Seven Criticisms," in *Environmental Innovation and Societal Transitions* 1 (2011), 25.

movement."[25] This means that to have a mobility approach is to consider mobility as an entanglement of movement, meaning, and power, or what Creswell calls a constellation of mobility.[26] A constellation of mobility stipulates accounting for a historical sense of movement, the meaning and practice, and the ways they interrelate.

Finally, urban development intensified in speed and reach in the last century. The scale of technologically mediated urban life created what Marvin and Graham call networked infrastructure. Cities are the spaces with the most concentrated sources of demand for water, energy, transport, and communication services. At the same time, the urban landscape is an infrastructural fabric. A fabric that includes material and technology in the service of water energy, communication, and transport systems.[27] Drawing from Thomas Hughes's idea that society is a "seamless web" of socio-technical constructions[28] and Bruno Latour's actor-network theory, in which society is not social or technological but both existing across time and space and linked through human and technological agency.[29] Networked infrastructure exists within and between cities and boils down to the linkage of arrays of technological elements, actors, and services across multiple spaces.[30]

Scenario analysis is the process of uncovering the embodied perspectives of a creator's explicit or implicit intentions.[31] To begin organization futures into a taxonomy, I

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[25] Tim Creswell, "Toward a Politics of Mobility," *Environment and Planning D: Society and Space* 28, no 1 (January 2010): 21-22.
[26] Creswell, "Toward a Politics of Mobility," 26-27.
[27] Stephen Graham and Marvin Simon, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition* (London and New York: Routledge, 2001), 13.
[28] Thomas Hughes, "The Evolution of Large Technologies." In *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, eds. W. E. Bijker, T. P. Hughes and T. Pinch (Cambridge, Massachusetts & London, England: MIT Press, 1987), 53.
[29] Bruno Latour, "On Actor-Network Theory. A Few Clarifications," *Soziale Welt* 47, no. 4 (1996): 169-170.
[30] Graham and Simon, *Splintering Urbanism*, 185.
[31] Gallopin et al, *Branch Points*, 11.

drew from Neil MacDonald's 2012 study. MacDonald examines the recurring narratives on future studies using 20 scenario sets constructed between 1990 and 2008. In a two-step process, he analyzed each scenario's macro and micro characteristics to develop a taxonomy that identified the archetypes of the narratives. This method fragmented the narratives into conceptual elements, allowing them to determine the relationship between them.[32] In this dissertation, my two-step process will include looking at the financial background, the actors involved, and the technical, formal, and system-wide interventions of each future scenario.

1.1 An (Auto)mobility Perspective

An auto(mobility) perspective stipulates a methodology that identifies the automobility system within urban streets. In this study, I use the system of automobility to identify the physical manifestation of the system and its social influences. This dissertation intends to expand the literature investigating the automobile regime in the United States.

Millions of people around the world travel from their homes into their communities every second. In 2018, United States transportation systems moved an average of 51.10 million tons of freight daily, valued at more than $51.8 billion.[33] More than 186,200,000 people traveled to the United States in the same year.[34] The study of mobility and the increase in worldwide movement, in terms of form and frequency, is not new. But the study

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[32] Neil MacDonald, "Futures and Culture," 279.

[33] United States Department of Transportation, "Moving Goods in the United States," Bureau of Transportation Statistics, accessed on May 19, 2021. https://data.bts.gov/stories/s/Moving-Goods-in-the-United-States/bcyt-rqmu.

[34] Department of Homeland Security, "2019 Yearbook of Immigration Statistics, Nonimmigrant Admission by Class of Admission: Fiscal Years 2017 to 2019," accessed on May 19, 2021, https://www.dhs.gov/immigration-statistics/yearbook/2019/table25#.

of mobility has gained popularity in the last decade and undergone some change, with research focusing on the role of the movement of people and objects in social life and within the urban form. This was based on the elementary observation that everyone and everything moves.[35]

Whether it is movement for work, recreation, leisure, or safety, the need to move has never been greater. With the spread of the internet, smartphones, and new forms of virtual communication, we have created additional mobility flows that occur with physical flows. Researchers study mobility to understand people's movements, infrastructure systems, objects, and information while emphasizing the complex assemblies between different mobilities.[36] As a field, mobility studies combines social, spatial, and critical theory to provide what Mimi Sheller calls "a realist relational ontology for contemporary social science capable of transcending old debates and bridging disciplinary boundaries."[37] The field of mobility studies examines the role of movement and how it affects social interaction, technological advancement, and physical space.[38]

In 2006, Mimi Sheller and John Urry argued that a growing body of research revealed a new emerging paradigm to frame research in the social sciences. Mobilities, they argued, transformed social science by "connecting different forms of transport with complex patterns of social experience conducted through communications at-a-distance."[39] This new mobilities paradigm was built on a studies that emerged across disciplines,

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[35] Mimi Sheller and John Urry, "The New Mobilities Paradigm," *Environment and Planning* A38, no. 2 (2006): 207.
[36] John Urry, *Mobilities* (Cambridge, MA: Polity Press, 2007), 4-6.
[37] Mimi Sheller, "The New Mobilities Paradigm for a Live Sociology," *Current Sociology*, no. 6 (2014): 790.
[38] Peter Adey, et al, "Introduction" in *The Routledge Handbook of Mobilities*, ed. Peter Adey, David Bissell, Kevin Hannam, Peter Merriman, and Mimi Sheller (London and New York: Routledge, 2014), 1-4.
[39] Sheller and Urry, "The New Mobilities Paradigm," 208.

combining the study of people's movements, infrastructure systems, objects, and information and emphasizing the complex assemblies between those different mobilities.[40] Tim Cresswell describes the mobilities turn as having "wide theoretical purchase because of its centrality to what it is to be in the world,"[41] and making connections between and among different forms of movement. In mobilities as a discipline, physical science and social science link to humanities at different scales, both the small scale of individual human movement and the movement of large-scale data. Mobilities research overlaps with countless fields, including globalization studies, communications research, cultural geography, transport geography, and the anthropology of circulation. New ways of theorizing mobilities have focused on material movements, digital and communicative mobilities, and, most relevant to this study, the infrastructure and systems of governance and design that enable or disable movements.[42] This dissertation expands on the role of street design in relationship to the movement of people and materials.

Mobilities methodology "involves paying attention to how people, things and seemingly intangible entities such as ideas are on the move, as well as to how environments themselves make a difference."[43] Movement as an idea is foundational to how I examine entities, people, and projects that have or are attempting to change the urban street's environment—using the geographic concept of mobility and its relationship to other core concepts similar to place and scale.[44] It is precisely placed within the body of work that evolved from John Urry's argument about the character of mobility systems.[45] As Simon

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[40] Urry, *Mobilities*, 5-6.
[41] Tim Cresswell, "Mobilities I: Catching up," *Progress in Human Geography* 35, no.4 (2010): 551.
[42] Sheller, "The New Mobilities Paradigm for a Live Sociology," 789-790.
[43] Peter Adey, et al, "Introduction: Methodologies," 504.
[44] Mei-Po Kwan and Tim Schwanen, "Geographies of Mobility," *Annals of the American Association of Geographers* 106, no. 2 (2016): 244.
[45] Urry, *Mobilities*, 48.

Marvin and Steven Graham argue in *Splintering Urbanism*, the attention given to infrastructure networks has been reactive to crises or collapses rather than being sustained and systematic. Infrastructure facilitates technologies of mobilities that reproduce and reinforce their (uneven) distributions of power. The global mobility network is on the cusp of significant transformations in sociotechnical arrangements, despite the apparent lock-in of historic structures surrounding the system of automobility.[46]

In the United States, when people leave homes in a suburb, large city, or small town, they are confronted by an automobility system. This section reviews important aspects of this automobility system and explores how it manifests in American urban streets. I plan to conduct a similar process with the scenarios of possible urban street futures (Chapter 4).

The system of automobility is a socio-technical system that has dominated urban form in the United States since the early 20th century. It is a collection of people, objects, infrastructures, and policies that produce behavior patterns over time.[47] Automobility is one of the principal socio-technical institutions through which modernity is organized or clustered around the various elements of the system. These elements include technologies, markets, cultural meanings, infrastructure, supply, maintenance networks, regulations, and user practices.[48] It is a theoretical concept expressed by the physical conditions of places, technological developments, and behaviors (both social and cultural). Automobility is a system and part of the modern mobility paradigm.

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46 Graham and Simon, *Splintering Urbanism*, 414-415.

47 Donnella H. Meadows and Diana Wright, *Thinking in Systems: A Primer* (London: Earthscan, 2009), 2.

48 Böhm, *Against Automobility*, 3; John Schot, Remco Hoogma, and Boelie Elzen, “Strategies for Shifting Technological Systems: The Case of the Automobile System,” *Futures* 26, no. 10 (1994): 1063.

Figure 1.1 The System of Automobility in urban spaces. From the top left: Sleepy Hollow, NY; San Francisco, CA; Princeton, NJ; Newark, NJ; Arlington, VA; New York, NY; Los Angeles, CA; Las Vegas, NV; Philadelphia, PA; and Portland, OR.
Note: Photos by the author.

The images in Figure 1.1 illustrate the automobility system in typical urban streets in the United States. In each image, the automobile infrastructure is marked in red to show its overwhelming presence regardless of geography or population density, and yellow lines mark relevant conditions. Pedestrian infrastructure is always smaller and crowded with other objects of infrastructure systems. In Sleepy Hollow, New York (Picture 1), a bus stop has no infrastructural access for pedestrians. Located near a four-lane, two-way street, the stop consists of a pole and a bench on the curb of a non-existing sidewalk. Pedestrian infrastructure is not designed to consider pedestrian routes and destinations; it often lacks crosswalks and sidewalks. The lack of pedestrian and cycling infrastructure is a constant in American urban streets. In San Francisco (Picture 2), cars dominate infrastructure formally and visually; this is especially evident in the space allotted to on-street parking. Even with ample car-centric infrastructure, drivers park their vehicles on pedestrian and transit infrastructures, as seen in Princeton, New Jersey, and New York City (Pictures 3 and 6). Painted infrastructures, crosswalks, bus lanes, bike lanes, and sharrows share the road with bicycle-road markings and are ignored by car drivers. Car infrastructure has pushed all other street activities to the sidewalk, which, as mentioned above, is smaller than the roadway. Unlike car infrastructure, which is continuous and consistent in its marking, pedestrian and cycling infrastructure is not. Crosswalks are marked by two lines or zebra patterns or not at all. In Arlington, Virginia (Picture 5), a street with two driving lanes has only one completed sidewalk. There is no crosswalk marking or any other form of pedestrian infrastructure, signage, or crossing lights at an intersection with an access point to a highway ramp. Sidewalks are the central pedestrian infrastructure of urban streets and the space used to install car-infrastructure lights, signage, and traffic polls (see Pictures 4, 5, and 9). Water-management infrastructure and sewage-access points are also installed within the physical space of sidewalks. Porous surfaces taking the form of trees and grass are part of pedestrian infrastructure and rarely encroach on car infrastructure. Urban greenery is often confined to small areas, with frequently limited human access, blocked by fences, or located between roadways as a vehicular barrier. Cycling infrastructure, increasingly introduced in American urban streets since 2010, is often painted instead of permanently constructed. This allows drivers to use the bike lane as an extension of the roadway. Whether parking or standing in the bike lane, drivers put bicyclists at risk by removing them from their dedicated infrastructure into car space.

The prioritization of car infrastructure over other means of mobility is also evident with the introduction of additional transit infrastructure, like the bus lane. Painting bus lanes red has become a standard form of transit infrastructure in the United States in recent years. In New York City (Picture 6), it is hardly adequate when used as a pickup or drop-off space. As a lane that is only distinguished by its paint can be easily blocked by other vehicles. Picture 6 also shows a painted bike lane given protection by moving on-street parking toward the center of the road. A thin painted barrier acts as the protected line for the bike lane. The infrastructure is also partial: there are no bike lanes in cross streets, nor is there space for bike storage or parking. In Philadelphia (Picture 9), the bike lane is painted green, but it is not protected beyond this marking. Vehicular lanes travel adjacent to it and even cross it when making a turn. There is no bicycle infrastructure in any of these intersections.

An outcome of automobile dependency is an infrastructure system that enables drivers to disregard traffic laws and the safety of non-drivers; it also produces cultural acceptance of certain risks and of the additional distance pedestrians must walk to preserve drivers' level of service (LOS). Las Vegas Boulevard is a major thoroughfare in the Las Vegas metropolitan area. Picture 8, of the intersection of the Boulevard and East Harmon Avenue (an eleven-lane roadway with a collection of adjacent outdoor pedestrian-infrastructure spaces), shows a system of elevated pedestrian bridges, escalators, and an occasional elevator that provides people with the means to cross the street. High fences have been installed at the ground level to prevent pedestrians from attempting to cross the street. Pedestrian bridges that run above streets privilege car infrastructure over people infrastructure, allowing the car driver to maintain a continuous drive and level of service (LOS). This supposed pedestrian-oriented infrastructure is exclusive to those able to use the stairs or the escalators; an elevator requires double the process of crossing the street than the bridge, and the bridge already requires additional circulation time and walking distance for pedestrians.

The private car has been the primary means of transportation in the United States since the 1950s.[49] The object (the car) and the system (automobility) dictate the conditions of the built form. As a system, it includes the manufactured objects produced by well-known (for-profit) corporations such as Ford, GM, and Toyota. The system also includes the material and resources required to make the cars and the political and infrastructural systems that enable society to use it: in short, the industry of automobile manufacturing, oil, gas, and road construction. The term automobility also refers to the values we assign to owning or driving a car: freedom, family, career success, power, and safety.[50] The consumption of cars (buying and driving them) frequently transcends a rational choice of how to get from Point A to Point B. It is an emotional, aesthetic, and sensory (visual and auditory) response to patterns of sociability, infrastructure, and habits.[51] In American society, the car has been historically associated with the freedom to be able to go anywhere at any time and at any speed. The car is seen as the thing that allows for personal, economic, and social growth.[52]

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[49] Christopher W. Wells, *Car Country: An Environmental History* (University of Washington Press, 2012), 286.
[50] John Urry, "The System of Automobility," *Theory, Culture & Society*, 21 (2004): 25-26.
[51] Mimi Sheller, "Automotive Emotions: Feeling the Car," *Theory, Culture & Society*, 21, no. 4-5 (May 2003): 222.
[52] Alan Walks, *The Urban Political Economy and Ecology of the Automobility: Driving Cities, Driving Inequality, Driving Politics* (Routledge: New York, 2015), 9-10.

Through years of marketing and advertising by automobile manufacturers, these associations with the car have been ingrained in the collective consciousness of society.[53] Legislation also reinforces that association by continually supporting the construction of physical environments that allow for mostly unrestricted car use. For example, providing funding for roadways but not streets; maintaining roadways and not expanding pedestrian, cycling, or transit infrastructure. The world of advertisements has given the car has a level of agency separate from the driver, which has expanded well beyond the world of car commercials. The car is its own entity, capable of actions separated from the driver. [54] The language used in contemporary news reporting removes the driver from any responsibility[55] (as does the legal system), which in turn helps account for the lack of widespread public concern over the increased domination of the car over public life since the turn of the twentieth century. Media has a substantial influence on public opinion and policies, not just on what the public thinks but also on *how* people think and feel about issues.[56] So when news reports discuss crashes as occurring between a person walking and a car, not a driver inside a vehicle, it gives the car (the object) autonomy on the urban street. In contemporary media coverage, blame is often placed on pedestrians (and cyclists) as if they are responsible for being hit or run over by a driver operating a vehicle. The implication is that they do not have a place in the street. A study from the Department of Landscape Architecture and Urban Planning at Texas A&M University and the Edward J.

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[53] Sheller, "Automotive Emotions," 5.

[54] Tara Goddard, et al., "Does News Coverage of Traffic Crashes Affect Perceived Blame and Preferred Solutions? Evidence from an Experiment," *Transportation Research Interdisciplinary Perspectives* 3 (2019): 1-3.

[55] Heather Magusin, "If You Want to Get Away with Murder, Use Your Car: A Discursive Content Analysis of Pedestrian Traffic Fatalities in News Headlines ," *Earth Common Journal* 7, no. 1 (2017): 69-70.

[56] Magusin, "If You Want to Get Away with Murder," 68.

Bloustein School of Planning and Public Policy at Rutgers University found that editorial patterns significantly influence how readers assign blame for a crash. More than that, editorial patterns in reporting also shape readers' perceptions of punishment.[57] The use of active or passive voice and the words used to identify and describe a victim versus an offender carry implication about the resultant public perception. When the media identifies a victim as a pedestrian or a cyclist (rather than a person), it dehumanizes them. This is significantly emphasized if the group being affected, such as cyclists, already maintains a stigma in the eyes of the public.

In contrast, when the media discusses the victim with a narrative that humanizes them (such as discussing family and friends), it creates empathy, removes out-group bias, and makes the reader/viewer associate with them more closely.[58] In a study of Canadian news media, only three out of 71 headlines framed the act of a driver hitting and killing a pedestrian in an active voice with direct blame due to the driver's actions.[59] In 2017, faulting people walking, crossing the street, or riding a bike for being hit by a driver in a car escalated into a "distracted walking law," a policy meant to penalize pedestrians for texting while crossing the street instead of the car driver operating a 3,000 to 4,000-pound vehicle (1,360-1,814 kg).[60] In Honolulu, Hawaii, a Cross and Text Law was piloted with the support of the local police department. After three months, a period the department called an "education and warning period," citations would be given on a rising scale of

[57] Goddard et al., "Does News Coverage," 4.
[58] Magusin, "If You Want to Get Away with Murder," 70.
[59] Magusin, "If You Want to Get Away with Murder," 87.
[60] Maurie Cohen and Esther Zipori. "Distracted Pedestrians Are Not the Threat Honolulu Says They Are." *Next City*, August 15, 2017.

$15-$35 for the first offense, $35-$75 for the second, and $75-$99 for a third.[61] By November 2019, the police issued 232 citations, but pedestrian fatalities in the city did not drop. Even the notion of jaywalking is a car-manufacturing invention from the early twentieth century to counter public outrage against traffic deaths. The automobile industry needed to shift the blame from the driver to the person on the street, so they invented a Mr. J. Walker, who "stepped from the curb without looking," said a Packard Motor Car company sign in a 1922 Detroit Safety Week parade.[62]

Beyond their cultural control over the understanding of safety car manufacturing financial gains have increased dramatically since the early twentieth century. In 2019 alone, Toyota, Ford, Honda, and GM made a combined revenue of more than $710 billion, more than the gross domestic product (GDP) of Ireland and Denmark combined (Ireland's GDP was $331 billion and Denmark's $330 billion, per the United Nations). The following year, more than 281 million vehicles were registered in the United States, representing a significant rise from the 133 million cars on the road in 2004.[63] While knowledge and public awareness of the adverse effects of the car have grown in the last decade, it has done little to curb the control that automobility systems have on urban form. This is partly because the system of automobility facilitates social conditions that skews understanding

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[61] City Council and County of Honolulu Hawaii, *A Bill for an Ordinance Relating to Mobile Electronic Devices* (City Council City and County of Honolulu: City of Honolulu, Hawaii, 2017), http://www4.honolulu.gov/docushare/dsweb/Get/Document-189688/BILL006%2817%29.htm; Gordon Y.K. Pang, "Honolulu May be First U.S. City to Outlaw Texting While Crossing the Street," *The Honolulu Star-Advertiser at Governing online Archive*, July 21, 2017, https://www.governing.com/archive/tns-texting-honolulu-crosswalk.html

[62] Peter D. Norton, *Fighting Traffic: The Dawn of the Motor Age in the American City* (The MIT Press: Cambridge, MA and London, England, 2008), 77.

[63] Mathilde Charlier, "Revenue of Leading Carmakers Worldwide 2020," *Statista*, accessed October 8, 2020, https://www.statista.com/statistics/232958/revenue-of-the-leading-car-manufacturers-worldwide/; I Wagner, "Vehicles in Operations in the United States – Statistics & Facts," *Statista*, accessed October 8, 2020, https://www.statista.com/topics/4578/vehicles-in-use-in-the-us/; Mathilde Carlier, "United States Automobile Registrations from 1999 to 2019," *Statista*, accessed October 8, 2020, statista.com/statistics/192998/registered-passenger-cars-in-the-united-states-since-1975/.

of what happens on urban streets. It dominates media, local laws, and urban infrastructure. As mentioned above, automobility is also the byproduct of car infrastructure that prioritizes drivers' convenience, but ignores pedestrian safety by not, for example, installing crosswalks with traffic lights. This system of infrastructure that leads to urban development in the United States forces people to continue to use a car even if they do not want to drive. Because American cities are designed to drive from one place to another easily, places (stores, restaurants, offices) are often one-story, mostly windowless squares, with the front façade facing on-street parking. For a driver, even one living in walking distance from these places, not driving is often not an option. Narrow sidewalks or no sidewalks, missing crosswalks, and large frontal parking spaces make walking (or cycling) to the supermarket a dangerous (and unpleasant) activity.

1.2 A Utopian Perspective

A utopian perspective adopts a methodology that each future vision assumes a step toward utopia that in real world terms means maximizing sustainability. This is an idea elaborated on by sociologist Erik Olin Wright emancipatory social science, a heuristic informed by critical realism and social theory research on which future alternatives can move society toward achieving sustainability.[64] Sustainability that is defined as a framework to achieve human flourishing—the ways people can develop and exercise their talents, capacities, or any other identity, to realize their potential.[65] It is an idea that embraces equal access and opportunity in the same way that contemporary definitions of sustainability do.[66]

[64] Erik Olin Wright, *Envisioning Real Utopias* (Verso, 2010), 11-12.
[65] Wright, *Envisioning Real Utopias*, 13.
[66] David Harnesk and Ellinor Isgren, "Sustainability as a Real Utopia-Heuristics for Transformative Sustainability Research," *Environment and Planning E: Nature and Space*, Vol 5, no 3 (2022): 1678-1679.

The history of future studies has its roots in the relationship between sociology and utopia. Since the nineteenth century, the origins of sociology, socialism, and utopia have been intertwined: from Auguste Compte (1798-1857), who coined the word "sociology," along with utopian socialist Henri de Saint-Simon (1760-1825) and Herbert Spencer (1820-1903), who are credited as the discipline's founders. Describing sociology-as-utopian is to assert that it contains ideas of a good society.[67] A good society in public discourse is often referred to as a utopia, a word that is synonymous with the quest for perfection. But as Loretta Lees argued, utopian thinking is not just the articulation of the ideal; it is the diagnosis of present problems usually with some sort of implicit means to achieve the utopian ideal.[68]

Utopia is a Latin pun conflating *utopos* or no place and *eutopos* or good place. In contemporary English use of the term, "utopia" describes a variety of circumstances and conditions. Utopia may be a society, a place, a state of mind, or a method. It is often regarded as a manifestation of a desire for and model of a better way of life.[69] In contemporary culture, utopia is often perceived as an imagined perfect society or a wishfully constructed place that does not and cannot exist.[70] This is, in part, related to the origins of the term attributed to Thomas More's *Utopia* (1516), a story of a fictional community where ownership of private property or the accumulation of wealth is forbidden. More's community was steeped with Christian values and an authoritarian ethos. For example, while women are given the same education as men and work lasts no

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[67] Ruth Levitas, *Utopia as Method: The Imaginary Reconstitution of Society* (Houndmills, Basingstoke, Hampshire: Palgrave Macmillan, 2013), 67.
[68] Loretta Lees, *The Emancipatory City? Paradoxes and Possibilities* (London, Thousand Oaks, CA: Sage Publications, 2004), 15.
[69] Levitas, "*Utopia as Method*, 16-17.
[70] Levitas, *Utopia as Method*, 3.

more than six hours a day, the culture is homogenous and controlled by strict rules.[71] More's utopia was not perfect by modern standards, but it was a narrative crafted to oppose the feudalism and extreme poverty of the sixteenth century. It offered a view on social and environmental conditions set in a modern urban place. Many of the utopias and dystopias that followed continued to explore the relationship between utopia and urban places. Utopia, or utopian, is an expression of a *desire* for a better way of being and living. Utopias do not require an imaginative construction of an entire world; they can be isolated elements, part of the wide range of human creation.[72] They entail a constitutive understanding of ourselves and our present political and civic arrangement. Utopia's general character offers alternative possibilities to the existing reality.[73]

This study takes a descriptive definition of utopia, in which it can be fragmented and elusive. These fragmented utopias (alternative mobilities) focus on the urban street and how we move through it or use it, and they include public, private, for-profit and not-for-profit authors. They are temporary or permanent, imaginary, and built. They are digital (apps), local, and spontaneous. The process of thinking and anticipating the future has been part of societies and organizations since before the nineteenth century.[74] Anticipating the future provides coherence and direction to planning and development processes. Studying the future can illuminate policy choices, identification, and evaluation of alternative actions;[75] therefore, real utopias and sustainable development are connected. When using the term sustainability, I mean it as a response to the climate crisis.

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[71] Donna Goodman, *A History of the Future* (New York: The Monacelli Press, 2008), 15-16.
[72] Levitas, *Utopia as Method* 5.
[73] Levitas, *Utopia as Method*, 9.
[74] John Urry, *What Is the Future?* (Cambridge, UK: Polity Press, 2016), 18-20.
[75] Jerome C. Glenn, "Futures Research Methodology," in *The 10th Federal Forecasters Conference -1999 Papers and Proceedings,* ed. Debra E. Gerald (Washington, DC: Bureau of Labor Statistics, June 1999), 194.

The United Nations Sustainable Development Goals (SDGs) offer a global framework to respond to the climate crisis. Unlike traditional sustainability measures focused on carbon output, the SDGs cover standards of living including access to food, equity within communities and among nations, and access to self-fulfillment and the ability to flourish.[76] The goals present routes of prospective sustainable transitions balancing the need to reduce both global emissions on the unequal standards of living around the world. The goals are not perfect, but they provide a broader understanding of the sustainability of a place that offers access to what Erik Olin Wright describes as the basic resources needed to make life choices for prosperity.[77]

The scenarios I am looking to identify in this study are not scenarios that plan the future, nor do they produce a complete or accurate description of the future. Rather, I am documenting scenarios that reflect a moment (between 2017 to 2020), a snapshot of a specific culture, belief, technology, and governance.[78] These scenarios then can be viewed as the optics and tuning instruments for the possible future organization and use of the urban street.

1.3 Summary

The following chapters of this dissertation discuss the conditions of the urban street. In Chapter 2, I outline the policies and design practices that guide the development of the urban street. I explain the multidimensional role the urban street has in cities and its

[76] United Nations, Department of Economic and Social Affairs, Sustainable Development, The 17 Goals, https://sdgs.un.org/goals, accessed November 27, 2022.
[77] Wright, *Envisioning Real Utopias* , 18-19.
[78] Keller Easterling, "Going Wrong," *e-flux*, December 2019, https://www.e-flux.com/architecture/collectivity/304220/going-wrong/

relationship to societal development. I make an argument that the importance of the urban street lays in its influence on the safety and well-being of people.

Chapter 3 is an overview of the contemporary elements in the urban street in the twenty-first century. It is organized into four elements relevant for the understanding of the contemporary urban street: the shifting nature of companies that operate within the urban street, technological elements, elements of service, and elements of urban (physical) intervention, pedestrianization, bicycification, the red bus lane, and curbs.

Chapter 4 lays out the dissertation design including data-collection, how the COVID-19 interrupted the data collection and the scenario selection and data-analysis process. The analysis of the scenarios follows an interdisciplinarity framework to measure sustainable urban conditions in terms of their safety, comfort, and levels of delight. I briefly consider the research-design limitation as a study of an in-process transition and within a field (sustainable development) that is still being defined (and quantified).

Chapter 5 introduces the twelve visions I selected for in-depth analysis. The scenarios are organized through a framework of types and categories intended to convey the diverse nature of elements used to influence the future of the urban street, physical urban interventions, temporary events, services, and objects. Each scenario is measured using the lenses of safety, comfort, and delight and given a score reflecting the vision of sustainable development.

I conclude, in Chapter 6, with a debate on the factors hindering the wider spread of sustainable urban street development in the United States.

CHAPTER 2

THE URBAN STREET

The Merriam-Webster Dictionary defines the street as "a throughfare especially in a city, town, or village that is wider than an alley or lane and that usually includes sidewalks," but it is also "the part of a street reserved for vehicles" or "a thoroughfare with abutting property."[1] The street, in most contemporary planning and organization, is often confused with the roadway. It is easy to forget that the purpose of the street is much more than just providing travel space for automobiles.

The street is an invention believed to have been first built in 600 B.C.E. at Khirokitia (Cyprus). Constructed from limestone and raised above the ground level, it included ramps at regular intervals leading to houses alongside it. Before streets, pedestrian movement occurred on the roofs of buildings or through collections of courtyards.[2] Street infrastructure development since then has gone from dirt to gravel to pavement to asphalt. As an institution, the street is a product of societal actions in space that have changed in the past and will continue to change in the future. Despite how essential they are to movement and maintaining contemporary society, streets are often overlooked as public spaces, reserved for other spaces designated as a park or a courtyard. In North America, streets are perceived as roadways and rarely, since the rise of automobility, as places of community.

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[1] "Street," Merriam-Webster, accessed March 16, 2021, https://www.merriam-webster.com/dictionary/street.
[2] Spiro Kostof, *The City Assembled: The Elements of Urban Form through History* (Boston: Little, Brown, 1992), 190.

The word “street” summons up many common and uncommon images. The most common image is as a thruway for vehicular traffic; among the least common is it being transformed into a sitting area. A street, as a place, is a noun; but it can be used to form an adjective: a person who is “streetsmart” is someone who understands the complex and unexpected city. The street is a space for public life, a place that connects homes with parks, plazas, offices, stores, and restaurants. The street is also a complex network of infrastructure systems serving multiple users moving in various ways at different speeds above and below ground. The street provides the primary infrastructure for utilities and services while also allowing for the movement and access of people to places. It can also become a stage for parades, protest demonstrations, or governmental and military power. The street is a space of social circulation, the stage of society’s constant movements and interactions. It is what social theorist Henri Lefebvre calls the “representation of space” and the “space of representation.”[3]

The street is a place to express power. Those who control the street use it to impose their social and political beliefs.[4] In prioritizing American urban streets, this is expressed through the supremacy of the private car on street design and use as a roadway first, and a common space last. *Streets* as a vocabulary term (morphology) encompasses different types of streets, usually indicating a difference in scale and/or uses or users. While the definition of streets might vary from city to city based on local needs, overall classification systems are consistent across jurisdictions.[5] For example, an avenue could be commercial;

[3] Henri Lefebvre, “The Right to the City,” in *Writing on Cities: Henri Lefebvre*, eds. Eleonore Kofman and Elizabeth Lebas (Blackwell Publishers, 1996), 155.
[4] Vikas Mehta, *The Street: A Quintessential Social Public Space* (London and New York: Routledge, 2013), 12.
[5] Joan Busquets, *Urban Grids: Handbook for Regular City Design*, ed. Dingliang Yang and Michael Keller (San Francisco: ORO Editions, 2019), 37.

a boulevard can be industrial, and a street might be residential, but all three types are still streets. Other distinctions stem from the matter of legal ownership: arterial streets in the United States are often controlled by the municipal government, but they can also be owned by state or federal agencies. Some streets owned by states are not considered streets, but rather thruways or highways. In Princeton, New Jersey, for example, Stockton Street, which runs between Princeton University and the town (turning into Nassau Street), is one of the municipality's main commercial corridors. But the street is also Route 206, a state-owned road. There is a legal ramification in the United States when a city street is also a state road since the state rather than the local government regulates and maintains it.

The street is a means of access to buildings, parks, and plazas. It is a path of circulation as well as a space of occupation. The street is, in short, a public space, a shared good (or commons) that individual actors may access and use freely.[6] The public urban street is public because it is a free commodity. While variations of payments for the street do exist—taxes on gas and vehicle sales, tolls, parking, and increasingly, in some places, congestion pricing—those charges are placed on vehicles not people; it is the access and use of the *vehicle* that has a cost.

Architectural historian Spiro Kostof described the street as the thing that structures community: "It puts on display the working of the city and supplies a backdrop for its common rituals."[7] From this, we can conceptualize public space in the city as a single continuous system. Streets, parks, squares, plazas, and crosswalks form a non-hegemonic

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[6] David Crouch, "The Street in the Making of Popular Geographical Knowledge," in *Images of the Street: Planning, Identity and Control in Public Space*, ed. Nicholas R. Fyfe (London and New York: Routledge, 1998), 163.

[7] Spiro Kostof, *The City Assembled: The Elements of Urban Form through History* (Boston: Little, Brown, 1992), 194.

and contiguous urban public space. The ecology of streets—the totality of the relations between the various parts and users—is what distinguishes the differences between them. A street with two 12-foot, 25 miles per hour driving lanes and two 12-foot parking lanes, with 3-foot-wide sidewalks on either side, is an urban street; so is a street with no vehicular travel lanes and a single paved surface restricted to pedestrians and cyclists. The scales of the streets are different, and their various parts are differently configured, but their existence within the city fabric renders them equal to urban streets.

Throughout history, the street has fulfilled the role of public space like no other spatial typology. People depend on streets for their daily functional, social, and leisure activities.[8] The evolution of the street's social role reflects the city's changing state and society itself, because the space of the street expresses society.[9] The urban street is not a static space but a place of constant movement and connections. In the early twentieth century, street maintenance (smoothness of surface and cleanliness) in American cities was not the authorities' responsibility but the owners and residents of the street's buildings. As local and regional governmental authorities took over street management in the 1930s, city officials and engineers in the United States remade the urban street according to their preferences and priorities. Sidewalks are still the owners' responsibility in most urban places in the country, but the roadway has become the government's responsibility. The urban street is no longer the spatial extension of the residents and users but a space

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[8] Mehta, *The Street*, 32.

[9] Manuel Castells, "Space of Flows, Space of Places: Materials for a Theory of Urbanism in the Information Age," in *Comparative Planning Cultures*, ed. Sanyal Bishwapriya (London: Taylor and Francis, 2012), 57.

servicing a larger number of people coming from further away.[10] By the turn of the twenty-first century, the urban street had been the domain of the automobile for almost 100 years.

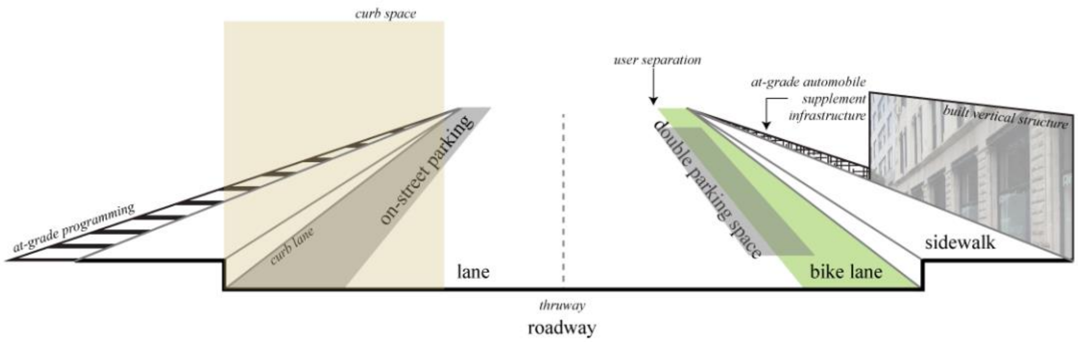

Figure 2.1 Infrastructure elements and spatial distribution of the urban street.
Note: Drawn by the author.

The roadway now dominates street design, encouraging the use of the street as a road. Typical one-way streets often consist of two on-street parking lanes, creating a three-lane route within local residential streets. While sidewalks remain pedestrians' domain, they also serve as a space for other logistical systems and users. Examples include mail infrastructure of multiple entities and various utility holes to provide access to other infrastructural systems co-existing with bus stops, newspaper stands, street signage, trees (or flower beds), and vendors. Figure 2.1 shows the spaces of a typical street, often framed by buildings but also at-grade programming such as parks or plazas. There is also at-grade flat programming in support of automobile infrastructures such as surface-parking lots and automobile repair shops. The roadway, often the center of the street, is framed by sidewalks that share a space with the curb. The curb is often a space for car storage or painted bike lanes. This curb space spills into the sidewalk and the road, as they are rarely formally organized (they are only painted). Just as the sidewalk overflows into the curb but with

[10] Christopher W. Wells, *Car Country: An Environmental History* (University of Washington Press, 2012), 125-127.

very different consequences, drivers often use the space between the bike lane and the roadway as a temporary parking space putting cyclists at risk.

In the United States, street development and design since the turn of the twenty-first century increasingly focused on multiple users, beyond drivers of privately-owned vehicles. Before that, composition of streets focused on their roadway function for driver convenience. For example, most American streets are arranged for a level of service (LOS) measured by traffic flow at an intersection or travel lane, meaning quantifying the delay experienced by drivers. From A (least delay) through F (most delay), the scale is mono-model and measures a street not by social or economic value, but by its ability to process vehicles.[11]

The street is a collection of spaces: sidewalk, storefront, curb, and roadway, each with its own spatial conditions, users, and typologies. These spaces can shift and change in alternative mobilities as part of a desire to improve a known urban problem, such as a street where drivers often speed or a community demand for more open space. In fact, many alternative mobilities present themselves as solutions to specific issues. For example, autonomous vehicles (AVs) are often proposed as a safety solution, bicycle systems as ways to improve public health, or holistic city-wide visions are meant to resolve climate crisis-related issues like rising water and air pollution.

The street is a networked infrastructure system that plays a vital role in developing a city's physical and social formation. It is an ever-changing space allowing for a complex reshaping of society. As a networked infrastructure system, the street facilitates cultural, economic, and environmental change. It creates a dynamic relationship between various

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[11] "Urban Street Design Guide: Performance Measures," *NACTO*, accessed March 16, 2021, https://nacto.org/publication/urban-street-design-guide/design-controls/performance-measures/.

urban elements, objects, and actors. Streets are a significant portion (between 30-50%) of the physical fabric of cities. As such, they are a fundamental part of cities' economic and social fabric, helping to structure the experience of both residents and visitors.[12] The street embodies the day-to-day life of society at a particular moment in time.

Affordable housing, access to food, clean water, heating, mobility services, education, and other vital necessities are all fighting for limited space on the streets of existing and developing cities. In the United States, most of the urban street surface is the domain of the private vehicle. It is presented as a thruway, not a public space for multiple users. But in the last two decades, questions of what and who the street is for have increased, partially through the emergence of alternative mobilities. Because alternative mobilities respond to different parts of the street, it is important to understand the street's elements first.

The rest of this chapter discusses the contemporary American urban street's physical elements, contemporary users, and uses in the last two decades (Section 2.1). It is followed by a discussion of the rules and policies that create (and maintain) the contemporary American urban street (Section 2.2). Lastly, this chapter discusses the role of the urban street within the network that is urban development (cities); here, it is not just a space, but an area that is part of many networks of socio-technological systems responsible for the well-being and safety of people.

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[12] Stephen Graham and Marvin Simon, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition* (London and New York: Routledge, 2001), 11-12.

2.1 The American Urban Street

The transition of the American urban street from a semi-public space to a thruway was filled with death, political fights, and large-scale marketing. Before the mass production of automobiles, streets in American cities were relatively safe from existing traffic. By the 1920s, more than 200,000 people had died due to vehicle accidents, caused mainly by drivers in private automobiles.[13] Drivers were initially held accountable for any injury or death caused to pedestrians, and speed was seen as the main danger.[14] But this perception of driver responsibility was overtaken by traffic-regulation reform and increased use of private cars. Road standards (materiality and width), the introduction of crosswalks, traffic lights, and parking regulations remade the street and the built form around it. Sociologist Manuel Castells writes that "spatial transformation is a fundamental dimension of the overall process of structure change."[15] He bases his argument on observations of the spatial trends of the 21st century and the premise that space expresses (rather than reflects). The street of the late 21st century expressed American society's priorities through its redesign.[16] From the 1930s onward, traffic engineers designing the system determined the dimensions of the roadways, the turning radius of the driveways and with it the hierarchy of tertiary, secondary, and minor streets.[17]

By the 1970s, American urban streets were surrounded by spaces accommodating individual movement with privately-owned car. Ramps, overpasses, and expressways in

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[13] Peter D. Norton, *Fighting Traffic: The Dawn of the Motor Age in the American City* (The MIT Press: Cambridge, Massachusetts, 2008), 21.
[14] Norton, *Fighting Traffic*, 30-31.
[15] Castells, "Space of Flows," 45.
[16] Stephen Graham and Marvin Simon, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition* (London and New York: Routledge, 2001), 66.
[17] Keller Easterling, "Differential Highways," in *Organization Space: Landscape, Highways and Houses in America* (Cambridge, Massachusetts and London, England: The MIT Press, 1999), 75-76.

service of people in private cars (and other vehicles) became part of urban streets as highways were built through existing neighborhoods.[18] While there were always variations in how the street elements come together, there was a consistent automobile form. It was an asphalted landscape produced for the efficient storage and movement of private automobiles. The dimensions and visual experience of the street were—and continue to be—dominated by parked and in-motion vehicles.

In 2013, Strong Towns, a non-profit organization advocating for fiscally resilient design, coined the term “stroad” (street + road), a word meant to express the multi-lane thoroughfares (at grade) that are common in almost every American city or suburb. Also referred to as an urban highway, these stroads are urban streets, used by drivers as means of efficient travel, and by pedestrians and cyclists as their public day-to-day space. These are streets dominated by their roads. It is not just their circulation space; it is also their space of daily experiences. For drivers, it is only a circulation and storage space. This clash of occupancy is evident in terms of visual and physical experiential use of the space as well as the number of fatalities and injuries in American cities. On average, one pedestrian was injured every 7 minutes, and another killed every 85 minutes on American streets in 2019.[19]

To summarize, the contemporary American urban street is car-based. No matter what kind of urban built form one lives in, suburb or city, no matter its size, once you leave your home you are surrounded by cars and their infrastructure. The street, if you are a car owner living in a big city, is often the place in which you store your vehicle. For those who do not own a car, the street is limited to the sidewalk and crosswalks with little claim to

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[18] Mimi Sheller and John Urry, “The City and the Car,” *International Journal of Urban and Regional Research* 24 (December 2000): 740.
[19] National Highway Traffic Safety Administration, *Traffic Safety Facts* (U.S Department of Transportation, May 2021), 1.

the curb. Temporary or long-term car storage is the visual backdrop of reality with the streetscape being dominated by on-street parking and the roadway. The sidewalk becomes the part of the street serving as the only space available for pedestrians and amenities. Facilities like trees, café seating, bike parking, and mailboxes all occupy the same limited space. Alternative mobilities each address a different part of the street or a collection of elements of the street. Some of them have even evolved as a response to current street conditions.

2.2 The Design of the American Urban Street

Between 2010 and 2019, cities across the United States added more than 28,500 new lane-miles of roadway compared to 1,200 new miles of transit service.[20] Half of the added transit was bus lanes, with the rest taking the form of extended rail lines. In 2016, the average car-owning American spent about $7,427 on automobile transportation.[21] Boston University's Menino Survey is distributed to mayors of American cities with populations of more than 75,000 residents, asking for their insights and perspectives on infrastructure, mobility, and public safety. Since the survey began in 2014, roads have topped the list of infrastructure priorities, with 66% citing roads as the area they would prioritize with new funds. Only 11% identified climate change as a significant issue. There are no "streets" in the 2019 Menino Survey, only roads. Indicating a lack of attention to the street as a multi-purposed

[20]Yonah Freemark, "Transit investments 2010-2019 US and Canada," Google Sheet, accessed March 17, 2021, https://docs.google.com/spreadsheets/d/12Hx1p1VbAiAu9Yf6OOuychofOUUF7aYKEi5CnaesaAw/edit#gid=0

[21] Yonah Freemark, "Too little, too late? A Decade of Transit Investment in the United States," *The Transport Politic*, January 7, 2020, https://www.thetransportpolitic.com/2020/01/07/too-little-too-late-a-decade-of-transit-investment-in-the-u-s/.

space facilitating much more than vehicular circulation. The only mention of streets appears in the form of a discussion about on-street parking: over 75% thought residential street parking was priced and distributed correctly within the urban form.[22] There was no recognition of the misallocation of public space as a space dominated by cars, in motion and stationery.

The issue of street vs. road misunderstanding stems also from how the United States Department of Transportation (USDOT) organizes modes of transportation (aviation, maritime, pipelines, railroads, transit, and roadways). Various federal entities manage those modes of transportation through a dedicated entity; the Federal Highway Administration (FHWA), the National Highway Traffic Safety Administration (NHTSA), and the Federal Motor Carrier Safety Administration (FMCSA). Biking and walking (meaning cycling and pedestrian infrastructure) are under the authority of the FHWA. Created in 1966, the FHWA grew out of the Office of Road Inquiry, founded in 1893. FHWA's mission is to "enable and empower the strengthening of the world-class highway system that promotes safety, mobility, and economic growth, while enhancing the quality of life of all Americans."[23] The FHWA is not solely in charge of the American highway systems, but it does take precedence in its work when it comes to funding, design, construction, operations, and research.

For the last 80 years, American streets have been designed principally using *A Policy on Geometric Design of Highways and Streets* (known as "the green book"), published by the American Association of State Highway and Transportation Officials

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[22] Initiative on Cities, *Menino Survey of Mayors 2019 Results* (Boston University, 2019), 15.
[23] United States Department of Transportation, "About," Federal Highway Administration, accessed January 13, 2021, https://www.fhwa.dot.gov/about/.

(AASHOT), and the federal *Manual on Uniform Traffic Control Devices* (*MUTCD*). The *MUTCD*, administrated by the FHWA since 1971,[24] defines the minimum standards used by road engineers and managers across the country and is the design reference for every street in the United States. The manual includes detailed design and construction instructions for the installation of traffic control, road marking, and traffic devices on public streets (as well as highways). States use the *MUTCD* to develop their own manuals, including the relevant information for their infrastructural context. Whenever a new edition or revision of the *MUTCD* is issued, states have two years to adopt it.

First published in 1935, the *MUTCD* standardized the growing list of traffic-control devices used across the United States to manage vehicular movement. Early revisions included the introduction of speed signs, pavement marking, and pedestrian signals. By 1954, the most significant changes to the manual had to do with development of new fade-resistant finishes and the introduction of guide signs. This kind of small change to the *MUTCD* has continued every few years, but they are always focused on driver experiences. The last time the *MUTCD* was updated (in 2009), many urban innovations and practices that focus on making safer spaces for pedestrians and cyclists were not included.

MUTCD prioritizes driving based on a 1930s speed-design standard for vehicle speed.[25] Known as the 85th percentile approach, this standard uses the speed at which the 85% of traffic is moving. According to the FHWA, this “yields the lowest crash risk for

[24] The MUTCD was adopted in accordance with title 23, U.S. Code, Section 109(d) and Title 23, Code of Federal Regulations, Part 655.603, and was approved as the national standard for designing, applying, and planning traffic control devices.
[25] Offer Grembek et al, “History of Speed and the 85th Percentile Rule in Research Synthesis for the California Zero Traffic Fatalities Task Force,” *UC Office of the President: University of California Institute of Transportation Studies* (April 2020): 35-36.

drivers;"[26] Pedestrians are not part of the equation. FHWA also defers to the "collective judgment of the vast majority of drivers as to a reasonable speed for given traffic and roadway conditions" and further notes that "setting a speed limit 5 mph (8 km/h) above the 85th percentile speed will likely make few additional drivers legal."[27] FHWA also claims that speed limits lower than the 85th percentile speed do not encourage drivers to comply with the posted speed limits.[28] The 85th percentile idea is based on the concept that higher speeds will reduce the number of people breaking the law because at higher speeds drivers perceived themselves safer. If speed limits were set above or below this percentage, unsafe conditions will be created because some drivers will adhere to the legal speed, and some will drive at a "naturally-induced speed."[29] While residential streets and school zones may be limited to 15-20 mph, they are often connected to higher-speed streets, resulting in overall urban speeding. Vehicle speed as a determinant of street design has resulted in wider urban roadways since the 1930s.[30] *MUTCD* places multiple geomatic design restrictions that maintain its 85th percentile mandate through built-in limitation and restrictions for bus systems, bicycle, and pedestrian infrastructure.

In 1979, the FHWA updated the process for making *MUTCD* changes so that now, before any revision is accepted, it needs to go through a two-step Federal Register rulemaking process in which the public is given the opportunity to comment. The final rule for FHWA to make any changes to the *MUTCD* can include adopting a proposed change, deferring the proposed change pending further research, or adopting a modification to a

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[26] Gerald J. Forbes et al., *Methods and Practices for Setting Speed Limits: An Informational Report* (Federal Highway Administration: Institute of Transportation Engineers, 2012), 12.
[27] Forbes et al., *Methods and Practices*, 12.
[28] Forbes et al., *Methods and Practices*, 13.
[29] Charles Marohn, "Understanding the 85th Percentile Speed," Strong Towns, last modified July 27, 2020, https://www.strongtowns.org/journal/2020/7/24/understanding-the-85th-percentile-speed.
[30] Wells, *Car Country*, 199.

proposed change based on public comments and additional information. Written requests for changes to the *MUTCD* can also be submitted by email or written letter.[31] This has made the *MUTCD* accessible to a larger pool of people commenting on its design policies. Now, the public (the people who use the street) comment on the proposed guidelines. Experts who concern themselves with the street and consequences from how the street is used—including health professionals, planners and designers, and safety advocates—have easier access to comment as well. Overall, this expands the scope of consideration for any new *MUTCD* changes.

In 2021, the FHWA was accepting comments for the 11th edition of the *MUTCD*. Several organizations—including the National Association of Transportation Officials (NACTO), Transportation for America, and America Walks—have collaborated to call on the current administration to rewrite and reframe the manual as a "proactive safety regulation" that ensures "safety, sustainability and equity" for all roadway users.[32] The campaign asked the public to submit comments (including letter templates) supporting a collection of projects having to do with traffic-control devices and barriers put in place, common contemporary pedestrian/cyclist design practices.[33] For example, under the proposed *MUTCD*, rainbow, or any colorful crosswalks, will not be compliant with FHWA guidelines.[34] The practice of making crosswalks and intersections colorful was introduced in the United States during the early 2000s as a way to make space more pedestrian

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[31] Manual on Uniform Traffic Control Devices, "Amendment Process," Federal Highway Administration, accessed January 1, 2021. https://mutcd.fhwa.dot.gov/kno_amend.htm.
[32] NACTO Executive Board, "Re: Detailed comments to restructure the MUTCD as a proactive safety regulation," letter to Stephanie Pollack, May 14, 2021.
[33] Transportation for America, "Month of Action Week 4: A Manual for Safer Streets," *Transportation for America*, last modified 23 March 2021. https://t4america.org/2021/03/23/month-of-action-week-4-a-manual-for-safer-streets/.
[34] Vince DiMiceli, "Feds Keep Cracking Down on Crosswalk Art," *Streetblog USA*, last modified September 30, 2019. https://usa.streetsblog.org/2019/09/30/feds-keep-cracking-down-on-crosswalk-art/.

friendly. It is a small intervention that assumes a certain vision for the urban street, but it is being blocked due to a different vision of what the street is supposed to be.

There are many *MUTCD* requirements and barriers to non-car mobility design. Don Kostelec, AICP, a 17-year professional in transportation planning, has shared his experience with *MUTCD* and its consequences for pedestrian safety. He writes about an attempt to install a pedestrian crossing in Garden City, Idaho in a low-income neighborhood. The local convenience store, the only food store in the area, is located across a five-lane arterial lacking a pedestrian crosswalk or signals. According to Kostelec, "The agencies applied the *MUTCD* 'warrant' of needing 20 pedestrians to risk their lives in an hour to justify the signal. The final count they came up with was 18 pedestrians. Another five people from this same neighborhood were seen driving across this intersection to access the store. Those five people could have chosen to walk had there been a signal here, but these highway agencies refused to count those trips as likely pedestrian trips. The signal was denied."[35] This makes it riskier for people to stroll down the street and forces them to make unsustainable decisions like driving instead of walking.

In 2015, the United States Congress passed a five-year $305 billion federal transportation bill, the Fixing America's Surface Transportation (FAST) Act. The law made NACTO's Urban Guide a standard that is permitted for local DOT roadway designs.[36] This opened the door for municipalities to utilize NACTO's host of guides including the *Urban Bikeway Design Guide* more freely, and *Transit Street Design Guide*

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[35] Don Kostelec, "How the MUTCD Creates Unsafe Conditions for People Just Trying to Access Food," *America Walks*, last modified March 29, 2021. https://americawalks.org/how-the-mutcd-creates-unsafe-conditions-for-people-trying-to-access-food/.

[36] Smart Growth America, "Safe Streets Provisions in FAST Act Represent a Huge Step Forward in the Effort to Strengthen Local Communities," *Smart Growth America*, last modified December 4, 2015, https://smartgrowthamerica.org/safe-streets-provisions-in-fast-act-represent-a-huge-step-forward-in-the-effort-to-strengthen-local-communities/.

instead of the *MUTCD*. Unlike the FHWA guidelines, NACTO details its guides with illustrated urban examples and quick, low-cost solutions that can be tested and improved over time in accordance with local conditions. Its guides are specifically designed for an urban context (rather than interstate and highway) and include design strategies for cities that embrace a safe system approach. The safe system focuses on preventing human error on roadways instead of accommodating it.[37]

Current street design, reflected in the actual physical condition of the urban street, has been correlated with poor community-health outcomes (physical and mental) and increasing pedestrian and cyclist fatalities. But the street is more than static infrastructure. It is also a space of movement, of both people and goods, visible and invisible.

2.3 The Roles of Urban Streets

According to *World Population Prospects 2019*, the global population is growing, although the rate of increase has slowed since 2010. The report, issued by the UN Department of Economic and Social Affairs, highlights increasing longevity and an unprecedented aging population. It also projects over one billion additional people between 2019 and 2050, with more than half of them living in only nine countries: Democratic Republic of Congo, Egypt, Ethiopia, India, Indonesia, Nigeria, Pakistan, United Republic of Tanzania, and the United States.[38] By 2050, urban areas are expected to absorb almost all world population growth. In 2018, more than half of the world's population already lived in urban areas; by 2050, that number is expected to be closer to 70%. There were about 48 cities with

[37] Liisa Ecola, et al., *The Road to Zero Executive Summary: A Vision for Achieving Zero Roadway Deaths by 2050* (Rand Corporation: National Safety Council, 2018), 7.
[38] United Nations Department of Economic and Social Affairs, "World Population Prospects 2019: Highlights" (New York, United Nations, 2019), 12.

populations of 5-10 million people worldwide in 2018. In 2030, 66 cities are projected to reach that level of population; 597 more will have between 1 and 5 million people, and the population of 710 more will reach 500,000 to one million. By 2030, there will be approximately 43 megacities, places with more than 10 million inhabitants. By 2100, the world population will be at 11.2 billion people.[39] For all of these individuals, the urban street will continue to be a vital connection.

Moments in human history can be measured by the social and political consequences of times of crises. According to the Merriam-Webster dictionary, a crisis is a turning point for better or worse. It is an emotionally significant event or a radical change that includes pain and distress. It is an unstable time in which a decisive change is impending.[40] Globally, we face the most significant crisis that humanity has ever faced: the climate crisis. This crisis has produced multiple environmental events (floods, fires, storms), and health crises which in turn make the risk of pandemics higher.[41] The street during any of these crises acts as a place of refuge (a way out) and the space of the crisis itself. Urban streets lack of porous surface can exacerbate a crisis during storms or floods. But more than that, the way the street is designed and used results in the very human activities that have aggravated climate change.[42]

The climate crisis is unlike anything humanity has previously faced in scale or severity. It is a crisis with consequences for every aspect of human and non-human life on Earth. Per the United Nations Intergovernmental Panel on Climate Change (IPCC), human

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39 United Nations Department of Economic and Social Affairs, "The World's Cities in 2018—Data Booklet" (United Nations, 2018), 2.

40 "Crisis," Merriam-Webster, accessed June 4th, 2021, https://www.merriam-webster.com/dictionary/crisis.

41 Georgetown University Medical Center, "Climate Change Could Spark the Next Pandemic, New Study Finds," *ScienceDaily*, 28 April 2022, www.sciencedaily.com/releases/2022/04/220428085820.htm.

42 Intergovernmental Panel on Climate Change, *Summary for Policymakers* (WHO and UNEP: Incheon, Republic of Korea, 2018), 4-5.

activities have caused an increase in global temperatures, with a likely range in excess of 1.5°C between 2030 and 2052.[43] There is a robust difference in regional climate characteristics between present-day and global warming of 1.5°C and what it means to urban life. How the warming is experienced in urban life depends on geographical location and existing infrastructure conditions. Droughts, increases in the number of yearly hot days, rising sea levels, floods, and fires are only some of the consequences of the climate crisis. Since it began measuring climate disasters in 1980, the National Center for Environmental Information identified 298 weather and climate disasters with overall damages and costs that exceeded $1 billion per event. These events (flooding, storms, and wildfire) have cost more than $1.975 trillion in the United States alone. Between 2010 and 2019, more than 5,224 people died in 123 climate events; 2020 broke all previous records with 22 separate events.[44]

A considerable contribution to the climate crisis is greenhouse gas emissions (GHGs), which trap heat and make the planet warmer. In the United States, transportation is directly responsible for 29% of GHGs.[45] The largest source of transportation related GHGs, accounting for more than half of the emissions from the transportation sector, comes from passenger cars and light, medium, and heavy-duty trucks, including pickup trucks and minivans.[46]

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[43] Intergovernmental Panel on Climate Change, *Summary for Policymakers*, 4.
[44] National Centers for Environmental Information, "United States Billion-Dollar Weather and Climate Disasters," National Oceanic and Atmospheric Administration, last updated April 8, 2022, https://www.ncdc.noaa.gov/billions/.
[45] Environmental Protection Agency. "Sources of Greenhouse Gas Emissions," United States Federal Government, accessed March 19, 2022, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.
[46] Environmental Protection Agency. "Transportation Sector Emissions," United States Federal Government, accessed March 19, 2022, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#transportation.

The American urban street is designed to maintain a high level of vehicular traffic continuously contributing the growing GHG emissions. Cars also produce non-exhaust particle emissions generated by the wear-and-tear of brakes and tires on the road. Epidemiological studies have established that exposure to these non-exhaust particulate matter emissions is associated with adverse health outcomes, including cardiovascular illness, respiratory illness, and overall mortality risk. Non-exhaust emissions are produced by internal combustion engine vehicles and electric vehicles and are completely unregulated.[47] The 2019 Pollution and Health Metrics by the Global Alliance on Health and Pollution places the United States at number seven, with more than 107,507 air pollution-related premature deaths.[48]

Beyond the climate crisis, the urban street in the Unites States is undergoing a crisis of pedestrian fatalities and increasing cyclist injuries. In 2015, about 5,977 pedestrians were killed by drivers on American streets: a death every 88 minutes. One of every five of those deaths is a child under fifteen.[49] Overall, in 2020, a year marked by a significant reduction in traffic during the early stages of the COVID-19 crisis, yet 27 states had increases in pedestrian fatalities from the year before. Overall, since 2010, pedestrian

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[47] Organization for Economic Cooperation and Development, "NON-exhaust Particulate Emissions from Road Transport An Ignored Environmental Policy Challenge: Executive Summary," OECD Publishing, December 7, 2020, https://www.oecd.org/environment/non-exhaust-particulate-emissions-from-road-transport-4a4dc6ca-en.htm.

[48] Global Alliance on Health and Pollution, *Pollution and Health Metrics: Global Regional, and Country Analysis* (GAHP online: Global Alliance on Health and Pollution, December 2019), 24, 49.

[49] Center for Disease Control and Prevention, "Transportation Safety," Injury Center Transportation Safety, accessed March 19, 2022, https://www.cdc.gov/transportationsafety/pedestrian_safety/index.html.

fatalities have risen almost every year in the United States, amounting to 17% of the total traffic fatalities.[50] In 2011, that meant 4,457 people; in 2017, it meant 6,075 people.[51]

The increase in pedestrian fatalities has been attributed in part to increased sales of larger SUVs and pickup trucks. In 2020, more than 75.9% of new car sales in the United States were of large cars (light trucks), up from 71.7% in 2019.[52] Cars have been getting bigger, making drivers less aware of their surroundings and more dangerous to pedestrians and cyclists. Higher vehicles with longer hoods create frontal blind spots 11 feet longer than traditional smaller vehicles. The hood of the Jeep Gladiator, for example, is 45.5 inches, almost four feet (1.1 meters) taller than the average five-year-old. The Ford F-250 has a front hood of 55 inches (1.4 meters). Since 2000, truck size has increased at least 11%, with new pickup trucks getting 24% heavier. When asked for the reason behind the increase in vehicle size, companies point to customers.[53]

Between 1993 and 2017, the United States added 42% more freeway-lane miles in its largest 100 urbanized areas. Congestion rose a staggering 144%, exceeding population growth that had only a 32% increase.[54] A Siena College poll supported by Transportation Alternatives, a New York City non-profit focused on changing the city's transportation priorities, found that more than 30% of New Yorkers have been injured in a crash. More

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[50] Governors Highway Safety Association, *Pedestrian Traffic Fatalities by State 2020 Preliminary Data* (GHSA online: Governors Highway Safety Association, 2021), 3, 5.
[51] National Highway Traffic Safety Administration, "Traffic Safety Facts 2017 Data: Pedestrians," United States Department of Transportation, March 2019, https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812681.
[52] Jim Henry, "2020 Truck, SUV, Car Sales: Winners and Losers," *Forbes Wheels*, January 7, 2021, https://www.forbes.com/wheels/news/2020-truck-suv-car-sales-winners-and-losers/.
[53] Keith Barry, "The Hidden Danger of BIG Trucks," *Consumer Report*, June 8, 2021, https://www.consumerreports.org/car-safety/the-hidden-dangers-of-big-trucks/.
[54] Transportation for America, *The Congestion Con* (Washington DC: Smart Growth America, March 2020), 5, 9.

than 70% knew someone injured or killed in a traffic crash.[55] Compared to the average of 34,000 people who die in the United States every year from traffic accidents, it is estimated that an additional 53,000 people prematurely die in the country due to automobile pollution.[56]

American urban infrastructure itself is also in crisis. According to the American Society of Civil Engineers (ASCE), American roads, bridges, and other infrastructure systems need serious updates and repairs. In 1988, a congressionally charted National Council on Public Works published a report on America's Public Works that it did not update. ASCE used the first report approach and methodology as the basis for publicizing its own first Report Card on America's Infrastructure in 1998. It was followed by reports every four years, beginning in 2001, that gave grades to infrastructure systems on a national scale and by state. Per the reports, since 1988, American road infrastructure has never been higher than a C+, and its transit infrastructure system has never been higher than C-.[57] According to the United States Department of Education, a C grade is a "fair" grade of 75-85% out of 100. A failure happens under a score of 65%.[58] According to the ASCE report, American roads are currently at a D, with over 40% of the roadway systems (including urban roads and highways) in poor or mediocre condition.[59] The debate about rebuilding

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[55] The Siena College Research Institute, “Siena Poll Results – Final,” *Transportation Alternatives*, accessed March 19, 2022, https://drive.google.com/file/d/1PQnCsTd86v5mq1mgzIAXz0ilsSDgOD75/view.
[56] Fabio Caiazzo, et al., “Air Pollution and Early Deaths in the United States. Part I: Quantifying the Impact of Major Sectors in 2005,” *Atmospheric Environment,* 79 (November 2013): 204.
[57] American Society of Civil Engineers, “Report Card History,” *2021 Report Card for America’s Infrastructure*, accessed March 20, 2022, https://infrastructurereportcard.org/making-the-grade/report-card-history/.
[58] United States Department of Education, *Structure of the United States Education System: United States Grading Systems* (International Affairs Office: United States Department of Education, February 2008), 1-2.
[59] American Society of Civil Engineers, *Roads: D* (Infrastructure Report Card: American Society of Civil Engineers, 2021), 108.

the infrastructure is another reason why the future of the urban street is so important. Should it be rebuilt to the system we know, or should it be constructed differently?

2.4 Summary

This chapter provided the background on the importance of the urban street and its role in cities as spaces of access and occupation. In short, the street is an invention. It is a network of spaces that society has control over. In the United States, the street is often a thruway for vehicular traffic with minimal infrastructure for any other use of the space. But the street was not always a place only for cars; it was also a place for play, commerce, and circulation. In this chapter, I expanded on the argument of the contemporary street as a place made up of several self-contained spaces, in both the theoretical sense and in physical occupation of those spaces. In Figure 2.1, I show those infrastructure elements and their spatial distribution, the sidewalk as an on-grade programming space reserved for people walking/rolling, and the curb lane programmed as on-street parking or bike lanes. I conclude the chapter with a discussion on the crises facing the urban street: a global crisis of increasing and multiplying climate threats and a local crisis of automobile congestion that is resulting in rising health issues, physical and mental, and a growing number of pedestrians and cyclists being killed. The street is at the very center of these crises.

CHAPTER 3

CONTEMPORARY ELEMENTS IN THE AMERICAN URBAN STREET: ACTORS, TECHNOLOGICAL DRIVERS, SYSTEMS OF SERVICE, AND URBAN INTERVENTIONS

One of the primary research questions of this dissertation is what the current forms and uses of the American urban street are. In this chapter, I begin answering the question by discussing what comprises the urban form's socio-technological system, including actors, technological drivers, systems of service, and urban interventions. I call these elements.

Actor-network theory (ANT) stipulates that the city is made of multiple partially localized assemblages built of networks, spaces, and practices. Its central message is that "modern societies cannot be described without recognizing them as having a fibrous, thread-like, wiry, stringy, ropy, capillary character that is never captured by the notions of levels, layers, territories, spheres, categories, structure, systems."[1] ANT emphasis how social situations and human actors deploy pieces of technology and machines into a network that configurate across space and time. The distinctions between 'social' and 'technological' is abandoned and contemporary life is understood as a complex and heterogenous assembly of both social and technological actors.[2]

I begin this chapter with a discussion of the nature of actors who have monopolized this moment of transition: technology companies, mobility companies, and automobile manufacturing companies trying to rebrand. It follows with a section (3.2) on the leading technological trends, electric vehicles (EVs), and autonomous vehicles (AVs). This section

[1] Bruno Latour, "On Actor-Network Theory. A Few Clarifications" in *Soziale Welt* 47, no 4 (1996): 170.
[2] Stephen Graham and Simon Marvin, *Splintering Urbanism* (London and New York: Routledge, 2001): 184-185.

includes a discussion of the relevant historical and technical narrative of each technology as well as examples of how they have been influencing the conditions of the urban street in different places around the United States.

Section 3.3, systems of service, is comprised of three parts: micromobility, microtransit, and Mobility as a Service (MaaS). In the sections on micromobility and microtransit, I address the multidimensionality of the terms, both of which describe a service, type of company, and object. For example, a scooter-share system is a microtransit system, the scooter is a microtransit object, and the system itself could be managed by a micromobility company. Microtransit as an object is a bit more straightforward than microtransit as a system in that it is a less diverse field (at the moment) of only limited amounts of microtransit pilots, microtransit objects, or companies. Before concluding the chapter with the types of urban intervention found in alternative mobilities visions, I discuss MaaS, a concept about connecting transportation options at a central location (digital) for easier mobility between systems.

The final section discusses four main urban interventions that have changed the American urban street: pedestrianization, the reclaiming of vehicular space to expand pedestrian use; bicycification, the reclaiming of vehicle space for use by bicyclists; the introduction of red bus lanes; and curb management.

3.1 Actors: Mobility Companies, Technology Companies, Manufacturing Companies

Many automobile and fossil fuel industries have been calling themselves mobility companies since the early 2000s.[3] Not in name only, these companies have begun to invest in a collection of automobile-adjacent and non-automobile projects. Automobile companies (like Ford, General Motors, and Toyota) and traditional manufacturing companies now also invest in bicycles, autonomous software, and various other technological and micromobility artifacts (such as scooters and bikes). Technology companies like Amazon and Alphabet are all investing in the future of urban streets through various software and hardware applications. But this change of name and diversification of agendas has not changed the continuity of the automotive industry.

How does one distinguish between each kind of company? Does it even matter if a company is a technology company or a mobility company? The answer is that it matters at least a little. It is valuable to understand a company's core product and mandate to clearly identify its intentions because a company providing a service to make a profit will have different priorities from a manufacturing company that needs to sell objects. Recognizing the multiple roles that companies have taken in recent years—and the extent to which they multi-brand themselves—showcases their influence on urban conditions and public perception.

Traditional car manufacturers have taken an active role in setting the narrative of the future of urban streets by embracing alternative mobilities and fitting them into the existing automobile system. General Motors (GM), for example, has branched out to

[3] Arnold Tukker and Maurie J. Cohen, "Industrial Ecology and the Automotive Transport System: Can Ford Shape the Future Again?" *Journal of Industrial Ecology* 8, no 3 (July 2014): 16.

develop and manufacture Origin (funded with Honda), an autonomous vehicles shuttle (AVS) that is expected to begin production sometime in 2023. During the 2020 Super Bowl, GM announced its electrical Hummer available for purchase for $112,000, pushing the vision of an electric vehicle future. In 2016, as part of its mobility expansion goals, GM launched Maven, a car-sharing service that ended up operating in Boston and Chicago before it was officially shut down (in April 2020), in part, according to GM, due to the COVID-19 pandemic.[4] Ford has invested in a mobility service platform to help cities "take back their streets" through a "Transportation Mobility Cloud" that is intended to provide a databank for residents and businesses to access information regarding various factors.[5] As part of its mobility research arm, a collaboration with Gehl Architecture, known for people-focused urban planning, Ford also launched the National Street Service, a project that supported a series of urban intervention pilots in 2018. Ford offered ten grants between $5-$500 in support of participants wanting to build various street experiments exploring what makes streets better places for people. Some of the winning pilots included murals by local artists, installations of local history signs, public workshops, and parklets.[6] In 2016, Ford bought the app-based service Chariot, a startup focused on using real-time traffic data to dispatch a 14-seat transit vehicle in high traffic areas to help ease congestion. Ford shut down the program in 2019. Ford also runs a delivery program with Walmart and Postmates using an AV to deliver groceries in Miami.

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[4] General Motors, "GMC Hummer EV," *GMC*, accessed March 23, 2022, https://www.gmc.com/electric/hummer-ev; Kaelan Deese, "GM Shuts Down Car-sharing Service Maven: Report," *The Hill*, April 21, 2020, https://thehill.com/homenews/news/493983-gm-shuts-down-car-sharing-service-maven-report/.

[5] Marcy Klevorn, "Taking Back the Streets: Using Systems Thinking to Return Our City Streets to the Community," *Medium*, January 9, 2018, https://medium.com/cityoftomorrow/taking-back-the-streets-using-systems-thinking-to-return-our-city-streets-to-the-community.

[6] National Street Service, "Summer Grants Debrief," *Ford Motor Company and Gehl Architecture*, accessed June 2, 2021, https://www.nationalstreetservice.org/blog/2018/12/6/summer-grants-debrief.

It is not only traditional manufacturers that are interested in guiding the narrative of the future of urban mobility. Many other organizations want to have a cut of the profits associated with future mobility. Alphabet (Google)—the parent company of Sidewalk Labs, Waymo, and Wing (a flying drone delivery program)—is no longer only an information/technology company, but a manufacturer of vehicles and autonomous software. Waymo has collaborations with a host of vendors including Avis and Walmart. The company also runs the Waymo One program, an AV taxi service operated with retrofitted Chrysler Pacifica. Sidewalk Labs is mostly known for its efforts toward smart city development in Toronto, but it is also the backer of COORD, a curb management company and the producer of LinkNYC, a digital wayfinding device installed on sidewalks among other investments and projects.

Figure 3.1 Urban Mobility Experience (CUbE) as presented in CES 2019.
Source: Megan Rose Dickey. Robot delivery dogs deployed by self-driving cars are coming. January 7, 2019. Tech Crunch. https://techcrunch.com/2019/01/07/robot-delivery-dogs-deployed-by-self-driving-cars-are-coming/.

Continental, a German automotive parts manufacturer with an American presence since the 1970s, has also ventured into the world of future mobilities. In 2019, during the Consumer Electronics Show (CES) in Las Vegas, it unveiled its Continental Urban Mobility Experience (CUbE), a vision for seamless mobility that includes a robot delivery dog and an autonomous electric shuttle (see Figure 3.1). In a press release covered by multiple digital outlets including TechCrunch,[7] a technology and startup news outlet, and *Dezeen*,[8] an architecture and design magazine, the company's Head of Systems and Technology, Ralph Lauxmann, was quoted as saying that "with the help of robot delivery, Continental's vision for seamless mobility can extend right to your doorstep. Our vision of cascaded robot delivery leverages a driverless vehicle to carry delivery robots, creating an efficient transport team."[9] As of January 2021, the CUbE concept has no mentions of robodogs. Regardless, the idea has become a reality through the efforts of Boston Dynamics Spot, a four-legged robot installed with thermal, acoustic, and visual sensors that can walk, climb stairs and avoid obstacles almost autonomously, without users' intervention. Spot is already being used by American police forces as well as the military.[10]

The Swedish furniture manufacturer IKEA has had retail outlets in the Unites States since 1985, and recently began experimenting with autonomous technology (AT) and the future of the street with a proposal for seven AVs as destinations where the vehicle itself facilities the program. Its innovation arm, SPACE10, a collaboration with f°am studio and

[7] Megan Rose Dickey, "Robot Delivery Dogs Deployed by Self-driving Cars are Coming," *Tech Crunch*, January 7, 2019, https://techcrunch.com/2019/01/07/robot-delivery-dogs-deployed-by-self-driving-cars-are-coming/.
[8] Rima Sabina Aouf, "Continental's Autonomous Robot Dogs Could Help Deliver Parcels," *Dezeen*, January 10, 2019, https://www.dezeen.com/2019/01/10/continental-autonomous-robot-dogs-parcel-delivery/.
[9] Dickey, "Robot Delivery Dogs."
[10] Boston Dynamics About, accessed June 2, 2021, https://www.bostondynamics.com/about#Q8.

the app developer Norgram, came up with an AV concept called "space on wheels."[11] It offers moving entertainment in the form of seven unique modules, such as "play on wheels"[12] featuring augmented reality windows; and a "hotel on wheels," powered by clean energy, supposedly containing all the perks of a traditional hotel room, on wheels! SPACE10 also offers healthcare centers, farms, shops and cafés, all on wheels. An "office on wheels" vehicle is also included a tag describing the pod as intending to "help people reclaim the lost time spent traveling to work."[13] Meaning, you can start working on your way to work!

Figure 3.2 "Rooms on Wheels" by IKEA SPACE10. First row (L-R): healthcare on wheels, farm on wheels, hotel on wheels, office on wheels. Second row (L-R): café on wheels, play on wheels, shop on wheels.
Source: Philip Stevens. IKEA's innovation lab unveils self-driving car concepts. September 17, 2018. Design Boom. https://www.designboom.com/technology/space10-ikea-self-driving-cars-autonomous-vehicles-09-17-2018/.

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[11] Philip Stevens, "IKEA's Innovation Lab Unveils Self-driving Car Concepts," *Design Boom*, September 17, 2018, https://www.designboom.com/technology/space10-ikea-self-driving-cars-autonomous-vehicles-09-17-2018/.
[12] Stevens, "IKEA's Innovation Lab."
[13] Stevens, "IKEA's Innovation Lab."

3.2 Technological Drivers

EVs and AVs are the two dominant technologies engaging the future of the American urban street at this moment in time.

3.2.1 Electric Vehicles (EVs)

EVs are not a new technology. On the contrary, EV technology, the battery, and the electric motor pre-date the combustion engine car. In 1890, William Morrison, a chemist from Des Moines, Iowa, made the first successful EV: a six-passenger car that could reach 14 miles per hour. By 1900, more than 60 electric taxis were being driven around NYC. Overall, EVs accounted for a third of all road vehicles.[14] At the time, there were more than 100 different manufacturers of vehicles making more than 4,192 unique cars. Steam cars accounted for 1,681 cars, electric engines for 1,575, and only 936 had a combustion engine.[15] The EV served the needs of daily transportation quite well. The private EV was particularly excellent for the city, as it could accelerate quickly and stop easily, unlike the gasoline car. What the combustion engine could do was reach higher speeds. Many EV top speeds were only 17 mph compared to the combustion engine vehicles able to make it to speeds as high as 40 mph. But the EV was reliable, easy to operate, quiet, and advertised as better suited for women. Women were assumed to be too weak and fragile to be able to use a smelly and noisy combustion engine car, the vehicle of men.[16]

Car manufacturers leveraged these cultural assumptions by featuring women driving and charging. A 1912 advertisement proudly stated, "a woman's car that any man

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[14] Department of Energy, "The History of the Electric Car: 1828-1835," DOE website, accessed March 22, 2021, https://www.energy.gov/articles/history-electric-car.

[15] Rudi Volti, *Cars and Culture: The Life Story of a Technology* (Baltimore, MD: John Hopkins University Press, 2006), 42-43.

[16] Dan Albert, *Are We There Yet? The American Automobile Past, Present, and Driverless* (New York and London: W.W. Norton, 2019), 26.

is proud to drive."[17] The private combustion engine car became inseparable from masculinity. The gasoline car, much more than the EV, was associated with freedom, power, and speed, which were assumed to be masculine. The EV could simply not compete with public perception, as well as the cheap cost of gasoline and the fact that a gasoline-powered vehicle did not require the development of a charging system. By 1935, EVs almost completely disappeared from the automobile landscape. In the United States, interest in EVs reemerged in the 1960s and 1970s as the country was experiencing negative effects from air pollution and a rise in oil prices. The 1965 Clean Air Act triggered a collection of research institutes and firms focused on EV development. But the surge did not result in widespread adoption of the technology.

In 1990, GM presented its electric concept car at the Los Angeles Auto Show as California was pushing new air emission regulations. The California Air Resource Board (CARB) set a strict emission standard to curb growing health issues in the Los Angeles area resulting from toxic emissions from single occupancy vehicles (SOVs).[18] The Low Emission Vehicle regulation required automobile manufacturers to introduce cleaner vehicles with more durable emission control from 1994 and 2003 models. Referred to as LEV I regulations, they included elements related to exhaust emission standards and a requirement for a certain percentage of SOVs to be zero-emission vehicles (ZEVs) with no exhaust or evaporative emissions.[19] By 1994, four additional states (New York, Vermont, Massachusetts, and Maine) adopted the California ZEV mandate.

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[17] Virginia Scharff, *Taking the Wheel: Women and the Coming of the Motor Age* (Albuquerque: University of New Mexico Press, 1991), 38.
[18] Marc Dijk, Renato J. Orsato, and René Kemp, "The Emergence of an Electric Mobility Trajectory," *Energy Policy* 52 (January 2013), 136.
[19] California Air Resources Boards, "Low-Emission Vehicle Program," California State Government, accessed March 23, 2021, https://ww2.arb.ca.gov/our-work/programs/low-emission-vehicle-program/about.

The only significant successes in EV development between 1997 and 2005 were of hybrid technology vehicles, particularly the Toyota Prius, which sold more than one million cars worldwide between 1997 and 2007.[20] In 2017, Norway held the world record for the number of owned all-electric (battery only) cars, with more than 100,000 vehicles. This represented nearly 40% of all of Norway's registered personal vehicles. The same year, Norway opened the world's largest fast-charging EV station, a station for a total of 28 vehicles.[21] In the United States, only 195,581 plug-in electric vehicles were sold in 2017and 361,782 cars in 2018.[22] Hybrid vehicle sales did a little bit better than EV, with 362,868 hybrid vehicles sold in 2017. This was a slight increase from several years of decline attributed to low gas prices.[23]

The demand for EVs has been projected to increase sharply over the next decade, with more than 19 million vehicles anticipated to be driven on American roads by 2030. This will require more than 9.6 million charging points. According to the United States Department of Energy Alternative Fuels Data Center, as of 2020, the United States had only 106,814 electric vehicle supply equipment (EVSE) ports with only 31,738 stations.[24] Stations will often have one or more EVSE ports. Each port can only charge one vehicle at a time, even if it has multiple connectors. Connectors are the actual 'nozzle' that gets

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[20] Dijk et al, "The Emergence of an Electric Mobility Trajectory," 137.

[21] Paul Hockenos, "With Norway in Lead, Europe Set for Surge in Electric Vehicles," Yale Environment 360, February 6, 2017, https://e360.yale.edu/features/with-norway-in-the-lead-europe-set-for-breakout-on-electric-vehicles.

[22]Transportation Research Center at Argonne National Laboratory, "United States Plug-in Electric Vehicle Sales by Model," United States Department of Energy Alternative Fuels Data Center, accessed March 23, 2021, https://afdc.energy.gov/data/10301.

[23] Transportation Research Center at Argonne National Laboratory, "United States HEV Sales by Model," United States Department of Energy Alternative Fuels Data Center, accessed March 23, 2021, https://afdc.energy.gov/data/10301.

[24] Alternative Fuels Data Center, "United States Public and Private Electric Vehicle Charging infrastructure," United States Department of Energy Alternative Fuels Data Center, accessed March 23, 2021, https://afdc.energy.gov/data/10964.

plugged into a vehicle to charge it. There has been no standardization of the connector's developments, so each port includes multiple types of connectors to allow multiple vehicles to be charged at that port. For example, all Tesla vehicles come with an adapter (J1772) that allows drivers to charge at non-Tesla charging equipment. The J1772 combo (also known as CCS connector) allows drivers to charge at Level 1, Level 2, and DC fast equipment charging ports.[25] As of 2020, more than 80% of public EVSE ports in the United States were Level 2, with only 15% of the public EVSE ports at DC Fast Charging type and even fewer public ESVE ports at Level 1, with only 5%.[26]

Range has been a complaint against the EV since its inception in 1900. A 1902 *Electrical World and Engineer* report on "The Program of the Automobile" pointed out that EVs will never have the freedom of the bicycle or the combustion engine because they will always need charging points or battery swapping stations.[27] Range concerns have remained at the front of EVs adoption debates in the United States even as the distances driven by households have declined. While the average driver spends almost 60 minutes behind the wheel in a single day, they only drive about 29 miles.[28] Range anxiety/EV anxiety refers to the fear of a vehicle not having enough charge to complete a trip. Part of EV's increased popularity is associated with not only environmental awareness but

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[25] Level 1 Charging charges a vehicle for 2-5 miles range for one hour of charging. It is a 120-volt (V) AC Plug, which means that eight hours of charging will replenish about 40 miles of electric range for a typical SOV; Level 2 Charging charges a vehicle for 10-20 miles of range per one hour of charging. It is most often used for public and workplace charging as it can operate at up to 80 amperes (Amp) and 19.2 kW; DC Fast Charging charges a vehicle for a range of 60-80 miles in 20 minutes. This rapid charging equipment is mostly installed along heavy traffic corridors; Alternative Fuels Data Center, "Charging Infrastructure Terminology," United States Department of Energy, accessed March 23, 2021, https://afdc.energy.gov/fuels/electricity_infrastructure.html#terms.

[26] Alternative Fuels Data Center, "Charging Infrastructure Terminology.".

[27] Albert, *Are We There Yet*, 27.

[28] Bureau of Transportation Statistics, "National Household Travel Survey Daily Travel Quick Facts" USDOT, May 31, 2017, https://www.bts.gov/statistical-products/surveys/national-household-travel-survey-daily-travel-quick-facts.

technological sophistication that parallels autonomous technology. A large part of this transition is credited to the American automaker Tesla Motors, founded in July 2003.[29]

Tesla made EVs cool.[30] Its first car, the Roadster, had a range of 245 miles and went from zero to 60 mph in 3.7 seconds. An open two-seat sports car, it was not intended to draw environmentally and economically concerned individuals but young, technologically passionate men.[31] Unlike traditional car manufacturers retrofitting electric technology on existing combustion engine vehicles, Tesla built its reputation by designing cars to be electric from the very first stage. By 2019, most Tesla vehicles looked like any other private car with rounder curves and design twists on door handles, dashboards, and wheels. In November 2019, Musk unveiled a new kind of Tesla vehicle. Its first electric pickup truck.

Unlike any other vehicle on the market, the Cybertruck is a tank-looking vehicle that could win a tug of war with a Ford150 and a drag race with a Porsche 911 which is how the company decided to showcase the vehicle's abilities. The vehicle is also being designed to withstand sledgehammers and bullets.[32] The vehicle unveiling began with a self-titled "cybergirl" who called the Cybertruck "the greatest evolution in vehicular fashion and function"[33] before she introduced her creator (her own words) Elon Musk. The

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[29] Zoe Long, John Axsen, Inger Miller, Christine Kormos, "What Does Tesla Mean to Car Buyers? Exploring the Role of Automotive Brand in Perceptions of Battery Electric Vehicles," *Transportation Research Part A: Policy and Practice*, Vol 129 (November 2019), 186-187.
[30] Long et al, "What Does Tesla Mean," 194.
[31] John Voelcker, "Wait, Tesla Owners and Fand Don't Care So Much About Green?" *Green Car Reports*, August 8, 2013, https://www.greencarreports.com/news/1086075_wait-tesla-owners-and-fans-dont-care-so-much-about-green.
[32] Sean O'Kane and Andrew J. Hawkins, "Tesla Cybertruck Will Get Up to 500 Miles of Range and Start at $39,900," *The Verge*, November 21, 2019, https://www.theverge.com/2019/11/21/20975475/tesla-cybertruck-announcement-musk-electric-truck-pickup-features-range-price-release-date.
[33] TopSpeed, "Tesla Cybertruck Unveiling Event: Watch the $39,900 Bulletproof Truck's Full Reveal Presentation," YouTube Video, November 22, 2019, https://www.youtube.com/watch?v=9P_1_oLGREM&ab_channel=TopSpeed.

crowd claps and hoots as Musk explains wanting to try something different in the world of pickup trucks, one of the top selling vehicle types in the United States.[34] When Musk introduces the Cybertruck, it is unveiled through smoke and accompanied by fire. The design alludes to a dystopian environment fitting of Mad Max with sharp angles and tinted windows to protect the occupants from the outside.

While Tesla did not upend the combustion engine market, it has dominated the now crowded EV market. A market that now includes GM, Volvo, Ford, and Honda to name a few. Tesla Model 3 sold more than 365,00 vehicles in 2020, making it the most popular plug-in EV worldwide.[35] Today, EVs are assumed to be part of the future of movement no matter if they are autonomous, shared, or public. BloombergNEF, the private media company's primary research service, published an annual long-term forecast of electrification, shared mobility, and autonomous driving and its impact on road transport by 2040. *The Electric Vehicle Outlook* offers various estimations, such as gains of $54 million by 2040, a rise in new car sales of 10% by 2025, and a global EV fleet of more than 116 million by 2030. They assume the global passenger vehicle fleets will be at about 1.4 billion in 2030, with EVs accounting for only 8%. BloombergNEF estimates that by 2040, EVs will be only 31% of the entire fleet.[36]

To sum up, EVs have become the preferred sustainable transportation option on American city streets today. However, the widespread use of EVs as a sustainable model

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[34]In 2021, all top three vehicles sold in the United States were trucks: the Ford F-series with 726,004 units sold, the Ram pickup with 569,388 units sold, and the Chevrolet Silverado with 519,774 units sold.
[35]Inside EVs. "Best-selling plug-in electric vehicle models worldwide 2020." Chart. February 2, 2022. *Statista.* Accessed March 22, 2022. https://www.statista.com/statistics/960121/sales-of-all-electric-vehicles-worldwide-by-model/.
[36]BloombergNEF, "Electric Vehicle Outlook 2020, Executive Summary, Long-term Passenger Vehicle Outlook," Bloomberg, accessed March 22, 2022, https://about.bnef.com/electric-vehicle-outlook/.

is organized within the existing automobile regime infrastructure without any changes in user habits.

3.2.2 Autonomous Vehicles (AVs)

AV technology development in the United States can be traced to the Defense Advanced Research Projects Agency, DARPA. Established in 1958 by President Dwight D. Eisenhower as a response to Sputnik 1[37], DARPA is part of the United States Department of Defense with a mission to "be the initiator and not the victim of strategic technological surprises."[38] Compromising about 220 government employees in six technical offices, DARPA "explicitly reaches for transformational changes instead of incremental advances."[39]

The terms autonomous, driverless, and self-driving are all used to describe a collection of technologies that make up the landscape of AV, including management, analytics, software development, and hardware manufacturers. Software is one of the most significant barriers to achieving fully automated and intelligent vehicles able to make independent decisions on the road. AV technology has been called the unicorn of many of the auto-related problems of contemporary society. There is nothing they cannot do! They are anticipated to improve accessibility and road safety, reduce energy consumption, improve air quality, and allow for better use of public spaces. All by simply becoming human-free. They are supposed to be the saving grace of contemporary automobile

[37]The first satellite to launch into Earth's low orbit by the U.S.S.R in 1957.
[38]DARPA, "About," Defense Advanced Research Projects Agency, accessed September 17, 2020, https://www.darpa.mil/about-us/about-darpa.
[39]DARPA, "About.".

development, with companies spending more than $64.2 billion on various AV technologies since 2010.[40]

In September 2012, California became the second state to permit self-driving vehicles to operate on public roads. The bill, SB 1298, required a driver to remain in the vehicle and in the driver's seat to monitor the operation of the AV, taking immediate manual control in case of autonomous technology (AT) failure. The bill also required the manufacturer to apply to the DOT before testing on public roads. The application includes a certification that the AT meets the Federal Motor Vehicle Safety Standards for the vehicle model/year and insurance in the amount of $5 million. The legislature declared that the state wanted to continue encouraging testing, operation, and development of AVs on public roads in California, avoiding interruption to the industry while making sure the operation on public roads is done safely.[41] Nuro Chief Legal and Policy Office David Estrada worked with state senator Alex Padilla to author the bill. In a 2020 *Medium* post, Estrada wrote: “at the time, now ancient history, our vision for the world of self-driving cars was archaic, but we knew then what we know now: autonomous driving technology can help save lives.”[42] There are more than 65 companies with active permits to test AVs on California roads but only two are allowed to operate completely driverless vehicles: Nuro and Waymo.[43]

Self-driving cars operate through three distinct system technologies: autonomous technology (AT), artificial intelligence (AI), and machine learning (ML). Three

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[40]Timo Möller et al, *The Future of Mobility is at our Doorstep* (McKinsey & Company: Our Insight, 2019).
[41]Alex Padilla, “SB 1298 Vehicles,” California Legislative Information, accessed April 7, 2020, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml.
[42]David Estrada, “State of California Approves Nuro’s Self Driving Delivery Vehicles for Public Road Operations.” *Nuro Medium*, April 7, 2020, https://medium.com/nuro/state-of-california-approves-nuros-self-driving-delivery-vehicles-for-public-road-operations-943a3cb8266
[43]Estrada, “State of California Approves Nuro’s Self Driving Delivery Vehicles.”

technologies that are often blurred because of their similarities. AT refers to the various automated technologies used in vehicles like guidance, braking, and lane-changing systems. ML is the method of data analysis that automates the analytical process. A branch of AI, the concept behind ML, is "the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention."[44] Coined in 1956, AI is different from automation. Automation takes a simple task and automates it. AI, however, is software that combines a large amount of data quickly, using an iterative process that allows it to automatically learn from patterns and features it finds in the data.[45] Autonomous, intelligent systems, and automation, have been used in recent years by various car manufacturers to loosely describe anything to do with the Advanced Driver Assistance System (ADAS). ADAS, which can be classified under AT, is a technology combined with various other technologies while operating simultaneously, allowing a vehicle to control itself. This is not an AV, meaning it is not intelligent and cannot make complicated decisions independently. For that to occur, AI needs to be able to analyze information in real-time and use that information to guide a vehicle through the complicated reality of streets and highways that includes other AIs.

AVs basically interpret their environments using a combination of real-time ADAS and LiDAR, among various other technologies. The promise is that one day the AV will be able to detect all people, conditions, or objects in a street and react in a manner safer than a human being. To "see" the street, an AV needs to determine quite a few things that humans do mostly unconsciously: where am I, who and what is around me, what are all

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[44]SAS Institute, "SAS Machine Learning," *SAS Analytics Insights*, accessed April 10, 2020, https://www.sas.com/en_us/insights/analytics/machine-learning.html.
[45]SAS Institute, "Artificial Intelligence," *SAS Analytics Insights*, accessed April 10, 2020, https://www.sas.com/en_us/insights/analytics/what-is-artificial-intelligence.html#howitworks.

those people and things doing, and what should I do next? Imagine walking down a sidewalk. Behind you, two young adults are walking quickly, while in front of you an elderly woman is pushing a shopping cart. Further from her, walking toward you, is a man walking a dog; further behind, a group of teenagers are talking, walking, and laughing. There are trees planted on the sidewalk, as well as entrances to various shops, a trashcan, and a mailbox. Intersections are further behind and ahead of you. While this does not seem incredibly complicated for humans, for a computer, the ability to navigate this sidewalk requires complete mapping of the sidewalk, identifying each object and person correctly, and responding appropriately, slowing down, going faster, stopping to let someone walk through. On the roadway, this is even more complicated. As drivers, we intersect not only with pedestrians and cyclists in crosswalks and on the road but with other drivers in variously sized vehicles, at various speeds that require much faster responses than while walking. An AV needs to be able to distinguish between a tree and a person, an act that for a sighted human is really a non-issue.

ADAS technology can make it appear as if a vehicle is autonomous when it is actually automated. The practice of calling ADAS autonomous has been coined by Liza Dixon as Autonowashing. Dixon defines Autonowashing as the "practice of making unverified or misleading claims which misrepresent the appropriate level of human supervision required by a particularly or semi-autonomous product, service or technology. Autonowashing makes something appear to be more autonomous than it really is."[46] AVs use cameras and sensors to collect information in real-time, analyze it, and apply it to avoid collisions. The details requiring analysis include observing the built environment and the

[46]Liza Dixon, "Autonowashing," Liza Dixon personal website, accessed April 20, 2020, https://lizadixon.com/Autonowashing.

various pedestrians, cyclists, and other drivers in vehicles. The data is then used to move the vehicle accordingly, a process that humans do easily but a computer does not. For example, in 2021, Tesla's Full Self-Driving (FSD) feature identified a particularly yellow moon as a traffic light.[47] This is because information analysis is done using high-performance computing and deep learning systems. Light detection and ranging systems, known as LiDAR, are mounted on top of vehicles that create a 360-degree imaging environment from the radar and light beams. This is used to measure the speed and distance of surrounding objects along with sensors installed in the vehicle's front, side, and back. The amount of information collected increases as the environment around the vehicle gets more complicated. With more frequent and different users, the more information needs to be processed more quickly to produce the appropriate response.

As early as 2016, Mercedes Benz announced that its future self-driving vehicle would be programmed to save drivers over the people they hit. According to Christoph von Hugo, the company manager for driverless car safety, "if you know you can save at least one person, at least save that one. Save the one in the car."[48] It is an argument based on the automobile regime that places blame on the victims outside the vehicle and an effort to remove the driver from responsibility, blaming instead a robot.

When Mercedes introduced its 2017 E-class, it produced a commercial that framed its car as able to drive itself. Titled "The Future," it begins with a voice over: "Is the world truly ready for a vehicle that can drive itself? An autonomous-thinking automobile that

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[47]Jordon Nelson, "Hey @elonmusk you might want to have your team look into the moon tricking the autopilot system. The car thinks the moon is a yellow traffic light and wanted to keep slowing down @Teslarati @teslaownersSV @TeslaJoy," Twitter, July 22, 2021, https://twitter.com/JordanTeslaTech/status/1418413307862585344.

[48]Michael Tylor, "Self-Driving Mercedes-Benzes Will Prioritize Occupant Safety over Pedestrians," *Car and Driver*, October 7, 2016, https://www.caranddriver.com/news/a15344706/self-driving-mercedes-will-prioritize-occupant-safety-over-pedestrians/.

protects those inside and outside. Ready or not, the future is here."[49] Sold as a privately-owned vehicle, the Mercedes E-class is part of an anticipated new market with the potential of reaching $77 billion by 2035, a mere 13 years from now. AV are expected to cut more than 250 million hours of commuting by reducing traffic.[50] The World Economic Forum anticipates driverless vehicles will generate $1 trillion in "economic benefit to consumers and society" over the next ten years. Those benefits are expected to prevent 9% of accidents by 2025, with the potential to save 900,000 lives. According to Passenger Economy research, more than 585,000 additional lives can be saved between 2035 and 2045 with the adoption of AV. Slashing traffic accidents and public safety costs by more than $234 billion in the same period, AV seems like the magic solution to all urban mobility woes.

Table 3.1 The Society of Automotive Engineers (SAE) Levels of Automation

Level 0	A vehicle with no automation features. Requires the full attention of the driver on the road and the act of driving.
Level 1	These vehicles feature things such as adaptive cruise control, automated parking, and active lane control: a driver must still pay attention, but several automated features provide assistance. Today, many of these features are standard in North American vehicles and do not require additional fees/installations.
Level 2	These vehicles feature automated steering and speed control for short periods of time. A Level 2 autonomous vehicle gives the impression that it is driving but requires the full attention of the driver. Tesla Autopilot system is generally considered a Level 2 technology.
Level 3	These vehicles are considered capable of interpreting the world around them without human intervention. Although SAE indicates that driver attention is still needed, most features of Level 3 AV are intended to replace a human's attention.
Level 4	These vehicles are considered fully autonomous but still allow for drivers to take control. Waymo vehicles, for example, use Level 4 applications.
Level 5	These vehicles are the holy grail of AV with no human engagement and fully independent vehicle. No such vehicle exists today.

[49]Mercedes-Benz Enthusiast Channel, "Mercedes-Benz 2017 E-Class commercials "The Future" and "The Journey," YouTube video, 01:30, March 21, 2016, https://www.youtube.com/watch?v=eS81h8J2Y3E.
[50]Marisa Kendall, "Car-Eat-Car World of Self-Driving Technology," *The Mercury News,* last modified April 5, 2017. https://www.govtech.com/fs/Car-Eat-Car-World-of-Self-Driving-Technology.html.

The Society of Automotive Engineers (SAE) publishes a classification system for levels of driving automation. First released in 2016, the J3016 Levels of Automated Driving standards are determined by how much attention a driver should give the road while autonomous features are active. As the industry of AV evolved, so has the J3016 with the latest update published in January 2019. The Levels of Driving Automation define six levels of driving automation: from SAE Level Zero, a none-automatic (or autonomous) vehicle, to SAE Level 5, which is a fully AV.[51] Levels 0, 1 and 2 require the full and continuous engagement of the drivers, but include various support features like blind spot warning, land centering, and adaptive cruise control.

Since 2016, the American Automobile Association (AAA) has been conducting an automated vehicle survey to determine how comfortable American drivers are with fully AVs. Key findings from the March 2019 update found that more than 70% of American drivers are afraid to ride in a fully autonomous car. On the other hand, almost 50% are comfortable with low-speed and short distance AVs, both like the ones already used in airports and theme parks as well as for food or packages delivery. However, only one in five people is at ease with the idea of transporting a loved one via autonomous technology.[52] Given that traditional vehicle crashes result in injuries and fatalities are often disregarded by the public, this is an intriguing discovery. For instance, 36,560 individuals died in car accidents in the United States in 2018, yet people were still at ease sending their loved ones into non-autonomous cars.[53]

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[51] Jennifer Shuttleworth, "Standards News: J3016 Automated-Driving Graphic Update, "*SAE International*, January 7, 2019, https://www.sae.org/news/2019/01/sae-updates-j3016-automated-driving-graphic.

[52] Ellen Edmonds, "Three in Four Americans Remain Afraid of Fully Self-Driving Vehicles," *AAA Newsroom*, last updated March 14, 2019, https://newsroom.aaa.com/2019/03/americans-fear-self-driving-cars-survey/.

[53] NHTSA, "2018 Fatal Motor Vehicle Crashes: Overview," Traffic Safety Facts Research Note, October 2019, https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812826.

Between October 2017 and November 2019, more than 64 cities in the United States and Canada piloted some sort of AV program or policy.[54] The USDOT's third iteration of its voluntary guidelines on AV development is titled *Preparing for the Future of Transportation*. The first two images on the cover show an SOV traveling on an urban street (there are no walkers, cyclists, or cars in the image); an urban train crossing a roadway with three waiting SOVs. Connected through a digital network, the train and the SOV intersect safely. The image is intended to allude to the efficiency benefits of different technologically connected kinds of transportation systems. The third image represents the autonomous trucking industry, focusing on long-distance trucking on non-urban highways. The last image, the only one with a person in it, shows a boxy AVS picking up a passenger waiting in what looks like a bus station in a city.[55]

In the contemporary future of the American urban street, AVs are seen as the solution to safety and environmental concerns. In terms of safety, AVs are seen as a way to keep the existing urban street conditions as they are, in service of the automobile and its system, while reducing injuries. This presents two problems. First, AT has yet to achieve a high-level of performance in urban streets. Second, as the technology evolves, the role of sensors on vehicles, infrastructure, and people, has become necessary, which raises a different set of privacy and security (surveillance) questions.[56] In terms of environmental concerns, AVs are assumed to be electrical, which makes them sustainable, and they will

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[54] The Aspen Institute, "From 2017-2019, 136 Cities Were Preparing for AVs. This Interactive Snapshot Shows How," *Bloomberg Philanthropies.* 2019. https://avsincities.bloomberg.org/global-atlas/about.
[55] United States DOT, "Automated Vehicles 3.0: Preparing for the Future of Transportation," October 2018. https://www.transportation.gov/sites/dot.gov/files/docs/policy-initiatives/automated-vehicles/320711/preparing-future-transportation-automated-vehicle-30.pdf
[56] Meriem Benyahya et al., "Automated City Shuttles: Mapping the Key Challenges in Cybersecurity, Privacy and Standards to Future Developments," *Computer & Security* 122, (November 2022): 3-6.

usher in an era of shared mobility.[57] In the next section, I discuss these notions of shared mobility in the contemporary American urban street.

3.3 Systems of Service

This section discusses elements of services that have emerged in the last two decades. Both micromobility (as a shared system or individually owned product) and microtransit offer a new scale of mobility service. This scale echoes familiar systems of transit through existing formats of public transit (buses) and shared systems (bicycles). The last system of service discussed in this section is MaaS, a service intended to connect multiple systems of service.

3.3.1 Micromobility

Micromobility is a term used to describe companies, shared systems, and many 2-wheel/1-wheel vehicles such as e-scooters, kick-scooters, and mopeds that do not require a motor vehicle license to be operated, which means that they do not have an age requirement for use. A five-year-old can use a kick-scooter, and an 85-year-old can use an electric bike. Micromobility artifacts can be manual or electric. They sometimes have three or four wheels with various boxes attached (front or back) to accommodate day-to-day tasks, including moving furniture, taking kids to school, or even cycling an intoxicated friend home. These kinds of vehicles include one-wheelers, electric skateboards, and cargo bikes in many shapes and sizes.

[57] Daniel Sperling, *Three Revolutions: Steering Automated, Shared, and Electric Vehicles to a Better Future* (Washington DC: Island Press, 2018), 3-4.

As a term, *micromobility* has been used frequently since 2016, but seldom before that. [58] Still, micromobility artifacts are neither new nor recent. The bicycle, the grandmother of all micromobility, was invented in 1815.[59] By 1890, more than a million bicycles were being manufactured in the United States annually.[60] Recordings of electric scooters can be found as early as 1915. Known as the Autoped (or as its 1916 patent indicates, a self-propelled vehicle[61]), the electrical scooter was marketed to women and older children for quick daily errands as well as to businesses and organizations. Advertisement for the vehicle stated, "it is new, but has been thoroughly tested by early ridings and runs 125 miles on a gallon of gasoline."[62] It was successful enough that the United States Postal Service used it for a special delivery program.[63] But all of these micromobility items mostly disappeared from popular use and remained fringe activities at best. The bicycle is the exception.

The micromobility revolution that became a household name in the United States in 2016 (and the world) had a very slow beginning, with the arrival of the Segway in 2003. The Segway was never a commercial or cultural success, even though it was endorsed by both Apple co-founder Steve Jobs and Amazon co-founder Jeff Bezos. Segway inventor Dean Kamen unveiled the micromobility vehicle on ABC's *Good Morning America*

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[58] Based on data from Google Trends and the search for the term "micromobility," December 2020.

[59] The first bike was a steerable bicycle with a front wheel fork. It was invented in Germany by Baron Karl von Daris de Sauerbronn of Mannheim, a man of the court of the grand duke of Baden. The first commercial bicycle was built in Paris in 1861 by carriagemakers Pierre and Ernest Michaux. The first modern bike, known as a safety bicycle, designed by John Startley in 1885.

[60] Maxwell G. Lay, *Ways of the World: A History of the World's Roads and of the Vehicles that Used Them* (New Brunswick: Rutgers University Press, 1992), 143.

[61] United States Patent and Trademark Office, "Self-Propelled Vehicle," U.S. Patent 1.192.514, July 25, 1916, https://pdfpiw.uspto.gov/.piw?Docid=01192514&homeurl=http://patft.uspto.gov/netacgi/nph-Parser

[62] Mike Hanlon, "(The Original) 100-Year-Old Motorscooter Up for Sale," *New Atlas*, last updated October 4, 2016, https://newatlas.com/original-scooter-eveready-autoped/45714/.

[63] Jackie Mansky, "The Motorized Scooter Boom That Hit a Century Before Dockless Scooters," *Smithsonian Magazine*, last updated April 18, 2019, https://www.smithsonianmag.com/history/motorized-scooter-boom-hit-century-dockless-scooters-180971989/.

saying, “will do for walking what the calculator did for pad and pencil."[64] It did not. Prior to its unveiling, Segway LLC pursued legislative efforts across the United States to allow the Segway vehicle to be used on sidewalks. By 2003, 33 states classified the Segway as a “electric personal assistive mobility device,” not an electric vehicle.[65] This promoted a renewed discussion of the role of the sidewalk in American cities. America Walks, a pedestrian advocacy group, argued that the Segway takes space away from already crowded sidewalks. Segway fans saw a future of fleets of various models on urban streets giving individuals an alternative vehicle to longer-than-walking distances.[66]

The Segway produced more mockery than awe. It suffered from a few technical issues the year of its unveiling, with 6,000 units being recalled because of a glitch causing users to fall off when the battery died. While attempting to test a Segway in 2003, then President George W. Bush was filmed falling off it.[67] In 2007, British journalist Piers Morgan broke three ribs falling off a Segway at 12 mph, adding to the poor image of the personal transport.[68] Kamen sold Segway to British millionaire Jim Heselden in 2009, at a time when a single Segway retailed for $5,000 and the product had a tarnished image. Heselden died ten months after the purchase of the company when the Segway he was riding veered off a 30-foot cliff near his country estate in North London. In 2015, elite Jamaican runner Usain Bolt was hit by a Segway while celebrating his 200-kilometer win

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[64] Andrew V. Clark, Carol Atkinson-Palombo, and Norman W. Garrick, “The Rise and Fall of the Segway: Lessons for the Social Adoption of Future Transportation, *Transfers* 9, no. 2 (2019): 30.
[65] Patricia Leigh Brown, “Whose Sidewalk Is It Anyway?” *New York Times*, January 5, 2003, https://www.nytimes.com/2003/01/05/weekinreview/ideas-trends-whose-sidewalk-is-it-anyway.html.
[66] John Schwartz, “On the Pavement, A New Contender,” *New York Times*, January 23, 2003, https://www.nytimes.com/2003/01/23/technology/on-the-pavement-a-new-contender.html
[67] “Bush Fails the Segway Test,” *BBC News*, June 14, 2003, http://news.bbc.co.uk/2/hi/americas/2989000.stm.
[68] James Tapper, “Ouch! The Moment Piers Morgan Broke Three Ribs Falling Off the Segway He Said Was ‘Idiot-Proof.’” *Daily Mail*, September 2, 2007, https://www.dailymail.co.uk/news/article-479271/Ouch-The-moment-Piers-Morgan-broke-ribs-falling-Segway-said-idiot-proof.html.

during the 15th IAAF World Championship in Beijing.[69] Segway's image never really recovered culturally from the series of events mentioned above. It remained a niche instrument, almost exclusively used in the tourist industry and by law enforcement agencies. But where the Segway failed the electric scooter succeeded.

Unlike Segway LLC's pursuit of legal recognition in local municipalities and its long marketing strategy, Bird, a shared-electric-scooter company, simply put its dockless e-scooters on Santa Monica streets. The premise was simple: using a smart phone, users could rent a scooter for $1 with a charge of 15-20 cents per minute of use. Scooters could be picked up and dropped off anywhere within the designated urban area. The model for recharging and placing scooters back into the urban fabric was conducted through a "gig economy" set up. Gig workers collect and recharge the scooters before returning them to various locations per the app's instructions. This allowed the company's expenses to be minimal, and in theory, its revenue return, larger. In 2018, Bird became the fastest company to reach $1 billion valuation supported by enormous amounts of venture capital. Bird alone raised over $500 million from firms such as Sequoia, Accel, and index Ventures.[70] On the other hand, by November 2018, Bird also paid over half a million dollars in fines and court fees. In the first quarter of 2019, its gross revenue shrank to $15 million, down from $40 million. Hundreds of its scooters were seized around the country, with the average scooter

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[69] Bill Chappell, "Usain Bolt is Knocked Over by Segway-Riding Cameraman After Winning Gold," *NPR*, August 27, 2015, https://www.npr.org/sections/thetwo-way/2015/08/27/435226790/usain-bolt-is-knocked-over-by-segway-riding-cameraman-after-winning-gold.

[70] Carolyn Said, "Ford Buys Spin, a San Francisco Scooter Startup, for $100 Million," *San Francisco Chronicle*, November 7, 2018, https://www.sfchronicle.com/business/article/Report-Ford-buys-Spin-a-San-Francisco-scooter-13372510.php.

lifespan being only 23 days.[71] During the COVID-19 pandemic, the company fired 406 of its 1,400 employees in a one-way two-minute Zoom webinar.[72]

Lime, a bike-sharing company, jumped into the e-scooter market and followed Bird's footsteps of introducing dockless e-scooters on city streets with no warning or permission from City Hall. In 2018, both Google Alphabet and Uber invested in Lime, contributing to a total of $335 million raised.[73] But venture capital players were not the only ones to see value and potential financial gains in e-scooter systems. Public officials realized the value of their streets to private companies. At the same time, fear of change and backlash from car-space reclamation had municipalities introduce a host of requirements for floating e-scooter systems. Some cities, such as Miami, San Francisco, and Denver, went as far as banning e-scooter operations until they could introduce regulations and set in place application procedures. In San Diego, the city approved rules for dockless scooters and bike sharing companies that included a six-month permitting process with a fixed cost of $5,000, and an annual per-device fee of $150. In response, Uber pulled all its Jump scooters from the city streets.[74]

In Raleigh, North Carolina, the city council raised its per scooter fee to $300. City council members asserted that the fee was needed to offset the cost of enforcing laws surrounding scooters. In response, Bird raised its unlocking price to $3 (per minute price

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[71] Alison Griswold, "Shared Scooters Don't Last Long," *Quartz: The Future of Cities*, March 1, 2019, https://qz.com/1561654/how-long-does-a-scooter-last-less-than-a-month-louisville-data-suggests/.
[72] Ben Bergman, "It Felt Like a Black Mirror Episode, the Inside Account of How Bird Laid Off 406 People in Two Minutes via a Zoom Webinar," dot.LA, April 1, 2020, https://dot.la/bird-layoffs-meeting-story-2645612465.html.
[73] Lime, "Lime's Next Chapter in Smart Mobility Backed by GV and Uber," 2nd Street Lime, July 9, 2018, https://www.li.me/second-street/lime-smart-mobility-backed-by-gv-uber.
[74] Joshua Emerson Smith, "Uber Pulls Jump Scooters from San Diego, Citing Frustration with City's New Rules," *The San Diego Union-Tribune*, September 12, 2019, https://www.sandiegouniontribune.com/news/transportation/story/2019-09-12/uber-pulls-jump-scooters-from-san-diego-citing-frustration-with-citys-new-rules.

remain at $0.15) and launched a campaign to replace the resolution.[75] Framing it as a tax on transportation, Bird argued that the city was being overly excessive. Sam Reed, Bird's Director of Government Partnerships, pointed to the city council's lack of environmentally friendly transportation support. The mayor responded, saying it is "ludicrous to say that we don't believe in environmentally-sustainable transportation because clearly if you look at our policies if you look at all the things, we've done in the past few years it proves that we have."[76] The city also invested in expanding its bicycle infrastructure and bike-share system, Citrix Cycle. On the other hand, the system only has 30 stations, located mainly at the downtown core and Hillsborough Street.[77] In 2010, the city conducted a GHG inventory to quantify emissions of municipal operations, but as of 2019, the only progress made has been another study regarding increasing the number of EVs and charging stations.[78] As of June 2021, 60 dockless bikeshares were serving 51 cities, and 214 e-scooter systems serving 92 cities in the United States. Docked bikeshare systems have more than doubled between 2015 and 2019, from 65 to 103 systems. But between 2019 and 2021, more than 37 systems closed permanently after a temporary COVID-19 shutdown, bringing the number of bikeshare systems in the United States back to 66.[79]

The adoption of urban e-scooter networks in the United States was met with two opposing perspectives. In one, e-scooters were hailed as the future of urban mobility, a

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[75] A website for the campaign provides a digital form to send an email to Raleigh Mayor with a pre-writing paragraph: "Please reconsider the enormous fees you have imposed on Bird so it can once again be an affordable and convenient transportation option in our community!" https://p2a.co/RO6tUPI.
[76] Gloria Rodríguez, "Bird Adds $2 Charge to Raleigh Rentals after City Enforces $300 Scooter Fee," *WTVD*, January 8, 2019. https://abc11.com/bird-scooter-rental-raleigh-price-tax/5028908/.
[77] The City of Raleigh, "Raleigh Bike Share Program", Raleigh Government, accessed March 20, 2022, https://raleighnc.gov/services/content/PWksTransit/Articles/RaleighBikeShare.html#paragraph--225246.
[78] The City of Raleigh, "Sustainability Reports," last updated June 8, 2021, https://raleighnc.gov/environment/content/AdminServSustain/Articles/SustainabilityReport.html.
[79] BTS, "Bikeshare and E-Scooter systems in the US," United States DOT, updated October 8, 2021, https://data.bts.gov/stories/s/Bikeshare-and-e-scooters-in-the-U-S-/fwcs-jprj/.

disruption of the status quo, and a gateway toward a car-less future. In the other, they were dangerous, unregulated, and a public nuisance. They were a summer activity only, a toy that is difficult to operate during any sort of weather that influences road conditions. But the kick-scooter, the micromobility vehicle that inspired the contemporary e-scooter was never intended for kids, even though they ended up being the demographic that used the scooter the most, at least in the 1990s. Wim Outboter, a Dutch-Swiss banker and amateur craftsman, created the modern kick scooter because he wanted to get a hotdog from a place that was too far to walk to but too short to drive to.[80] Outboter made a small and collapsible prototype, but lack of support from friends resulted in his abandoning the project and his "obsession with toy scooters."[81] In 1996/1997, he changed course and founded Micro Mobility Systems Ltd. (or Micro for short) with his wife and three other people. By 1999, he partnered with JD Corp, a Chinese bicycle manufacturing company, to sell the two-wheeled scooter version. At its peak, Micro Scooters sold 80,000 a day.[82]

More than a decade since micromobility vehicles come in two forms in the United States: private and shared. Shared systems bicycle stations debuted in the United States in 2010. With the introduction of new bicycle infrastructure (as discussed in further detail in Subsection 3.4.2, Bicycification), the use of bicycles quickly grew. Alyssa Walker, the urbanism editor for *Curbed*, called the introduction of bike-sharing systems to American cities "the transportation success of the decade."[83] In 2019, more than 136 million

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[80] Beatrice Heim et al., *Micro Mobility Systems: Realizing the Scooter Dream* (Web Archive: University of St. Gallen, 2011), 2.

[81] Sarah Holder, "The Man Behind the Scooter Revolution," *City Lab*, September 26, 2018. https://www.bloomberg.com/news/articles/2018-09-26/how-a-kids-scooter-became-a-micro-mobility-revolution.

[82] "About," Micro Mobility, accessed March 20, 2022, https://www.micro-mobility.com/en/experience-micro/micro-mobility/micro-mobility.

[83] Alissa Walker, "The Quiet Triumph of Bike Share," *Curbed Transportation*, December 16, 2019, https://www.curbed.com/2019/12/16/20864145/bike-share-citi-bike-jump-uber.

micromobility (not just bikes) trips were taken around the United States. It was a record year after a continuous increase in station-based bike-sharing systems usage since 2010.[84] Between 2010 and 2016, more than 88 million trips were taken in the various station-based bike systems in the United States. NACTO estimates that in 2018 alone, 36.5 million more trips were taken on station-based bike systems and 38.5 million trips on shared e-scooter systems (non-station-based systems).[85]

Shared mobility rides are short trips that average about 11-12 minutes (or less), covering distances of 1-1.5 miles. Enabling first-last mile solutions without additional vehicular traffic or pollution, the bicycle has emerged as the vehicle of sustainable transportation. Early bike-share systems only offered one type of manual bicycle that must be returned to a station within 30 minutes. Additions have been slow with only selected sharing systems offering electric bicycles. Distinguished sometimes from the electric-assist bicycles, which are slightly less powerful, the electric bicycle is also known as the e-bike. Able to reach between 20-28 miles per hour, the e-bike's electric motor comes in a variety of ways. Often easily removed, the battery and bike are not necessarily welded together. Some e-bikes, often called pedal-assist, require pedaling to be operated. Others have a throttle that allows travel without pedaling. Unlike manual road bikes that cost an average of $350-$700,[86] e-bikes' average cost runs between $1,500-$4,000. The cost of charging the bike's battery/motor is counted in cents.[87]

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[84] NACTO, "Shared Micromobility in the United States: 2019" (2020), 4.
[85] NACTO, "Shared Micromobility in the United States: 2018," National Association of Transportation Officials website, accessed March 22, 2022, https://nacto.org/shared-micromobility-2018/.
[86] Mick White, "How Much Does a Bike Cost?" *Bicycle Universe*, accessed March 20, 2022, https://bicycleuniverse.com/how-much-does-a-bike-cost/#Where_to_Ride.
[87] Steven Matthews, "Are Ebikes Worth It? All You Need to Know!" *Bicycle Universe*, accessed March 20, 2022, *https://bicycleuniverse.com/are-ebikes-worth-it-all-you-need-to-know/.*

As of December 2019, total station-based bike-share ridership increased by 10% even as the number of bike-sharing systems decreased to 72.[88] The increase in ridership mostly happened in already well-established bike-share systems: the Bay Area baywheels and Bluebikes; Boston's BLUEbikes; Chicago's Divvy; New York's CitiBike, and Washington, D.C.'s Capital Bikeshare. In Boston, the city expanded its BLUEbikes system with 50 new stations and 540 bicycles. Ridership increased by 45%, but the overall increase in the largest systems hid the fact that ridership did decline in 75% of the systems.[89] A few programs closed without introducing alternative micromobility programs to replace them, including B-cycle bike sharing in Denver, Ohio[90] and GreenBike in Boise, Idaho, which was run by Valley Regional Transit.[91] Overall, a large number of the smaller bicycle sharing programs were unable to endure over time. The programs' decline was caused by a lack of investment in the infrastructure needed to make the bike-share network simple (and valuable for individuals) to use.

Increasing bike infrastructure and access to shared bike systems has been a financial, political, and cultural/social challenge to many municipalities as it is a process that requires the redesign of streets among other policy changes. Consider, for example, the expansion of Divvy in Chicago. In 2019, the ride-hailing company Lyft entered a nine-year contract with City Hall to take ownership over the Divvy station-based bike-sharing system. Lyft bought Motivate International in 2018, which made it the owner and operator

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[88] NACTO, "Shared Micromobility in the US: 2019," 5.
[89] NACTO, "Shared Micromobility in the US: 2019," 6.
[90] Elizabeth Hernandez, "Denver B-cycle to End, City May Thin Herd of Scooter Operators as It Tightens Regulation of "Micromobility" Services," *The Denver Post*, November 21, 2019, https://www.denverpost.com/2019/11/21/denver-bcycle-scooters-bike-share/.
[91] KTVB, "Boise GreenBike Suspending Operations at the End of September," KTVB7, August 20, 2020. https://www.ktvb.com/article/news/local/boise-green-bike-suspend-operation-after-september-until-spring-2021/277-1c039a79-9d67-4958-97dc-5da4392e5db7.

of bike sharing systems across the United States, including CitiBike in Jersey City and New York, Baywheels in California, and BLUEbikes in Boston.[92] The contract had Lyft pay the city $77 million over the nine-year term. In return, Lyft would get all the revenue from the bicycle-sharing systems up to $20 million annually (the city gets 5% after that threshold is met) while being allowed to raise the system rates by 10% annually. As part of the contract, the city also required Lyft to install new stations, expanding the system's reach for a $50 million capital investment. In July 2020, the first phase of the program began with the introduction of 66 new stations expanding the systems reach by almost 60 square miles through Chicago's Far South Side. An additional 79 stations and 10,500 eBikes are included in future stages of the program expansion that also include 16.6 miles of bike lane to the Far South Side funded with additional money from the Chicago Department of Transposition (CDOT).[93]

Installation of bicycle stations requires either the removable of travel lanes or parking space. This in turn often results in opposition that is taken advantage by the very companies advocating for new micromobility infrastructure. When the city of Chicago first announced its intention to partner with Lyft exclusively in 2019, an Uber online campaign, *Pump the Brakes Chicago*, included a collection of misleading statements to convince residents to oppose the City Council approval for the Lyft deal. A website with a deactivated URL (PumpTheBrakesChicago.com) claimed the exclusive deal would monopolize Divvy and leave "money, jobs, and equitable transportation access for all

[92] The company also manages BIKETWON in Portland, OR, and Nice Ride in Minneapolis, MN.
[93] Mike Claffey and Susan Hofer, "CDOT and LYFT Join Alderman Howard B. Brookins Jr. and Advocates to Announce DIVVY Expansion into Far South Side*," Chicago Department of Transportation News*, July 16, 2020, https://www.chicago.gov/city/en/depts/cdot/provdrs/bike/news/2020/july/cdot-and-lyft-join-alderman-howard-b--brookins-jr--and-advocates.html.

neighborhoods on the table." A digital ad claimed that the city had turned down a $450 million bike-share investment package from JUMP. JUMP was Uber's dockless bike sharing system arm that it had bought in 2017 for $200 million.[94] The ad also argued that if given priority over Lyft, Uber would connect all 50 Chicago wards by 2019, while Lyft would do so only by 2021.[95] Uber went as far as to sue the city of Chicago over the deal, citing a non-exclusive pact that would have allowed it to offer 20,000 dockless bicycles and 2,000 scooters in all 50 wards immediately.[96] In 2020, Uber sold JUMP to Lime, a scooter-based micromobility company.[97] The Chicago battle for the right to develop and manage its bicycle sharing system was one of many over micromobility transit. Additional battles over micromobility systems have to do with the expansion of bicycle lanes to support the increasing shared systems offered in cities.

In 2017, the Seattle Department of Transportation (SDOT) introduced a private "free-floating bike-share marketplace." At the time, SDOT had established a permitting pilot to test dockless bikes systems around the city. Dockless bikes do not require riders to return bikes to a specific docking station, they can be left anywhere within the system. The pilot ran parallel to the existing station-based bike-share system known as *Pronto! Cycle*

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[94] Established in 2010 as Social Bicycles by Ryan Rzepecki, who used to work as a project manager for the NYCDOT Bike program. Uber rebranded the company to JUMP 2018 with Social Bicycles becoming the name for the company hardware and software solutions.

[95] John Greenfield, "Uber/JUMP Launches a Misleading Campaign to Sink the Lyft/Divvy deal," *Streetblog Chicago*, March 25, 2019, https://chi.streetsblog.org/2019/03/25/uberjump-launches-a-deceptive-campaign-to-sink-the-lyftdivvy-deal/.

[96] Heather Cherone, "Uber Sues Chicago Over its Divvy Bike Share Deal with Lyft, Calling It 'a Backroom Monopoly," *Block Club Chicago*, August 2, 2019, https://blockclubchicago.org/2019/08/02/uber-sues-chicago-over-its-divvy-bike-share-deal-with-lyft-calling-it-a-backroom-monopoly/.

[97] In 2020 while still under Uber management 400 JUMP employees were fired. Several weeks after, in a Slack group for the laid-off staff images and videos showed that thousands of JUMP bicycles been destroyed. A Motherboard deep dive into the Uber/JUMP relationship found a culture obsessed with growth. JUMP employees described it as applying a software business mentality to a bikeshare. See more by Aaron Gordon, "How Uber Turned a Promising Bikeshare Company into Literal Garbage", *Motherboard Tech via Vice*, June 23, 2020. https://www.vice.com/amp/en/article/5dz94x/uber-acquisition-jump-bikeshare-destroyed-thousands-of-bikes.

Share, which began operations in 2014. The new program allowed multiple companies to operate on its street with little to no infrastructural investment. Three companies participated in the pilot: LimeBike, ofo, and Spin.[98] Becoming the first United States city to allow dockless bikes, Seattle ended up closing all its stations and maintaining the system as fully dockless. Bikes are parked on the city sidewalks; riders are required to leave the bicycle parked with at least six-feet clearance for pedestrians to pass and to not block any other infrastructure, such as access to buildings, benches, and bus stops.[99] The question of where dockless bikes get left became a hot topic of discussion with the introduction of e-scooters into a host of American urban streets. Left on the sidewalk, they contributed to an already limited and very busy pedestrian space. Unlike privately-owned vehicles, scooters were new and seemed like clutter. The adoption of dockless micromobility systems allowed these items to "disappear" in urban form without changing the urban street, which has been adopted by many actors producing alternative mobilities.

Ashwini Chhabra, Bird's head of Public Affairs, published an online opinion piece with a before-and-after image of a typical five-car-lane urban street transitioning to a roadway dedicated to bicycles, buses, cars, and public spaces with a concluding remark that "streets should be for people, not cars."[100] The vision of the future urban street by Bird (as seen in Figure 3.3) shows a present and future street. Before, the street is mostly a road dedicated for the use of private cars. In the after, the same street has not changed but the

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[98] Seattle DOT, "2017 Free-Floating Bike Share Pilot Evaluation Report" (Seattle: Seattle Department of Transportation, 2018), 7.
[99] Seattle DOT, "Bike Share," Seattle government website, last updated August 23, 2021, http://www.seattle.gov/transportation/projects-and-programs/programs/bike-program/bike-share#permityearpermit2.5.
[100]Ashwini Chhabra, "The Era of Car-Clogged City Streets is Over," *Government Technology*, last updated November 11, 2019. https://www.govtech.com/fs/perspectives/The-Era-of-Car-Clogged-City-Streets-Is-Over-Contributed.html.

programming of the lane has. There is a green lane for bicycles and scooters, a red lane for buses, and a lane that has been converted to micromobility parking. The pedestrian infrastructure (the sidewalk) is still narrow, and the street is still a thruway.

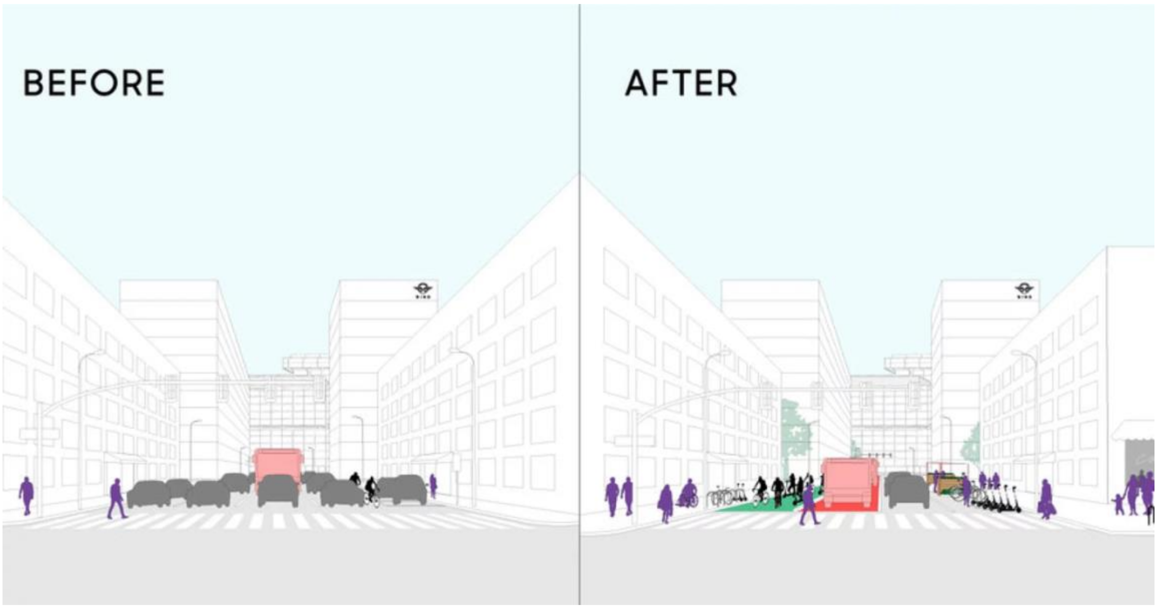

Figure 3.3 Bird before and after vision for the future of urban streets.
Source: Ashwini Chhabra, "The Era of Car-Clogged City Streets is over (contributed)," Government Technology, last updated November 11, 2019. https://www.govtech.com/fs/perspectives/The-Era-of-Car-Clogged-City-Streets-Is-Over-Contributed.html.

3.3.2 Microtransit

Like micromobility, microtransit refers to objects, companies, and services. Microtransit as an object refers to a mobility artifact that is smaller than what we understand most public transit objects to be. The use of the term *transit* refers to a shared mobility system: a bus network, a subway system, a high-speed rail network, or a light-rail system. Transit allows large numbers of people to move through large distances at high speeds with a (usually) low entry fee or free of charge. A microtransit vehicle is smaller than a bus but bigger than an SUV.

Like micromobility, microtransit is not a recent idea, but it has only recently been taken up by technology and mobility corporations. Traditional microtransit has often taken the form of what is known in North America as the dollar van. Dollar vans are often informal in that they are not part of a DOT sponsored system. However, they are licensed and regulated by local taxi commissions.[101] Microtransit often refers to autonomous vehicle shuttles (AVS), an eight to 15 seat vehicle designed with no driver seat or a wheel. At least, that is one version of an AVS. There are also shuttles that are retrofitted traditional private vehicles with autonomous technology (AT) and AVS designed for delivery only (NURO R2), and sidewalk delivery bots.

According to the Volpe National Transportation Systems Center (the USDOT resource branch for "multidisciplinary, multimodal transportation expertise"), as of 2018, there were more than 260 shuttle pilots across the world.[102] In October 2019, there were 128 projects across the United States in active planning or implementation stages, including ten completed projects. Out of the 73 projects in the United States, 16 were conducted in Texas, ten in Florida, and seven in California.[103]

The USDOT classifies a low-speed AVS as a vehicle that can hold up to 15 passengers, have a top speed of 25 mph or lower, and have a cruising speed of about 10 mph. Shuttles are intended to operate at a high level of automation, meaning SAE Level 4 and above (see Subsection 3.2.2). At early stages of deployment, the shuttles need to have an attendant on board ready to take control in case of emergency. The entities that are

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[101] Eric Goldwyn. "Anatomy of a New Dollar Van Route: Informal Transport and Planning in New York City," *Journal of Transport Geography*, no. 88 (2020) :1-2.
[102] Volpe National Transportation, *Low-Speed Automated Shuttles: State of the Practice* (Intelligent Transportation Systems Joint Program Office: United States Department of Transportation, 2019), 15.
[103] Kelley Coyner et al., *Low-Speed Automated Vehicles (LSAVs) in Public Transportation* (Washington, DC: National Academies of Science, Engineering and Medicine, 2021), 16-24, 26.

running or sponsoring low-speed AVS include government agencies, the private sector, and Universities. In some cases, a company will operate a service themselves or bring a separate transport operator to handle the day-to-day management. Pilot projects are conducted for various reasons, including data collection and first-and last-mile connections. Low-speed AVS usually runs on four wheels and have a boxy shape. Some of the better-known versions are manufactured by American company Local Motors and French companies EasyMile, and Navya. Other companies, such as American companies May Mobility, Optimus Ride, and Waymo, install additional equipment on commercially available, primarily single occupancy vehicles, to make them autonomously capable. These "shuttles" are typically designed for restricted operations and used in pre-determined routes.

Low-speed AVS can also be used for freight delivery. Overall, there are four types of organizations taking a role in the development of low-speed AVS: the manufacturer (the vehicle provider), the automated system provided (the autonomous software), the operators (those who maintain and provide the service), and the communities in which the deployments occur.

The current AVS generation provides limited service in specific built environment conditions. A few projects focus on operating exclusively on private roads, while others have run pilots in public busy roads. Optimus Ride, for example, which has roots at MIT (including participation in the DARPA Urban Challenge), operates AVS systems on private land only. Before the COVID-19 pandemic, it launched services at Reston, VA (at a Fannie Mae corporate campus), Paradise Valley Estates (a 60+ Life Plan Master Planned

Community), and in New York's Brooklyn Navy Yard.[104] Local Motors, a subsidiary of LM industries, which manufactures Olli, has completed a collection of pilots including a 1.5-mile-long test track at Peachtree Corners, a Georgia technology park. The pilot was part of the Olli Fleet Challenge in which municipalities competed against each other, campuses, and districts, for a short-term, local use of Olli.[105] Another completed pilot in the City of Rancho Cordova, in the Sacramento area, served the White Rock Corporate Campus for three months. The pilot was funded by the Sacramento Area Council of Governments through a $90,000 grant and additional funding from the City of Rancho Cordova. The pilot served the park's 1,600 employees as well as the public.[106] Several of the company's ongoing collaboration are of pilots for private use only. One pilot, a collaboration with the Goodyear Tire & Rubber Company, includes conducting tire testing with Olli in Akron, Ohio, the location of one of Goodyear's innovation centers. These pilots, away from the urban street, begin to hint of the limitation of current AV capabilities and the progress that still needs to be made for it to become a viable urban-mobility tool.

Another pilot for example, between AAA Northern California and the Contra Costa transportation authority, is focused on last-first-mile challenge by testing Olli in GoMentum Station, the largest closed-course testing facility for AVS in the United States. Managed by AAA Northern California, the facility offers a range of terrain including 20 miles of paved roads and 50 intersections. A mini city with overcrossings, tunnels, and

[104] Optimus Ride, accessed February 10, 2021, https://www.optimusride.com/company.
[105] "Curiosity Lab at Peachtree Corners Collaborators with Local Motors to Deploy Olli, the World's First Co-Created, Autonomous Electric Shuttle," *Local Motors*, September 30, 2019, https://localmotors.com/press-release/curiosity-lab-at-peachtree-corners-collaborates-with-local-motors-to-deploy-olli-the-worlds-first-co-created-autonomous-electric-shuttle/.
[106] "Self-Driving Shuttle Debuts in Rancho Cordova, California," *Local Motors*, August 7, 2019, https://localmotors.com/press-release/self-driving-shuttle-debuts-in-rancho-cordova-california/.

railroad tracks is used to test Olli capabilities before being deployed on public roads.[107] The testing done at GoMentum Station includes structured scenarios for various AV using test props to simulate urban conditions. An adult and child pedestrian, adult cyclist, motorcyclists, and wheeled scooter user props are used to create the friction between users in the real world. There is even a deer prop.[108] Using a 4Active Systems the props move on a track pulley system.[109] The number of props per track usually does not reflect dense urban conditions with more than one pedestrian per street. Regardless, it is used to teach AV software how to behave on the road (as discussed in Subsection 3.2.2).

In AVS pilots that include passengers, there is always a person within the vehicle to monitor the vehicle's operations, talk to passengers, and even take over if the urban situation requires it, which it almost always does. Little Roady for example, a fixed-route pilot in Providence, RI, run by May Mobility, was supposed to travel as a level 4 AVS. But in reality, more often than not, the vehicle was driven by its operators who did not always have the patience to wait for the AV software to understand what is going on and respond accordingly.[110] May Mobility is a software company that made its debut at Y Combinator demo day in 2017.[111] Within two years, the company acquired tens of millions in venture capital from investors including BMW and Toyota. The vehicle used in its pilots between 2017 and 2019 was a retrofitted GEM Polaris, a street-legal cart. Similar in concept to a

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[107] "3D Printed Self-Driving Shuttle, Olli, Undergoes Testing at GoMentum Station," *Local Motors*, October 16, 2019, https://localmotors.com/press-release/3d-printed-self-driving-shuttle-olli-undergoes-testing-at-gomentum-station/

[108] GoMentum Station, accessed May 20, 2021, https://gomentumstation.net/av-testing-services/.

[109] 4activesystems, accessed May 20, 2021, https://www.4activesystems.at/.

[110] Jack Stilgoe, "What Can We Learn from Little Roady?" *Driverless Future*, July 8, 2020. https://driverless-futures.com/2020/07/08/what-can-we-learn-from-little-roady/.

[111] Y Combinator provides seed funding for startups with small investments, as well as a three-month guidance. A second part of Y Combinator's function is to help founders reach investors and acquirers. They do that through Demo Day, a private, invitation-only event in which funded founders present their company to "specially selected investors and press. "Demo Day FAQ." https://www.ycombinator.com/demoday/faq.

golf cart, the GEM vehicles can travel at least 20 mph (32 km/h) and are installed with a collection of vehicular safety features.[112] With front facing seats, GEM has variations of the electric vehicles ranging from two to six seats and other customizable features like exterior colors, seat upholstery, wheels, and roof options. To drive the GEM vehicle, one needs a driver's license.[113]

May Mobility's retrofitted GEM did not include airbags or air conditioning, which required installing a diesel-powered heater in the vehicles. The vehicle was neither fully electric nor accessible, without a wheelchair restraint system or a retracting ramp. In 2019, Columbus, Ohio, asked May Mobility to bring its vehicles up to the Americans with Disabilities Act (ADA) standards. According to *Venture Beat*, May Mobility took weeks to roll out ADA shuttles. In the Little Roady route, riders with children had to bring their own boosters or safety seats to ride the shuttle.[114] In January 2020, May Mobility lost its Chief Operating Officer, Chief Technology Officer, and Chief Commercial Officer in a vote of no confidence. Its heads of reliability and sales, marketing, and product left the company by July. The loss of leading personnel was a result of a collection of failures, including struggles to maintain and upgrade its vehicles (hardware) and challenges in operations that resulted in extremely high costs. According to the *Venture Beat* investigation into the company operations, the City of Columbus Smart Columbus Scioto-Mile, a 1.2-mile loop pilot, cost the city an estimated $30 per passenger. For May Mobility, the cost was $90 per passenger.[115]

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[112] Headlights, taillights, reflections, turn signals, speedometer, mirror, horn, fenders, windshield, and seatbelts.
[113] GEM, "Street-legal Carts," accessed April 2, 20222, https://gem.polaris.com/en-us/street-legal-carts/.
[114] Kyle Wiggers, "How May Mobility's Autonomous Shuttle Ambitions Backfired," *Venture Beat*, July 6, 2020, https://venturebeat.com/2020/07/06/how-may-mobilitys-autonomous-shuttle-ambitions-backfired/.
[115] Wiggers, "How May Mobility's Autonomous Shuttle."

Some of the company's struggles came from its choice of hardware. The retrofitted electric GEMs had a hard time operating in cold weather with the battery of the vehicle unable to start. Shuttles constantly broke down and struggled to operate at a Level 4 autonomy. Even in locations where additional out-of-vehicle sensors were installed, the May Mobility software struggled to navigate the urban environment. The City of Columbus then proceeded to contract EasyMile, May Mobility's competitor, for its second autonomous route. But in February 2020, NHTSA halted all EasyMile AVS operations after a passenger on one of its shuttles in Columbus fell from their seat during an unexplained stop. Not the first time an EasyMile shuttle had suddenly stopped due to an obstacle, it was one of the first times the United States that the Federal Government took action to limit an AV technology company. EasyMile was allowed to continue operations on the road with no passengers until NHTSA completed its review.[116]

In a Las Vegas pilot between AAA, the City of Las Vegas, and the Regional Transportation Commission of Southern Nevada, run by Keolis, a company that manages public transportation systems. The pilot's shuttle, Navya ARMA, is manufactured with no front-facing seats or wheels. Running on a fixed route around a few blocks of the city's downtown with three stops located on Fremont Street and Carson Street between Las Vegas Boulevard and 8th Street.[117] As part of the collaboration with AAA, the automobile association was bound to donate $1 per passenger during the pilot for a minimum donation of $100,000 to the Last Vegas Victims Fund of those impacted by the mass shooting in the

[116] David Shepardson, "U.S. Agency Slams Brakes on Self-Driving Shuttles After Passenger Injury," *Reuters*, February 25, 2020, https://www.reuters.com/article/us-autos-selfdriving/u-s-agency-slams-brakes-on-self-driving-easymile-shuttles-after-passenger-injury-idUSKBN20J2N6.
[117] "AAA and Keolis Launch Nation's First Public Self-Driving Shuttle in Downtown Las Vegas," *Keolis*, August 11, 2017, https://www.keolis.com/fr/node/3213.

city on October 1, 2017. Between November 2017 and October 2018, the shuttle operated for 1,515 hours, making 32,827 rides.[118]

Similar to May Mobility pilots, the route streets were installed with communication sensors to provide the shuttles with light-phase information at signalized intersections (six of the route's eight intersections had traffic lights). A game controller was available inside the shuttle if an operator needed to take control of the vehicle for manual operations. The operator often did this because other drivers would take advantage of the autonomous software of the shuttle. Because the AV software responds to specific safety protocols, merging back into traffic after every stop during busy hours became impossible. Drivers used the visible AV presence to their advantage and bypassed it for closer access to the trafficked intersections. While most of the pilots remained uneventful, one hour into its first day of operation, on November 8, 2017, a truck crashed into the Navya shuttle. Although it was a minor collision with no injuries, the NTSB chose to investigate the crash. A 16-page report concludes that the truck driver assumed the shuttle would stop with sufficient distance for him to back into a nearby alley, which the vehicle did not.[119]

Besides that, first incident, the pilot was mostly uneventful. The typical operational speed of the shuttle was 10 mph.[120] While the shuttle hardware did not have the same issues as May Mobility's retrofitted GEM Navya, the shuttle struggled to deal with Nevada summers and the constant use of air conditioning reduced the battery life significantly. In

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[118] "Free Self-Driving Shuttle Pilot Program, November 2017-October 2018," *AAA*, accessed April 2, 2022, http://www.aaahoponlasvegas.com/.

[119] National Transportation Safety Board, *Low-Speed Collision Between Truck-Tractor and Autonomous Shuttle, Las Vegas Nevada, November 8, 2017* (Washington DC: National Transportation Safety Board, 2019), 3.

[120] Coyner et al., *Low-Speed Automated Vehicles* , 102.

August 2018, Keolis even suspended the shuttle operations due to excessive heat.[121] The City of Las Vegas runs a second autonomous project with Lyft and Aptiv, an automobile parts company. Intended as a one-week pilot, the project passed 50,000 rides in June 2019 and is running indefinitely. Operating as a traditional Lyft vehicle (discussed in Subsection 3.3.3), the program operates in Aptiv autonomous BMW 5 series and has a safety driver behind the wheel.[122] As mentioned in the beginning of this section, AVS are designed for the delivery of goods as well as people. AVS for delivery have three types: a fully autonomous delivery only vehicle, traditional SOV retrofitted with AV technology, and sidewalk delivery bots (a micromobility artifact).

Transporting people is not the only type of AVS being tested on American streets. Nuro is one of the few companies around the world making in-house, zero-occupant, delivery-only AVS. Nuro aims to accelerate the benefits of robotics for everyday life by focusing on the transport of goods. The startup Series A, led by Banyan Capital and Greylock Partners, raised $92 million. In 2019, the company raised an additional $940 million from SoftBank Vision Fund. Its first pilot, in Scottsdale, Arizona, was a collaboration with Kroger (a 135-year-old grocery retail store); it started with self-driving Toyota Prius sedans that had a human driver and passenger overseeing the AT operations. Several months into the pilot, Nuro was able to deploy its custom AV, the R1. A "toaster on wheels," it was intended to replace combustion-engine, people-operated vans. As co-

[121] Coyner et al., *Low-Speed Automated Vehicles*, 106.
[122] Kristen Korosec, "Aptiv's Self-Driving BMWs Have Made More Than 50,000 Rides on the Lyft App in Las Vegas," *Tech Crunch*, June 3, 2019, https://techcrunch.com/2019/06/03/aptivs-self-driving-bmws-have-made-more-than-50000-rides-on-the-lyft-app-in-las-vegas/.

founder Dave Ferguson explains, "people are busy, and they value convenience more than ever, and retailers are trying to cope with those consumer expectations."[123]

Unlike traditional delivery systems in which a person delivers the order to the consumer's door even if they are not home, Nuro requires people to be at home when their package arrives so they can retrieve it. This is the "last few steps" problem, which other companies are attempting to address with robodogs, like Continental CUbE (shown in Figure 3.1). The removal of humans from the delivery process is creating a host of new curb related troubles beyond the existing curb management problems. The convenience argument made by Ferguson is really one that has to do with financial and labor responsibilities of the delivery company and very little to do with urban ease or consumer benefits. The updated R1, the R2, received a regulatory exemption from NHTSA that allowed the designers to remove features for a human driver and instead install cameras and sensors. A narrow vehicle of 3.6ft x 9ft (1.1 meters over 2.75 meter) and a height of an above average human at 6ft (1.86 meters) the R2 is embedded with sensors (Lidar, thermal, and ultrasonic) on the top providing a 360 view of its surrounding. The vehicle's maximum speed is 25 mph, and its gross weight is 1150kg. The vehicle battery is double that of the R1, enabling longer operation days. The R2 can carry up to 22.38 cubic feet and comes with an interior that is temperature controlled to keep food fresh.

Nuro partnered with Roush Enterprises to produce the vehicle in Livonia, Michigan. Roush was founded by the automotive mogul Jack Roush as Jack Roush Performance Engineering. Today, with more than 4,000 employees, it offers testing,

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[123] Marco della Cava, "With Nuro Self-Driving R1, Your Delivery Just Shows Up – In a Toaster on Wheels with No Driver," *USA Today*, January 30, 2018, https://www.usatoday.com/story/tech/2018/01/30/your-delivery-just-showed-up-toaster-wheels-no-driver/1062856001/.

development, prototyping, and manufacturing. Ben Julian, one of the designers who worked on R1, describes the inspiration for the vehicle design as the F1 racing helmet. Building on the racer's eyes peering out and making eye contact, the R1 front is like a face. As Julian describes it, "the thing about the R1 is that it's not just driverless—there are no people in it at all. Other road users, such as pedestrians and cyclists, use eye contact with vehicles to communicate. We incorporated this facial feature into R1's front fascia design; R1's headlight cut-out resembles a helmet visor framing a driver's eyes. It conveys the feeling of something familiar but safe, a quick glance of connection between two road users."[124] The R1 represents a new class of vehicles, unmanned and only for objects that the Nuro team sees as a challenge for the public. The design team made the R1 "approachable and friendly"; in the R2 model, the form takes an even more pronounced characteristic of a "smile." The approachability of the vehicle, the creation of a friendly robot, is part of Nuro's strategy, going as far as intending for kids to hug it once the Nuro R2 arrives to the front of their house for delivery. The form of the vehicle is intentionally smaller in size, so it occupies less road space, making it safer for pedestrians and cyclists to be around.

Until now, this chapter discussed a collection of contemporary urban mobility elements in the form of technologies and the companies who produce and sell those technologies. MaaS offers a binding glue between all these various systems. The next section intends to clarify the trends of shared transit services as well as new technological operation tools and how they have been implemented in the United States in the last several years.

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[124] Nuro Team, "Faces and Fascia: A Discussion with Nuro's Design Team," *Nuro Medium*, December 5, 2018. https://medium.com/nuro/faces-and-fascia-a-discussion-with-nuros-design-team-b7a2fe2a3a74.

3.3.3 Mobility as a Service (MaaS)

MaaS is a framework for delivering multi-modal mobility service with the user at the center. In the simplest of terms, it is an integrated service facilitated by a digital platform. This digital platform provides ticketing, payments (pay as you go or subscription plans), booking, and information. A MaaS framework can cover urban, regional, or global scale with a variety of multi-modal and adjunct service including parking. MaaS is not a digital trip planner or a flexible transportation service (mobility on demand, taxis, or ride-hailing), but a framework that facilitates easy intramodality.[125] Ride-hailing and the companies that provide it, Lyft and Uber, are attempting to become MaaS providers and/or facilitators by having their apps (digital platforms) include public transit. Ride-hailing, which when it first emerged was widely considered as ridesharing, has grown the field of transit options alongside the growing introduction of bike and scooter shares. Today, transit options range beyond the bus, train (or light rail), or taxi, which make MaaS a useful tool. A common place to pay and buy access/trips to the various systems available instead of having to use a collection of different tickets/apps. MaaS is mostly invisible in scenarios of future urban streets, but the collection of systems it serves is not.

In the United States, individual mobility is often understood as a supply and demand chain: mobility demand by a user and mobility supply by various public or private entities. Until about a decade ago, this process was often analog. To catch a taxi, one had to call a taxi company using a land line. If you were in densely populated places with active taxi services, all you had to do was raise your hand at the sidewalk or walk to your local taxi stand. Today, transportation network companies (TNCs) offer ridehailing service

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[125] David A. Hensher, Corinne Mulley, and John D. Nelson, "Mobility as Service (MaaS) – Going Somewhere or Nowhere?" T*ransport Policy* 111 (September 2021): 153.

conducted entirely through a smart phone app. A “sophisticated” taxi, ridehailing has become a part of contemporary urban transit. Ridehailing is not ridesharing. Ridesharing, from ride + sharing, is about sharing a car trip with multiple people, almost like a micro-bus in a single occupancy vehicle. The term was introduced to contemporary language with the launch of UberCab in 2009. The company dropped the cab and became Uber (the German word for above) in October 2010. Like taxis and other car-for-hire programs, Uber provided a door-to-door service with a fare based on mileage and time, including a base-fee. The difference was that to call an Uber one used their smartphone; no human contact is required until you are sitting inside the backseat of a car taking you toward your destination. The driver is a gig worker, part of a not-informal but also not-formal economy of secondary small jobs and tasks. The car belongs to the worker, not the company, supporting the illusion of a shared system. The company, Uber, was the facilitator, providing software connecting riders and drivers in urban places.

UberCab was conceived by Travis Kalanick and Garret Camp. Camp, a Canadian entrepreneur, is still on the Uber board of directors. Kalanick became the face of the company and the “visionary” behind its business model. He has been credited with setting the workplace culture of the company as well as the overall tone of its relationships with other organizations, both private and public.

When UberCab started its operations on San Francisco streets in 2010, it did not provide any notice to the city or file any paperwork. In response, the San Francisco Metro Transit Authority & the Public Utilities Commission of California ordered the startup to cease and desist. However, UberCab continued operating its app and drivers kept picking up passengers. The city threatened fines of up to $5,000 per instance. Ryan Graves, the

Chief Executive of UberCab at the time, said, “we are working with the agencies [involved] to figure out their exact concerns and make sure that we’re in compliance.”[126] In a since deleted official blog post, the company wrote, “UberCab is a first to market, cutting edge transportation technology and it must be recognized that the regulations from both city and state regulatory bodies have not been written with these innovations in mind. As such, we are happy to help educate the regulatory bodies on this new generation of technology and work closely with both agencies to ensure compliance and keep our service available for our truly Uber users and their drivers.”[127] The company believed itself within its rights to operate on public roads. This mindset, of the street as a space that can be used by companies without prior notice to local municipalities, was also how scooters were first introduced in Santa Barbara by Bird.

Initially, Uber tried to market itself as a car-alternative. No need to own a car: simply take an UberCab instead. Lyft, Uber’s competitor, claimed the same, that ride-hailing apps have the potential to ease traffic and reduce personal car ownership. The claims were mostly based on rider surveys. One of those surveys, conducted by the University of Michigan Transportation Research Institute, Texas A&M Transportation Institute, and Columbia University surveyed 1,200 people in Austin, Texas. The 2017 survey was conducted during a time when ridehailing services were suspended in Austin, which created a “natural experiment to measure its impact on travel behavior.”[128] Looking for change in the choice of transportation mode, trip frequency, and vehicle ownership, the

[126]Lora Kolodny, “UberCab Ordered to Cease and Desist,” *Tech Crunch*, October 24, 2010, https://techcrunch.com/2010/10/24/ubercab-ordered-to-cease-and-desist/.
[127] Kolodny, “UberCab Ordered to Cease and Desist.”
[128] Robert Hampshire, “Evidence that Uber, Lyft Reduce Car Ownership,” University of Michigan, August 10, 2017. https://news.umich.edu/evidence-that-uber-lyft-reduce-car-ownership/.

researchers found that 41% returned to use their own vehicle and 9% bought an additional car. Only 3% switched to public transit. A total of 42% switched to another smaller TNC. A statistical analysis of the results revealed that the people who transitioned back to a privately-owned vehicle were also 23 times more likely to report that they make more trips. Overall trips decreased after Uber and Lyft suspended their operation in Austin due to strict regulation, a 68% drop from an average monthly frequency of 5.64 to 2.01.[129] More than that, the researchers also found a correlation between the level of inconvenience reported to the likelihood that the respondent would buy a car. Inconvenienced riders were five times more likely to buy a car. The researchers conclude that the finding shows that ride-hailing companies do change behavior.[130] A *Business Insider* article covering the survey results claimed that "ride-hailing giants have said for years that their services will start to kill car ownership" and concluded with a quote from Robert Hampshire, one of the researchers of the study: "what I thought stood out the most was for those who did switch to their personal vehicle, they drove considerably more often."[131] Another study, conducted by Lyft surveying its users, claimed that in 2017 alone almost 250,000 people sold their cars due to access of ridehailing services. Lyft also proclaimed that 50% of its users reported that they drive less because of the company service. About 25% of Lyft users reported that they did not feel owning a car was that important anymore.[132] But in city observations, car sales and increasing pedestrian and cyclist injuries alludes to a more

[129] Robert Hampshire, Chris Simek, Tayo Fabusuyi, Xuan Di, and Xi Chen, *Measuring the Impact of an Unanticipated Disruption of Uber/Lyft in Austin, TX* (SSRN: March 2018): 6.
[130] Hampshire et al., *Measuring the Impact,* 14.
[131] Danielle Muoio, "Uber and Lyft Could Destroy Car Ownership in Major Cities," *Business Insider*, September 4, 2017, https://www.businessinsider.com/uber-and-lyft-limit-personal-car-use-study-2017-8.
[132] Darrell Etherington, "Lyft Says Nearly 250K of its Passengers Ditched a Personal Car in 2017," *Tech Crunch*, January 16, 2018, https://techcrunch.com/2018/01/16/lyft-says-nearly-250k-of-its-passengers-ditched-a-personal-car-in-2017/.

complex reality. A 2017 study conducted by Schaller Consulting over the growth of app-based ride services in NYC found that ridehailing trips accounted for more than an additional 600 million miles of vehicle travel on the city streets. In 2016 alone, more than 15 million people were using ridehailing services for trips across the city, each month.[133] The 600 million additional miles generated by TNCs constitutes 7% of the total miles travel led by all vehicles in the area, which substantially worsened traffic congestion.[134] The added miles also affected traffic safety and GHG emissions. As discussed in Section 2.5, there has been a rise in both of those parameters across the United States. To add even more into the ineffectiveness of the ridesharing model as sustainability mobility (per TNC's early claims), a 2021 study from Seattle looking to clarify the relationship between ride-hailing trips and parking demand found it minor. The authors concluded that even though average daily trips taken by ride-hailing has continuously increased, it has not resulted in a decreased use of parking.[135] Yet the role of ride-hailing in the future persists in part through the assumption that it will reduce personal car usage, especially if it is done in electrical and AVs.

Nine large American cities—Boston, Chicago, Los Angeles, Miami, Philadelphia, San Francisco, Seattle, Washington DC, and New York—accounted for more than 70% of all TNC trips in 2017. More than 38% of all TNC trips happened in large cities, with only 23% of the total United States population using ridehailing services.[136] Those who choose to travel by ridehailing are usually age 25 to 54, with a college degree, and a household income of $50,000 or more. Across geographic groups, men seem to be heavier users, but

[133] Schaller Consulting, *Unsustainable?* (Brooklyn NY: Schaller Consulting, 2017), 9.
[134] Schaller, *Unsustainable*, 18-19.
[135] Benjamin Y. Clark and Anne Brown, "What Does Ride-Hailing Mean for Parking? Association between On-Street Parking Occupancy and Ride-Hail Trips in Seattle," *Case Studies on Transport Policy* 9, no 2 (June 2021): 775-783.
[136] Schaller Consulting, *The New Automobility: Lyft, Uber, and the Future of American Cities* (Brooklyn NY: Schaller Consulting, 2018), 8.

the difference is minor.[137] In those large cities, car ownership also grew. Between 2012 and 2017, at least 20% of urban households in seven of the nine cities became a two-or-more-car household. Bruce Schaller, a transportation expert focused on new mobilities, calls households with at least one vehicle per worker “car-rich.” These households—in Boston, Chicago, Los Angeles, Philadelphia, and Seattle—account for the bulk of increased car ownership.[138]

Since its emergence, the concept of ride-hailing has taken a lead role shaping the future vision of the urban street. Lyft cofounder John Zimmer famously stated in 2016 that by 2025 private car ownership will end in the United States.[139] But the mislabeling of ride-hailing and ridesharing resulted in strengthening the role of cars in cities. This is partly due to the fact that the concept and narrative of MaaS is useful for many for-profit companies, especially when executed under the ride-hailing model relying on underpaid labor and providing profits for private investors.

3.4 Urban Interventions

Unlike the previous sections that discussed technological and programmatical elements, the following section is focused on physical interventions to the urban street. Urban interventions can be categorized according to their types of projects, temporal conditions, physical parameters, and spatial conditions.

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[137] Schaller, *The New Automobility*, 11-12.
[138] Bruce Schaller, “In a Reversal, ‘Car-Rich’ Households Are Growing,” *Bloomberg CityLab*, January 7, 2019, https://www.bloomberg.com/news/articles/2019-01-07/despite-uber-and-lyft-urban-car-ownership-is-growing.
[139] David Dudley, “The Guy from Lyft Is Coming for Your Car,” *CityLab*, September 19, 2016, https://www.citylab.com/transportation/2016/09/the-guy-from-lyft-is-coming-for-your-car/500600/.

In the last decade, four main urban interventions have dominated urban spaces in North America: pedestrianization, bicycification, red bus lane, and curb management. Tactical urbanism has been used for "placemaking" and transitioning automobile infrastructure into mixed-used non-automobile space. This intervention is often referred to as the main tool in the process of pedestrianization. Increasing the introduction of bicycle infrastructure (specifically, bicycle lanes, protected but in most cases painted and un-protected) has increased the visible non-motorized vehicle users of the urban street. It has also changed the visual experience of many places for drivers and walkers. Curb management and the reallocation of curb spaces for deliveries, waste, and water management, as well as social activities, has shed light on the use of the space for storage of vehicles instead of anything else.

3.4.1 Pedestrianization

Pedestrianization is the act of making a place fit for the use of people on foot rather than people in cars. It can be temporary or permanent. Examples include the closure of a street for a farmer's market, closure of a parking lot for a party, or closure of vehicular lane to extend a sidewalk. Reclaiming car travel space (lanes) for extended plaza space and reclaiming car parking space for parklets/additional seating on commercial streets is another form of pedestrianization.

Pedestrianization is often achieved using tactical urbanism tools as an initial transition stage: painting a roadway with a mural, placing planters to block vehicular traffic, and adding movable furniture, mainly chairs and tables. Most pedestrianization projects happen gradually, beginning with low-cost and temporary tools to more permanent infrastructure after several month or years. These tools—contemporary DIY, Guerilla, and

Pop-Up Urbanism—all use the same toolbox of interventions the field of urban design/planning has called Tactical Urbanism. Although an argument has been made that there is a difference between DIY Urbanism and Tactical Urbanism, the difference has to do with when frequently unsanctioned individuals intervene in the physical elements of the street versus sanctioned interventions led by organizations/the city.[140] Basically, tactical urbanism is meant to be a circle of actions between the city, design firms, citizens, and developers. Both bottom-up (individuals, community, neighborhood groups/organizations) and top down (mayor, city councilors and departments) change the urban form through the various tools of tactical urbanism.[141]

Andrés Duany, the founder of the Congress for New Urbanism (CNU), calls Tactical Urbanism the Extra Small (XS) formulation of urbanism in the twenty-first century. Referring to Rem Koolhaas *S, M, L, XL* published in 1995, Duany introduces tactical urbanism as the anti-XL. Chair Bombing, guerilla gardening, and ad busting are some unsanctioned citizen actions taken in the name of Tactical Urbanism. But as cities adopted the tool the less people had to intervene and could focus on maintaining/enjoying the new spaces introduced by the city. For example, when Janette Sadik-Khan, as the NYCDOT Commissioner during the Bloomberg administration, closed Broadway to cars at Times and Herald Square in 2009 and placed 376 beach chairs, people simply sat down and enjoyed the view. As Sadik-Khan describes it, "tap dances strutted and musicians

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[140] Mike Lydon and Anthony Garcia, *Tactical Urbanism: Short-term Action for Long-term Change* (Washington, Covelo, London: Island Press, 2015), 9.
[141] Lydon and Garcia, *Tactical Urbanism*, 11.

performed as crowds gathered to watch. Hot dog vendors handed out free franks. Some visitors brought baseball gloves and played catch."[142]

But calling street closures, block parties, and road painting Tactical Urbanism is to place the long history of urban intervention into a very small box. Many tools of Tactical Urbanism have their own reasons for implementation and what kind of results they produce. For example, New York City Summer Streets program, held every August, is a multi-day car-free event. From 7am to 1pm, using simple barriers, and in some cases police presence, streets in Manhattan between the Brooklyn Bridge and Central Park are closed for vehicular traffic. Approximately seven miles of street opens for pedestrian and cyclist activities, including sponsored workshops, performances, and even bike repair stations.[143] According to NYCDOT, the program facilitator, 300,000 people enjoyed the open streets in 2019 alone.[144]

Street closures in New York City are also not new. When the Summer Street program first opened in 2014, a *New York Times* article noted that "there seem to be street fairs almost every weekend somewhere in New York."[145] Street fairs, just like Summer/Open streets, are simple, temporary, street closures. Unlike Summer/Open streets, street fairs include a heavy temporary commercial vendor presence by sellers who pay a fee to participate in the event.[146] But both allow every pedestrian, cyclist, and wheeled individual to experience the street to its full and not just from the sidewalk. Play Streets,

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[142] Jannette Sadik-Khan and Seth Solomonow, *Streetfight: Handbook for an Urban Revolution* (New York: Penguin Books, 2016), 99.
[143] "Summer Streets Activities," New York City Government website, accessed February 20, 2022, https://www1.nyc.gov/html/dot/summerstreets/html/route/activities.shtml.
[144] Ibid.
[145] Steven McElroy, "Summer Streets Program Begins in Manhattan," *New York Times*, July 21, 2014, https://www.nytimes.com/2014/08/01/arts/design/summer-streets-program-begins-in-manhattan.html.
[146] "Street Fair," DOT Street Design Manual, accessed February 20, 2022, https://www.nycstreetdesign.info/programming/street-fair.

car free streets hosted around New York City, often adjacent to schools, have become a local solution for schools in need of recreational space.

Play Streets in New York City go back as far as 1909 when they were introduced by the Parks and Playgrounds Association in response to a rise in children's injuries. In the first five months of 1909 alone, more then 20 children were killed while playing in streets. Once the program started, the number of children playing in certain NYC blocks ranged from 240 to 1,075 kids in a single block.[147] The program only closed the streets for three hours a day from 3-6pm. By 1914, a new program was established by the NYC Police Athletic League (PAL). Twenty-five playstreets were created by 1921 and more were added offering a safe and supervised option to play sports and games outdoors.[148] PAL Playstreets still exists today for seven weeks during the summer but has been reduced to 15 public areas in "neighborhoods suffering from high rates of crime and poverty." Activities include soccer, basketball, tye-dying, and outdoor board games. NYPD officers participate and provide staff for the event, including a site director, Arts and Sports specialists, and multiple adult mentors.[149]

Other organizations providing activities in urban streets have emerged in recent years. The Uni Project, for example, re-branded as Street Lab in 2020, is a non-profit with roots in Boston (since 2006) where it created pop-ups programs. Working in New York since 2011, the organization has focused on pop-up reading rooms, drawing stations, portable museum exhibits, and even small-scale music-making and performance

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[147]"Plan Safe Streets for Children's Play," *New York Times*, May 7, 1909, accessed October 12th, 2020, https://timesmachine.nytimes.com/timesmachine/1909/05/07/101880043.html.
[148] Lydon and Garcia, *Tactical Urbanism*, 40.
[149] "PAL Playstreets," Police Athletic League, accessed October 13, 2020, https://www.palnyc.org/playstreets.

activities.[150] The concept of Street Lab pop-ups is temporary program-based street closure activation. They provide, through temporary programing and furniture, a collection of examples of how to use a street that has been closed for cars. Street Lab offers a host of temporary programs. These include READ NYC, a pop-up reading room created with eight benches and a custom-designed cart to store, move, and display books with two staff members managing the "space." Staff members also run mini-book reviews and read to participants.[151] There is also DRAW NYC, a pop-up art creation space made with the same type of eight benches and a custom-designed cart for paper and art supplies. Two staff members run this space as well, creating adjacent "street galleries" displaying drawings from other pop-up locations.[152] SOLVE NYC, EXPLORE NYC, and WRITE NYC follow similar formats with temporary furniture, short programs and activities around their namesake, hands-on puzzle stations, and science exhibits.[153] Since 2013, Street Lab also runs play streets using a collection of table games and physical activities. During the first year of the COVID-19 pandemic (2020), in collaboration with industrial designer Hannah Berkin-Harper, the program was relaunched with touch-free games (mazes and racetracks). The program also began relying on Open Streets as the space provider and on chalk as a way to create custom programs and activities.[154] During the pandemic, the organization, launched Street Marker, an experimental program for people to draw together while social

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[150] "About," *Street Lab*, accessed February 10, 2022, https://www.streetlab.org/about/.
[151] "READ NYC, a pop-up reading room," *Street Lab*, accessed February 10, 2022, https://www.streetlab.org/programming-nyc-public-space/read/.
[152] "DRAW NYC, an open-air drawing studio," *Street Lab*, accessed February 10, 2022, https://www.streetlab.org/programming-nyc-public-space/draw/.
[153] "Our Programs," *Street Lab*, accessed February 10, 2022, https://www.streetlab.org/programming-nyc-public-space/.
[154] "PLAY NYC," *Street Lab*, accessed February 10, 2022, https://www.streetlab.org/programming-nyc-public-space/play/.

distancing on the road.[155] The COVID-19 crisis forced many cities to re-evaluate, at least temporarily, how they used their urban streets. Using chalk, bringing tables and chairs, and providing programs were all being experimented with before the pandemic.

During 2007 Earth Day, then New York City Mayor Bloomberg unveiled PlaNYC, a document produced under then Deputy Mayor Dan Doctoroff (Doctoroff will later launch Sidewalk Labs under the Alphabet umbrella). The document provided an inventory of all the city resources, assets, and deficiencies,[156] including 127 proposals to prepare for to the challenges of climate change. With 2030 as a target year, PlaNYC addressed open space, congestion, air quality, and congestion. Giving high level goals with a collection of initiatives such as completing the city 1,800-mile bike master plan, improving and expanding bus service, including expanding bus rapid transit routes, addressing congestion, and managing roads more efficiently by reaching a state of good repair across authorities.[157] This framework allowed Sadik-Kahn to push forward with actions to implement the PlaNYC transportation agenda. Within a year, the city DOT published Sustainable Streets, a conversion of the PlaNYC with specific goals and benchmarks.[158] By 2009, the city established Safe Routes to Schools (SRTS), a federal program to promote walking and cycling to school through enforcement, safety education, and infrastructure improvements.[159] It also paved more than 90 miles of bike lanes, implemented a complete-street roadway design strategy, and created the Public Plaza program.

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[155] "Street Marker," *Street Lab*, accessed February 10, 2022, https://www.streetlab.org/programming-nyc-public-space/street-marker/.
[156] Sadik-Khan and Solomonow, *Streetfight*, 33.
[157] The City of New York, *PlaNYC* (New York City: 2007), 81,83,85, 89, 92, 95.
[158] Sadik-Khan and Solomonow, *Streetfight*, 38.
[159] "Safe Routes to School," New York State Department of Transportation, accessed February 10, 2022, https://www.dot.ny.gov/safe-routes-to-school.

The city's complete-street roadway design strategy and the Public Plaza programs were based on a street-life analysis philosophy. Street-life analysis intends to provide an accurate reading of streets to help designers reconstruct space allocation. For example, a street with four lanes, two used for travel and two for on-street parking, may appear as a street with no room for users who are not inside a car. But simple geometric changes to the size of travel lanes—from 12 feet to nine feet—yielded enough space to install a painted bike lane. No significant financial investment required.[160] I'll discuss bike lanes in the next section on bicycification, but it is important to note the early 'power of paint' to produce new urban space accrued via pedestrianization and bicycification schemes.

Curb extensions, or bulb-out/neck-downs, urban design features that have also been called road diets/traffic calming, were used by the city to re-address curb turns. Again, paint was used; this time to mark new curbs at crosswalks in order to make shorter crossing distances. But the most important use of paint by the city comes with the redesign of streets from pedestrian space extensions to simplify complex intersection where pedestrians are at high risk of injury from drivers and/or do not have ample connection between sidewalks. The NYCDOT reconfigured vehicular roadways using all these geomatical tools, reducing lane sizes, adding bulb outs at intersections and mid-block crosswalks, and reclaiming car infrastructure to complete pedestrian infrastructure and introduce bicycling infrastructure. As Sadik-Khan notes, it was not about designing a new street, but about revealing what was already there with paint.[161]

The extended pedestrian infrastructure that Sadik-Khan called street plazas gradually evolved into the city Public Plaza program. A collaboration between local

[160] Sadik-Khan and Solomonow, *Streetfight*, 51.
[161] Sadik-Khan and Solomonow, *Streetfight*, 78-79.

organizations and the city, these neighborhood plazas were part of an effort to achieve the PlaNYC goal of every New Yorker living within a 10-minute walk of quality open space. Designed, constructed, and funded by NYCDOT, local organizations are responsible for the management (programming and events) and maintenance of the plazas, including providing a funding plan.[162] The first plaza created by the NYCDOT was in DUMBO Brooklyn. A triangle part of the roadway (Pearl Street) that was being used as a parking lot was identified as the space to be reprogramed as a pocket plaza. It was painted with bright green epoxy acrylic to "mimic an open green space"[163] and furnished with tables and chairs. Large planters and granite blocks were used to mark the borders of the space, provide additional seating places, and act as safety features for pedestrians. The plazas that followed, this time in Manhattan, were created with small changes to traffic directions. For example, a plaza near the Flatiron Building where Broadway meets Fifth Avenue and 23rd Street was made possible through a redesign of an intersection a block away. Re-organizing traffic upstream, consolidating Broadway vehicular traffic onto southbound Fifth Avenue or Broadway, simplified vehicular traffic and allowed the creation of a plaza. Instead of paint, the plaza was outlined with thermoplastic and filled with texturized gravel that adhered to the existing asphalt. Per Sadik-Khan, "minutes after workers set out the first construction barrels to detour traffic and start work on the plaza, a group of art students materialized, sat on the blacktop, and started to sketch nearby buildings," an example of how street life emerges when space is made at human scale.[164]

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162 "NYC Plaza Program," New York City Department of Transportation website, accessed February 10, 2022, https://www1.nyc.gov/html/dot/html/pedestrians/nyc-plaza-program.shtml#overview.
163 Sadik-Khan and Solomonow, *Streetfight*, 80.
164 Sadik-Khan and Solomonow, *Streetfight*, 87.

The successes of the various tools that DOT began using, a gematric changes through temporary and cheap tools, paint, and the reprogramming of streets, inspired other cities to use similar tools to improve pedestrian infrastructure and introduce bicycling infrastructure. Painting roadways, closing side streets for temporary events, or creating permeant seating spaces became common tools for DOTs trying to manage traffic and growing calls for more livable and sustainable streets. Between 2010 and 2016, even the USDOT and FHWA embraced more flexible approaches to pedestrian facility design and issued support for the NACTO design guidelines on which the NYCDOT Street Design Manual is based. The federal government also allowed cities to use eligible funding for the development of pedestrian walkways and bicycle transportation facilities.[165] The Public Plaza program and the NYCDOT approach to roadway design were described by Sadik-Kahn as a process that "incorporates both Jacobs's view from the street and Moses's approach of cutting thorough development paralysis to implement change in real-time."[166] Here, she is referring to the Jane Jacobs' argument that streets are for people and Robert Moses brutal and efficient public work mindset as described by Robert A. Caro in *The Power Broker*. Sadik-Kahn's vision for NYC streets was change-based urbanism that created short-term results.[167] But short-term results were only the beginning. If one project can express what pedestrianization means today in the United States it is the reformatting of Times Square, a project that began with paint and beach chairs and evolved into permanent pedestrian space that improved traffic and commercial access.

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[165] "FHWA Guidance: Bicycle and Pedestrian Provision of Federal Transportation Legislation," United States Department of Transportation Office of Planning, Environment, & Realty (HEP), accessed February 10, 2020, fhwa.dot.gov/environment/bicycle_pedestrian/guidance/guidance_2015.cfm.
[166] Sadik-Khan and Solomonow, *Streetfight*, 21.
[167] Sadik-Khan and Solomonow, *Streetfight*, 19.

In 2009, Broadway, the diagonal street across the New York City grid, was closed to vehicular traffic at Times and Herald Squares. The grid around the closure was changed slightly to fix traffic flow issues that existed in the area. A more extensive plan, to slim Broadway into one lane and add a plaza at every square from 59th Street to 17th Street and Union Square, was turned down by Mayor Bloomberg. Instead, a program launched to pedestrianize Broadway first, temporarily, for six months, to test the closure and collect data on how it was used, and traffic results around it.[168] During the first day of the closure people stopped to take pictures, tap dancers and musicians performed, hot-dog vendors appeared, and some people even brought a baseball glove and played catch.[169] Times Square as a public plaza, was made permanent in 2012. Designed to be completed in stages, in part due to local utility work complexity, the pedestrianization of Broadway was completed in December 2016.[170] The final design was completed by the Norway based architectural firm Snøhetta. The design included new custom pavers made from pre-cast concrete and two different finishes embedded with nickel-sized still discs that reflect the neon glow from the signs above. A collection of raised volumes (design gestures according to the architect) hides utilities while doubling pedestrian spaces for seating and standing.[171]

Pedestrianization is a vital design process used to create walkable conditions for all abilities and ages. Pedestrianization and walkability go hand in hand. Successful pedestrianization supports walkability, meaning it encourages people to walk to places and spend time outdoors. Both activities are important to our physical and mental wellbeing.

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[168] Sadik-Khan and Solomonow, *Streetfight*, 93.
[169] Sadik-Khan and Solomonow, *Streetfight*, 99.
[170] "Times Square Transformation," Times Square official website, accessed February 10, 2020, https://www.timessquarenyc.org/times-square-transformation.
[171] "Times Square," *Snøhetta*, accessed February 10, 2021, https://snohetta.com/projects/327-times-square.

Walkability is also a cornerstone in the measurement of livability and sustainability of a neighborhood. For example, a Walk Score of a neighborhood, the level of access by walking to various amenities while being able to do so safely, has become a common tool in real estate estimates. In 2014, the number of Americans walking to work increased from 3,327,276 to 4,002,946 representing a 20% increase.[172] But a concerning trend began to emerge with pedestrian fatalities rising. In 2014, a pedestrian was killed every two hours and injured every eight minutes representing 15% of the total traffic fatalities in the US.[173] In NYC, Mayor Bill de Blasio announced Vision Zero, intended to eliminate traffic deaths in New York City. Through the program, the city introduced a speed cap of 25 mph on most urban streets and switched its focus to policing the street instead of redesigning it (a trend I will discuss in more depth in Subsection 5.2.3). Around the United States, pedestrianization projects remained mostly small scale. Conversions of small side streets or temporary car-free events became the most dominate pedestrianization tool. In 2015, pedestrian fatalities on American streets rose from 4,910 people to 5,495. In 2016, the percentage of pedestrian fatalities rose to 16% (of total traffic related fatalities), with almost 6,000 people killed. Seventy-six percent of pedestrian fatalities occurred in urban areas.[174]

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[172] "Strategic Agenda for Pedestrian and Bicycle Transportation," United States Department of Transportation Office of Planning, Environment, & Realty, accessed February 10, 2021, https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/strategic_agenda/page02.cfm#figure3.

[173] NHTSA, *Traffic Safety Facts: 2014 Data* (US Department of Transportation: National Highway Traffic Safety Administration, 2016).

[174] NHTSA, *Traffic Safety Facts: 2016 Data* (US Department of Transportation: National Highway Traffic Safety Administration, 2018).

Figure 3.4 NYC temporary street transformations. Top row (L-R): Street Lab play streets at 5th Avenue 58th-59th street; 34th Avenue at 93rd Street (Queens); and Lexington Avenue 101st Street. Second row (L-R): Times Square before and after; Broadway near Madison Square Park near the Flatiron building before and after; Dumbo (Brooklyn) Pearl Street before and after.

Source: Street Lab, Play NYC, New York City 5th Avenue 58th-59th street, 34th at avenue 93rd street (Queens)t, Lexington Avenue 101street, https://www.streetlab.org/programming-nyc-public-space/play/. Heidi Wolf and Julio Palleiro, Times Square before and after, in Street Fight (New York: Penguin Books, 2016), plate 6. Heidi Wolf, Broadway near Madison Square Park before and after, in Street Fight (New York: Penguin Books, 2016), plate 3. Ryan Russo, Pearl Street before and after, in Street Fight (New York: Penguin Books, 2016), plate 1.

In 2018, the percentage of the pedestrian fatalities rose again: 6,375 people were killed, making pedestrian fatalities 17% of total traffic fatalities.[175] As discussed in Section 2.3, the rise in pedestrian (and cyclist) fatalities is attributed to a collection of reasons, but most influenceable of them all is the urban form and the distribution of urban street spaces. During the first year of the COVID-19 crisis, at the height of the pandemic and urban quarantines, pedestrianization made a huge comeback. Municipalities closed streets to create urban public spaces and introduced a host of shortcuts to allow for pedestrian

[175] NHTSA, *Traffic Safety Facts: 2019 Data* (US Department of Transportation: National Highway Traffic Safety Administration, 2021).

friendly occupation of the curb. Most of the interventions are temporary in nature, but technically, so was the Broadway pedestrianization at Times Square, at first.

3.4.2 Bicycification

In 2021, the Ada County Highway District (ACHD), which handles all the roads in Ada County Idaho (a sprawling 1,000-square-mile region that includes the city of Boise), began measuring user experiences of pedestrians and bicyclists according to Livable Streets Performance Measures.[176] It is one of the first departments to adopt a measurement that mimic to driver's Level of Service (LOS), but prioritizes non-drivers. Bicycles' level of traffic stress (BLTS) and pedestrians' level of traffic stress (PLTS) are used to evaluate the performance of the street. In a press release announcing the new adoption, ACHD Commission President Kent Goldthorpe said, "I'm glad it's happening; it's making a lot of folks much more comfortable with the thought of riding or walking in our right of way going forward. For that I'm grateful."[177] The rise of bicycle use in the United States in the last two decades can be attributed, in part, to the increase in governmental investment in bicycle infrastructures like bike lanes and bike-sharing systems (stations). Rarely has investment included parking, retrofitted curbs, services, or interconnectivity with existing systems (being able to take your bicycle easily onto the bus or a train for a portion of your trip). Even so, the investments made to develop bicycle infrastructure have resulted in an

[176] Kea Wilson, "The Newest Bike-Friendly County in the U.S. is in Suburban Idaho?" *Streetblog USA*, June 29, 2021, https://usa.streetsblog.org/2021/06/29/the-newest-bike-friendly-county-in-the-u-s-is-in-suburban-idaho/.

[177] "ACHD to Begin Measuring Pedestrian, Bicycle Performance," Ada County Highway District News and Press Releases, June 24, 2021, https://achdidaho.org/News/Stories/2021/news_20210624_measure_ped_bike.aspx.

increase in urban cyclists. Between 2000 and 2017, bicycle commuting rose 43% across the United States, with more than 836,569 people commuting by bike in 2017.[178]

When NYCDOT began installing one of the city's first new bike lanes in Prospect Park, Brooklyn, in late 2010, it was called by a local tabloid newspaper "the most controversial slab of cement outside of the Gaza Strip."[179] The controversy, in a nutshell, was around the street transition from a car-only space to one shared with cyclists. Those who opposed the Prospect Park bike lanes opposed it for a specific change to the street: parking. It will be a common battle in New York and other American cities that will escalate to lawsuits preventing cities from pursuing non-automobile urban projects. (I discuss the 14th Street busway in New York in the following section on the red bus lane.) Lawsuits against bike lane construction are not common, instead opposition delays projects through the complex system of implementable urban design' that involves the community approval through local community boards. When NYCDOT was planning the installation of bicycle lanes between 2007 and 2009, it went through community board approval before it began the re-organization of the street. There was no new construction, only repainting driving lanes to be narrower and eliminating on-street parking lanes. Some projects simply moved the parking lane and made it "floating," meaning the curb became the space for the bike lane and the parking lane became a barrier between cyclists and traffic. Most of the first 200 miles painted on New York streets were welcomed or unremarked on by local communities. But the few who opposed the introduction of bicycle infrastructure, and fomented the bike backlash, highlights the tensions within communities.[180]

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[178] Ken McLeod, *Where We Ride: Analysis of Bicycle Commuting in American Cities* (2017 American Community Survey Data Report: League of American Bicyclists, 2017), 2.
[179] Sadik-Khan and Solomonow, *Streetfight*, 8.
[180] Sadik-Khan and Solomonow, *Streetfight*, 157-159.

The PlaNYC program that was introduced in 2007 required that the city build 50 miles of bike lanes a year.[181] Under Sadik-Kahn, the transition began with green paint that slightly matched to the green used for bulb-out extensions and new pedestrian spaces discussed in the previous section. Bike lanes change the street not just at intersections, but through the entire streetscape. Drivers took notice. The AASHTO *Guide for the Development of Bicycle Facilities* defines a bike lane as "a portion of a roadway which has been designated by striping, signing, and pavement markings for the preferential or exclusive use of bicyclists."[182] The NACTO *Urban Bikeway Design Guide* expands on the definition, specifying that a bike is " distinguished from a cycle track in that it has no physical barrier (bollards, medians, raised curbs, etc.) that restricts the encroachment of motorized traffic."[183] In the United States, most bike lanes are design to allow for vehicle access, what is seen in Figure 3.5 shared use lane and painted lanes, unsuitable for travel of all ages and abilities.

The NACTO *Urban Bikeway Design Guide* was inspired by the city of Vancouver, British Columbia, Canada, All Ages and Abilities (AAA) criteria for cycling facilities (as seen in Figure 3.5). AAA users are defined by NACTO as the non-traditional confident rider, meaning children, children who are smaller (school age); seniors who may not have the same physical abilities as younger adults, but are at higher risk of injuries resulting in life threatening consequences (people aged 65 and over); women who are more likely to be harassed; ride-share riders, people of color, low-income riders who are more likely to

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[181] The City of New York, *PlaNYC* (New York City, 2007), 87-88.
[182] "Bicycle Lanes," Federal Highway Administration, accessed March 10, 2021, https://safety.fhwa.dot.gov/PED_BIKE/univcourse/swless19.cfm.
[183] NACTO, "Bike Lanes," Urban Bikeway Design Guide, accessed March 10, 2021, https://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/.

be the target of law enforcement; people with disabilities, and people moving goods/cargo.[184] These groups of people are the people most likely to use a bicycle facility if it is comfortable and safe and much less likely if it was designed for the confident cyclists (adult male) only. The AAA criteria includes rules on designing cycling facilities and ensuring that the designed biking spaces are comfortable for all.

Figure 3.5 City of Vancouver All Ages and Abilities (AAA) Level of Comfort of bike lanes/routes.
Source: City of Vancouver, "Transportation Design Guidelines: All Ages and Abilities Cycling Routes," Version 1.1, March 2017.

A comfortable cycling lane is a lane that allows people on bikes to pass each other safely. A unidirectional lane should be at least 8ft (2.5m) and a bidirectional one 10ft (3m). It is well paved and clear of any obstacles. A comfortable cycling street is one that exists in a street that has a low vehicle travel speed (30 km/h or 18 mph) and volume or one that

[184] NACTO, *Designing for All Ages & Abilities: Contextual Guidance for High-Comfort Bicycle Facilities* (National Association of City Transportation Officials, 2017), 3.

has a physical separation between the bike lane and the busy street. A comfortable cycling route is a route that does not have too many intersections with vehicular traffic or is too close to a parking lane (26ft, 8m, to allow parking on one side and 33ft, 10m, to allow parking on both sides). It is a route that is well lit throughout the day/year and is protected from people as well as vehicular traffic.[185]

In the United States, most bike lanes cannot be defined as suitable for all ages and abilities. Lanes are almost always painted on a street designed for vehicular use. Routes are rarely completed, as lanes are designed per street and not as a complete network. Most lanes offer little protection from crossing pedestrians, obstructions, or vehicular traffic. Regardless, the bikes lanes that were introduced in New York, Seattle, Boston, and other cities across the country were being used. Between 2000 and 2011, bicycle commuting rose by 47% representing only 0.56% of the population.[186] What really pushed cycling forward in American cities was the introduction of bicycle-shares. As discussed earlier in this chapter, shared bicycle systems first made an appearance in the U.S in 2010 with 1,600 bikes in cities across the country. Much of the advancement in bicycle share use in the United States is attributed to CitiBike's expansion between 2010 and 2016, but other systems grew along with it, maintaining the growth of cycling trips in urban streets across the country. Washington, DC's Capital Bikeshare, Miami's CitiBike, and Chicago's Divvy saw a consistent but moderate increase in trips.[187]

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185 City of Vancouver, *Transportation Design Guidelines: All Ages and Abilities Cycling Routes* (City of Vancouver, 2017), 6.

186 Wendell Cox, "A Summary of 2011 Commuting Data Released Today," *New Geography*, September 20, 2012, http://www.newgeography.com/content/003088-a-summary-2011-commuting-data-released-today

187 "Bike Share in the US: 2010-2016," NACTO, accessed January 25, 2022, https://nacto.org/bike-share-statistics-2016.

Like pedestrianization, the term bicycification is meant to express the process of transforming a space fit for the use of cyclists. It includes physical infrastructure in its various forms, including lanes and parking facilities. It is also intended to include the policy and pragmatic changes necessary for a successful bicycle network. The bicycle lane, even painted and un-protected, changes the scale of a street by reducing the number of vehicles dedicated lanes. But lanes are not the only infrastructure required for a successful bicycle system. As we saw for pedestrians, there are temporary events, programming, and permanent expansions of infrastructure that together have created a trend of pedestrianization. The same is required for bicycification.

Several car-free events cater for both pedestrians and cyclists. NYC Summer Streets, for example, is designed to be a walking/cycling experience. Open Streets in general allows for flexibility, being part bicycle route, pedestrian path, and play/rest area. Other events such as the Bike Jumble in Brooklyn—a sort of bicycle flea-market with vendors selling new and used bikes, accessories, and even local non-profit cycling groups—provide the cycling community a place to meet each other outside of a bike lane.[188] In Austin, Texas, a similar event called FrankenBike, founded in 2005, offers a space for bicycle swap meetup. The event, held once a month, happens in cities across Texas, including Houston and San Antonio.[189] Urban Bicycle Gallery in Houston, Texas hosts the UBG Cycling Club for a weekly twenty-mile bike ride: one on Wednesday evening and another on Saturday morning with various routes around the city.[190] The San

[188] "New York Bike Jumble," accessed January 25, 2022, http://www.nybikejumble.com/about-1.
[189] "About FrankenBike," *FrankenBike the Ultimate Swap Meet*, accessed January 25, 2022, https://frankenbike.net/about/.
[190] "Riders and Event Calendar," *Urban Bicycle Gallery*, accessed January 25, 2022, https://www.urbanbicyclegallery.com/about/rides-and-event-calendar-pg182.htm.

Francisco Bicycle Coalition hosts rides, webinars, and coffee meetings. Providing training for beginning urban riders, the bicycle advocacy organization, one of the oldest in the country, offers classes for families, youth, and adults in both Spanish and English.[191] Membership which is not mandatory for access to the organization's resources, provides discounts to more than 70 local businesses.[192]

Organizations are rooted in communities, fostering relationships among riders and among riders and the commercial landscape of the city. There is the Los Angeles Party on Wheels and San Jose Bike Party, in which people on bike set out after dark[193] on a Friday night riding around the city. San Jose Bike Party is sponsored by the United States based Knight Foundation, with close to $2.5 billion in assets,[194] features a different starting location, route, and theme every month. Riders are encouraged to dress up per the theme, for example, in September 2021, with the theme of Under the Sea, the volunteers recommended "flippers and snorkels, get out your floaties, strap on your shark fins, and make sure your yellow submarine is in working order."[195] Some events take themselves more seriously than others, reflecting the diversity of the cycling community.

In Portland, Oregon, a World Naked Bike Ride (WNBR) is held every year as a community act of defiance: "we face automobile traffic with our naked bodies as the best way of defending our dignity and exposing the unique dangers faced by cyclist and pedestrians as well as the negative consequences, we all face due to dependence on oil, and

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[191]"Urban Bicycling Workshops," *San Francisco Bicycle Coalition*, accessed January 25, 2022, https://sfbike.org/resources/.
[192] "Membership," *San Francisco Bicycle Coalition*, accessed January 25, 2022, https://sfbike.org/membership/
[193] "Home." San Jose Bike Party, accessed January 25, 2022, http://www.sjbikeparty.org/
[194]"Financial Information: Assets and Grantmaking," *Knight Foundation*, accessed January 25, 2022, https://knightfoundation.org/about/financial-info/.
[195]"SJBP Presents the Under the Sea Ride!" San Jose Bike Party, September 16, 2021, http://www.sjbikeparty.org/2021/2861307807533229/.

other forms of non-renewable energy."[196] A global event of riding "as bare as you dare," it is hosted in locations across the United States, but Portland's is the largest with attendance reaching 10,000 in 2014.[197] Since the first ride in 2004, with only 125 cyclists, the ride's appeal has broadened beyond protesting oil dependency, to embody celebrating riding a bike.[198] Riding means different things to different people. In a short documentary made by volunteers about the WNBR in Portland, people share why they ride. Some do it to celebrate their bodies, remind themselves of their own autonomy; others ride for self-expression, to find community, and to break boundaries.[199]

In New York, there are several well-known bike rides, the Tour de Bronx offers an advanced riding experience and the Five Boro Bike Tour. The Five Boro Bike Tour first ran in 1977 as a celebration of the urban landscape. About 200 bicycle clubs' members and 50 high schools' students rode 50-miles from Flushing Meadows-Corona Park in Queens to south Brooklyn and over the Verrazano-Narrows Bridge into Staten Island. A ferry ride, through Manhattan, into the Bronx, and back to Queens over the Throgs Neck Bridge concluded the ride back in its Queens starting point. In 1978, under newly elected mayor Ed Koch, city hall gave its support to the event but requested it be shortened to 40-miles. In return, organizers enjoyed the support of the New York City Fire Department and Emergency Medical Services and the Department of Transportation involvement in making the route car-free. Today, more than 32,000 cyclists (capped by city officials) from around the United States and the world attend the event.[200] In the Tour de Bronx riders can choose

[196] *World Naked Bike Ride*, accessed January 25, 2022, http://worldnakedbikeride.org/.
[197] "History," *Portland Naked Bike Ride*, accessed January 25, 2022, https://pdxwnbr.org/history/
[198] "Why," *Portland Naked Bike Ride*, accessed January 25, 2022, https://pdxwnbr.org/why/.
[199] Ian McCulskey, "Bare as Your Dare: Portland's World Naked Bike Ride," Vimeo video, May 6, 2013, 00:17:04 https://vimeo.com/65591403?embedded=true&source=video_title&owner=5832098.
[200] "Our Story," Bike New York, accessed January 25, 2022, https://www.bike.nyc/about/our-story/.

one of two routes, either 25-miles or 40-miles, that take them through the borough's Mott Haven district, the East River, and Pelham Bay Park, a park with 3,000 acres of natural forest. It is a daylong event that ends at the New York Botanical Garden, with each rider receiving a complimentary t-shirt as a souvenir.[201]

Races are not as common as the types of urban biking gathering that has become dominant in American cities with few bike lanes or a bicycle-sharing system. The organization People for Bikes, a non-profit advocating and promoting cycling and bicycle infrastructure in the United States, keeps an ongoing list of bike rides shared by other riders, local bike shops, and advocacy groups.[202] Called Ride Spot, it includes an app that people on bikes can use to navigate tours like a 33.5 miles route through Minneapolis best bikeways and local artists murals[203] or a 3.5 miles ride through downtown Los Angeles titled the Half Dozen Donut Ride with stops at six donut shops.[204]

Bicycification is meant to encompass the activities that can be facilitated once there is physical infrastructure (the bike lanes and access to bicycles) and the communal infrastructure that evolves as more people bike. But it is still very dangerous to bike on American urban streets because while there was cycling boom with unprecedent number of cycling and continued investment in bicycling infrastructure, streets are still designed to accommodate vehicular traffic. As discussed in section 2.3, the increase in vehicle size also contributed to an increase in pedestrian and cyclist deaths. Since 2015, more than 800

[201] Jonas Bronck, "Tour de Bronx 2019," *The Bronx Daily*, October 2, 2019, https://bronx.com/tour-de-bronx-2019/

[202] "Ride Spot," People for Bikes, accessed January 25, 2022, https://www.ridespot.org/.

[203] "Ride Spot Minneapolis Murals + More," *People for Bikes*, accessed January 25, 2022, https://www.ridespot.org/rides/1637.

[204] "Ride Spot Half Dozen Donut Ride," *People for Bikes*, accessed January 25, 2022, https://www.ridespot.org/rides/185716.

people on bikes were killed every year on American roads.[205] In response to this growing crisis, cyclists have responded as a collective through a growing presence on urban streets. As discussed, there has been a growing number of events and types of cycling events, some of which are based on the concept (and event) known as Critical Mass.

In 1992, cyclists in San Francisco would gather every month to celebrate cycling. It was an expression of solidarity to send a message to the public that "we are not blocking traffic, we *are* traffic!"[206] Similar to the WNBR, Massers would ride with costumes, decorate their bikes with noise makers and signs, and play music. There is safety in numbers and Critical Mass is an event that puts large amount of people on the urban street making a point to ensure that everyone else on that street sees them too. By the turn of the century, Critical Mass was critiqued for its confrontational nature.[207] There are no leaders in Critical Mass events, no routes pre-determined or planned, it is an "organized coincidence" ride. But in 2009, Chris Carlsson, a Critical Mass founder, issued the first "official" written statement including a list of "Dos and Don'ts" that asks rides to not ride into oncoming traffic, on the wrong side of the road or pick fights with drivers "even (especially) if they're itching for one." It instead reminds riders to talk to strangers and welcome them to join next time, help drivers stuck in the middle of the mass exit, stop at red lights to allow the mass to catch up, and slow down, "critical mass depends on bicycle density to displace car."[208]

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[205] "Number of Annual Bicyclist Fatalities," *The League of American Bicyclists*, accessed March 20, 2022, https://data.bikeleague.org/show-your-data/national-data/nation-bicyclist-pedestrian-road-safety/.
[206] Zack Furness, "Critical Mass Rides Against Car Culture" in *Cycling-Philosophy for Everyone: A Philosophical Tour de Force,* ed. Fritz Allhoff, Jesús Ilundáin-Agurruza, and Michael W. Austin (Chichester; Malden, MA: Wiley-Blackwell, 2010), 134.
[207] John Stehlin, "Regulating Inclusion: Spatial Form, Social Process, and the Normalization of Cycling Practice in the United Sates," *Mobilities* 9, no. 1 (2013): *7*.
[208] "Critical Mass Do's & Don'ts," *San Francisco Critical Mass*, October 27, 2009, https://www.sfcriticalmass.org/2009/10/27/critical-mass-dos-donts/.

Critical Mass inspired other events (Party Rides) that did not want to be even semi-confrontational. While not all Critical Mass riders see it as a defiance, the public often does because it is an alternative (that also blocks vehicular traffic) to what the public knows and understand the public street to be. Critical Mass Houston, for example, warns its riders not to show aggression to drivers as "they sometimes show their frustration by honking or yelling at the mass." Instead, the organizers remind riders that the mass is a casual bike ride, "cars rule the road every day, but one day a month we get together to celebrate out love for bicycles and have fun riding out bikes."[209] Miami Critical Mass also reminds riders to avoid altercations: "if any irate drive honks or yells at you simply ignore them or just smile and say 'thank you' and/or wish them a 'Happy Friday.'"[210] Critical Mass is a response to the conditions, and lack thereof, of bicycle infrastructure and accountability to people on bikes. A day before Houston 2021 Critical Mass, the first after a yearlong break due to COVID-19, 18-year-old Juana Boada was hit and killed by a driver. The driver was not charged.[211] The duality of high cyclist fatalities and the lack of public outrage (like the lack of concern over pedestrian deaths) has birthed the Ghost Bike, memorials installed on urban streets in locations where a cyclist was killed. It is a monument and a warning.

Bicycification, as a term describing both the physical system and cultural meanings that come with the use of the bicycle, as an urban-mobility vehicle, requires Ghost Bikes be included in this discussion. They are as much part of the contemporary bicycle infrastructure of the American urban street as bike-lanes. Ghost Bikes first appeared in St.

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[209] "Home," *Critical Mass Houston*, accessed March 22, 2022, https://www.criticalmasshouston.com/.
[210] "Critical Mass," *The Miami Bike Scene*, accessed March 22, 2022, https://www.themiamibikescene.com/p/miami-critical-mass-guidelines.html.
[211] Jay R. Jordan, "What I Learned Riding with Critical Mass, Houston's Most-Hated (and Misunderstood) Bike Ride," CHRON, June 23, 2021, https://www.chron.com/news/houston-texas/transportation/article/critical-mass-houston-bike-ride-date-time-meet-16216772.php.

Louis around 2003, when Patrick Van Der Tuin witnessed a female cyclist hit by a driver from behind. While the cyclists' injuries were minor, Der Tuin, who lived a block away from where he saw the incident, decided to take broken bicycles, paint them white, and place them in locations where cyclists were injured or killed. According to Der Tuin, who called the project at the time "Broken Bikes, Broken Lives," the first white-painted bike didn't last 24 hours.[212]

While Der Tuin intended the white bikes to be temporary, families in St. Louis began taking care of the memorials. Ghost Bikes got their name in Pittsburgh from Eric Boerer, who was running the community bicycle cooperative Free Ride, an organization dedicated to the reuse and recycling of bicycles, almost like a repair shop, but with educational facilities open to the public.[213] Together, they registered the domain ghostbikes.org and began installing Ghost Bikes in intersections where cyclists have died. Between 2003 and 2012, more than 630 Ghost Bikes were placed in over 210 streets around the world.[214] Jessie Singer, a journalist and author of *There Are No Accidents*, writes about the experience of building Ghost Bikes. Singer has helped build more than 250 Ghost Bikes in New York alone. In 2020, she was part of the effort to build 14 Ghost Bikes for some of the 22 people killed on bikes in New York that year. To make a Ghost Bike, the group looks for a bike that is no longer working. The idea is never to take a functioning bicycle off the road. A stencil is made, a sign to fit along the painted bike, with the name and age of the rider and how the rider died, (Killed by Truck or Car), followed by Rest in Peace.

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212 Madeleine Thomas, "The Story of "Ghost Bikes": How a Bike Memorial in St. Louis Sparked a Global Movement," *Grist*, October 7, 2015, https://grist.org/living/the-story-of-ghost-bikes-how-a-bike-memorial-in-st-louis-sparked-a-global-movement/.
213 "Home," *Free Ride Pittsburgh*, accessed March 21, 2022, https://freeridepgh.org/.
214 "Locations," Ghostbikes.org, accessed March 21, 2022, http://ghostbikes.org/locations.

The group then goes to the site of the crash, locks the white bike to a street sign, installs the plaque, and hopes they will never have to do it again.[215]

3.4.3 Red Bus Lane

Unlike other city-wide transit systems (subways and light-rails for example), bus systems do not require the same financial or infrastructural investment. Even bus rapid transit (referred to as BRT) infrastructure requirements are not nearly as great as those of light-rail or any other surface transit systems. The Institute for Transportation & Development Policy (ITDP) defines BRT through five features: 1) dedicated right of way with bus-only lanes ensuring that buses are not delayed due to mixing with traffic; 2) bus-only corridors or placing bus lanes at the center of roadways to avoid the curb; 3) off-board fare collection where payment is done at the station instead of on the bus; 4) organizing traffic by prohibiting traffic turns across the bus lane to reduce delays by turning traffic; and 5) stations should be at level with the bus for quick boarding.[216] In short, BRT has all the features associated with light-rail/trams without the need to install tracks.

In 2000, Bogotá, Colombia launched the TransMilenio, a BRT system with buses moving in dedicated lanes separated by barriers to not mix with general traffic. People pay their fare at the station before boarding the bus, which can be boarded from all of its three doors. When the system launched, it cost the city 5% of the cost of a new metro system. By 2008, the TransMilenio was able to carry more than 2.2 million daily passengers on eleven routes. Around the same time (2008), the New York City bus system, which moves an average of 2.5 million passengers a week, was traveling at a speed of about 4.7 miles

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[215] Jessie Singer, "I Build Ghost bikes. Here's What It's Taught me About Who Dies on a Bike," *Bicycling*, December 2, 2020, https://www.bicycling.com/culture/a34703255/ghost-bikes-memorials-for-cyclists/.
[216] "What is BRT?" *Institute for Transportation & Development Policy*, accessed March 21, 2022, https://www.itdp.org/library/standards-and-guides/the-bus-rapid-transit-standard/what-is-brt/.

per hour (7.5km).[217] Inspired by what was happening in Bogotá, then NYCDOT commissioner Janette Sadik-Khan worked with the Metropolitan Transportation Authority (MTA) to launch a BRT like system through a network called Select Bus Service (SBS). The city adopted a collection of TransMilenio inspired elements, but the two systems cannot really be compared.

In New York, the SBS stations remained minimal with a poll and sign that notes the station. A small ticket machine was added to allow for passengers to buy tickets not on the bus. Instead of raising platforms to match traditional buses, the city secured low-floored buses; but one problem remained: not being able to physically separate the bus lane from traffic, meant, no guarantee that the bus lane remains free of obstructions to be a successful and operating BRT system. The solution was paint and technology. At the time, as discussed in the previous two sections, paint was a very popular trend in urban planning: painting the bus lane red and using cameras to enforce the bus lane by issuing tickets to any car that drives, stops, or dawdles on the lane.[218] But challenges remained as temporary interventions, like red painted bus lanes, are subject to federal law. According to the *MUTCD*, painted red bus lanes are not allowed to be used if the transit lane is part time or allows pick-ups and drop-offs, which is what every bus does on a bus lane.[219]

The first red bus lane in New York was painted on 57th Street in 2007 and the second on 34th Street in 2008. Following those experimentations, other city agencies adopted the tool. In San Francisco, ten miles of red bus lanes were installed between 2013 and 2016. The San Francisco Municipal Transportation Agency completed evaluation of red bus lanes

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[217] Sadik-Kahn and Solomonow, *Streetfight*, 235-236.
[218] Sadik-Kahn and Solomonow, *Streetfight*, 238.
[219] "End the Red Tape for Red Bus Lanes," *Transit Center*, May 11, 2021, https://transitcenter.org/end-the-red-tape-for-red-bus-lanes/.

(2017) found that red treatment reduced the number of violations by 48 to 55 %.[220] In 2017, the Maryland Transit Administration added 5.5 miles of red painted bus lanes,[221] and in 2019, Washington, DC, H and I streets NW past the White House, were painted red between Pennsylvania and New York avenues. The bus lane is only active for a limited amount of time during the day in DC, between 7am-9:30am and 4pm-6:30pm on weekdays. The rest of the time, they serve as parking lanes.[222]

Figure 3.6 Better Market Street section between 5th and 8th Street in San Francisco.
Source: Better Market Street Fact sheet, http://bettermarketstreetsf.org/about.html.

In 2019, New York installed a red bus lane on 14th street in Manhattan, it went a step further, closing the entire street to private vehicular traffic, sort of. Like in DC, the 14th Street red bus lane only operates between 6am-10pm. Other vehicles must make the first available right turn away for 14th street if they need to enter the street for local access to businesses or garages. Between 10pm-6am, any vehicle may drive through 14th Street.

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220 San Francisco Municipal Transportation Agency, *Red Transit Lanes Final Evaluation Report* (Federal Highway Administration, Office of Traffic Operations: California Traffic Control Device Committee, 2017), 2.

221 Colin Campbell, "Do Police Actually Ticket Drivers for Illegally Using Baltimore's Red, Bus-Only Lanes?" *The Baltimore Sun*, April 9th, 2019, https://www.baltimoresun.com/maryland/baltimore-city/bs-md-mta-bus-lanes-report-20190409-story.html.

222 David Alpert, "DC Rolls Out the "Red Carpet" for New Bus Lanes," *Greater Greater Washington*, May 28, 2019, https://ggwash.org/view/72297/dc-rolls-out-the-red-carpet-for-new-bus-lanes.

So, it's a transit corridor for more than half of the day and a traditional street during the night.[223] In San Francisco, similar actions were taken on Market Street. The bus lane is in the center of the street, unlike most red bus lanes in the United States, which are still at the curb. As seen in Figure 3.6, the only travel lanes are dedicated to transit, while the rest of the street is allocated for people walking and on bicycles or other micromobility devices.

Figure 3.7 Worst bus stations from Streetblog sorriest bus stop competition: Houston, 20th Street and Durham, 2015; St Louis under Interstate 70, 2017; Encinitas, California, 2015.
Source: Angie Schmitt, "America's Sorriest Bus Stop: Omaha vs. St. Louis," Streetblog USA, 6 September, 2017, https://usa.streetsblog.org/2017/09/06/americas-sorriest-bus-stop-omaha-vs-st-louis/ & Angie Schmitt, "It's Time to Vote for the Sorriest Bus Stop in America," Streetblog USA, 6 February, 2015, https://usa.streetsblog.org/2015/02/06/its-time-to-vote-for-the-sorriest-bus-stop-in-america/.

Until the red painted lane, the most significant infrastructural contribution of the bus network to the urban street was its stops (stations), which in the United States often come in the form of a single poll with a sign containing the bus's numbers. Streetblog, an online news outlet that began operating in 2006, covers the movement to transform cities by reducing people's dependency on private cars and improving conditions for pedestrians, cyclists, and transit riders.[224] It runs a yearly competition to find the sorriest American bus

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[223] "14th Street Busway," NYCDOT, accessed March 25, 2022, https://www1.nyc.gov/html/brt/html/routes/14th-street.shtml.
[224] "About," *Streetblog USA*, accessed March 25, 2022, https://usa.streetsblog.org/about/.

stations, asking readers to submit images of the most neglected, dangerous, bus stops in the United States.[225] Between 2015 and 2018, the competition was run by Angie Schmitt, author of *Right of Way*, about the growing pedestrian death crisis in the United States. Figure 3.7 depicts three stations submitted to Streetblog showing poor conditions, lack of people focused design and poor urban conditions for pedestrians in general. There are no shelters or benches and, in some cases, no sidewalk or crosswalk to give access to the bus station.

3.4.4 Curbs

The curb connects cyclists, pedestrians, and drivers. This space between the sidewalk and the roadway is often expressed through minor elevation changes in urban streets. It is a space that is not directly part of the sidewalk and not really part of the roadway. Adjacent to both, the curb space is used as an in-between boundary between the realm of the pedestrians (on the sidewalk) and car drivers (on the road). As discussed in the previous section, cycling infrastructure has often come as a replacement to existing curb usage, which in most American cities is parking. Depending on the street, the curb then becomes even more complex, serving parking needs for drivers as well as barriers for pedestrians and cyclists. An almost invisible space in the urban street, the curb is distinguished from the roadway or the sidewalk for its program which in the United States is often used for private car storage (on-street parking), loading areas, and pick-up zones. In short, the curb is often used in the service of the automobile system.

The curb has two main users in the contemporary American urban street: the private driver and the commercial/delivery driver. The private driver is mostly concerned with the

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[225] Angie Schmitt, "Help Streetblog Find the Sorriest Bus Stop in America," *Streetblog USA*, January 27, 2015, https://usa.streetsblog.org/2015/01/27/help-streetsblog-find-the-sorriest-bus-stop-in-america/.

curb for parking. The delivery driver is concerned with temporary parking, but with a more complex list of requirements, including needing space to off-load boxes safely. Improved management of the curb has increasingly emerged as a vital piece of the urban mobility puzzle. In 2005, Donald Shoup, a Distinguished Research Professor in the Department of Urban Planning at UCLA, published *The High Cost of Free Parking*, a book about the financial, environmental, and societal consequences of providing free parking in urban places. Shoup's work focused on minimum parking requirements that force developers to offer a certain number of parking spots per designated commercial space. He also made the connection between free parking and reliance on cars. Parking, Shoup argues, is a passive part of the transportation system affecting land use, urban design, and urban form. Parking influences urban form in a very specific way.

People are more likely to buy a car when there is free parking available, which encourages the owner to drive the automobile. As a result, people drive more miles wanting more driving lanes with lots of parking. Which causes the center city's public transportation infrastructure to deteriorate, which in turn increases vehicle ownership, and so on.[226] Not only does providing parking increase the likelihood of people getting a car, the cost of parking spaces in the US exceeds the value of all cars and roads. Even though it is often provided for free, a parking spot costs a city an average of $125 a month.[227] Beyond cost and because cities require parking to be designed for peak demand for all land uses (including work, school, or commerce), there are many cities in which the curb and the sidewalk are adjunct to parking. This in turn influences the experience and safety of the pedestrian and cyclist creating vast areas of asphalt occupied only by vehicles.

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[226] Donald Shoup, *The High Cost of Free Parking* (Chicago: Routledge, 2005), 129.
[227] Shoup, *The High Cost of Free Parking*, 185.

Is the curb parking a public good? Shoup argues that curb parking spaces are closer to being private good than public ones. He stresses the fact that the social cost of not charging for parking, traffic congestion, air pollution, and crashes are huge.[228] Looking for parking, which if often not directly connected to parking itself in the minds of urban designers, also has consequences for the street. It is an urban planning blind spot going back to Le Corbusier's *Radiant City* (*Ville Radieuse*) with real consequences on urban form. In Washington, DC, San Francisco, Los Angeles, and New York, people spend more than ten minutes per trip driving on streets searching for parking at more than $1,200 cost per drive. Overall, people in New York search for parking an average of 107 hours per year, followed by Los Angeles, where drivers look for parking an average of 85 hours a year.[229]

A group of friends in San Francisco also questioned the role of the curb during a discussion of how cheap parking spaces were in the city. In fact, parking was the cheapest piece of San Francisco real estate. Calling themselves Rebar Art and Design Studio, they discovered that it was not illegal to put something other than a car in a parking space, and they came up with a simple idea for an urban park in a parking space. The firm Park(ing) installation in November 2005, at 1st and Mission Street, was held for two hours with the organizers paying the parking meter.[230] In place of a car, the group laid down a grass carpet, a bench, and a potted tree. When pictures of the tiny park appeared online, people took an interest in recreating the idea. The Trust for Public Land (TPL), a nonprofit land

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228 Shoup, *The High Cost of Free Parking*, 296.
229 "Searching for Parking Costs Americans $72 Billion a Year," INRIX, July 12, 2017, https://inrix.com/press-releases/parking-pain-us/.
230 "The Origin Story," *Park(ing) Day*, accessed March 25, 2022, https://www.myparkingday.org/about.

conservation organization, funded the creation of an official Park(ing) Day in 2006. A year later, more than 150 park(ing) spots were in more than 42 American cities.[231]

In cities all around the United States, the ideas and tools of tactical urbanism began showing up in myriad ways. In bike lanes and Complete Streets programs, paint and temporary furniture were used to create a new kind of urban street.[232] In 2009, the city of San Francisco created a Pavement to Parks (P2P) program, which is credited with the creation of the first parklet. Parklets the size of a parking spot are more permanent even if they are removable; built to match the sidewalk height they often include built-in seating. Inspired by the work being done in New York to pedestrianize spaces through paint, the P2P program installed more than 60 parklets around San Francisco.[233]

By 2019, it seemed as if every other city had Parklets guidelines or a design manual, or an application process for businesses to apply for a parklet as part of a collection of other small-scale urban interventions. Pedestrianization (as a trend) made the Parklet became a standard feature in the urban planning toolkit and was seen in city streets around the United States. The programs that evolved were based on community applications, operation, and maintenance requiring funding resources and were usually allowed only for a limited time. For example, in Los Angles, the People ST Parklet requires an eligible organization[234] and a community partner with a history of public realm improvements and the capacity to

[231]Aaron Naparstek, "StreetFilms: Park(ing) Day 2007," *Streetblog NYC*, September 24, 2007, https://nyc.streetsblog.org/2007/09/24/streetfilms-parking-day-2007/.
[232] "Parklet," NACTO, accessed March 25, 2022, https://nacto.org/publication/urban-street-design-guide/interim-design-strategies/parklets/.
[233] "Case Study: Pavement to Parks; San Francisco, USA," *Global Designing Cities Initiative*, accessed March 25, 2022, https://globaldesigningcities.org/publication/global-street-design-guide/streets/pedestrian-priority-spaces/parklets/case-study-pavement-to-parks-san-francisco-usa/.
[234] A Community Benefit District, Community Improvement District, Chambers of Commerce, a ground-floor business owner, a fronting property owner, a nonprofit / community-based organization.

maintain the parklet daily.[235] Construction and installation of a parklet runs between $40,000 and $80,000, not including the cost of maintenance. The Los Angeles DOT (LADOT) provides a Kit of Parts for Parklets that includes eleven parklet models, which helps cut design costs for organizations. The parklet models are organized into three types: a sidewalk café, a sidewalk extension, and a landscape lounge. Each model provides a variation of benches, furnishings, planters and perimeter design, while focusing on specific needs per the type of parklet. The sidewalk café can hold the most seating and tables and is meant to be used for meals and meetings. The sidewalk extension only has a few seats, mostly providing more walking room. The landscape lounge is a mix of the sidewalk café and extension, with seating and planters.[236] LADOT parklet application resources are part of the city Livable Streets program, which also includes a Vision Zero policy, a Safe Routes to School program, and Play and Open Streets.[237]

Parklets in Boston are either funded privately or by the city transportation department (only one or two parklets a year). Parklets for Café seating require a separate application. An application requires a series of street-level photographs of the proposed curb space and its existing conditions, as well as one aerial view indicating the proposed parklet location. Successful applicants for a parklet become an official Parklet Partner and must sign a Memorandum of Understanding (MOU) with the Boston Public Improvement Commission. The MOU clearly defines the role of the Parklet Partner, regular maintenance, cleaning, and watering plants, and the role of the city, dismantling and reinstalling the

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[235] LADOT, *Parklet Application Manual* (Los Angeles: Department of Transportation, 2020), 12.
[236] LADOT, *Kit of Parts for Parklets* (Los Angeles: Department of Transportation, 2020), 8.
[237] "Great Streets Support Our Communities," *Los Angeles Livable Streets*, accessed April 1, 2022, https://ladotlivablestreets.org/.

parklet and maintaining bollards.[238] The Boston Transportation Department (BTD) parklet program is part of the city's Tactical Public Realm. It includes a host of urban street interventions beyond parklets and outdoor parklet cafés, including street murals and tactical plazas. Tactical Plazas are large scale curb extensions that close a redundant street or fill in a redundant lane, square a street corner or fill in a diagonal intersection to the grid.[239] These plaza infills are similar to the plazas of New York (discussed in 3.4.1), and like Parklets, they are intended to expand pedestrian space.

As these examples show, the curb is being re-imaged from a space of parking and travel to a public space serving pedestrians occupying the sidewalk. Between 2000 and 2017, supported by increased municipality investment in bicycle infrastructure and introductions of bicycle sharing networks, bicycle commuting rose 43% across the US, with more than 836,569 people commuting by bike in 2017.[240] A new curb situation started to appear, whereby cyclists were the only vehicles traveling beside pedestrians on the sidewalk. But bike lanes were mostly painted rather than constructed, making it easy for vehicles to obstruct them. This became common with the increase of ride hailing and urban delivery. The rise of ride-hailing complicated the use of the curb because, unlike traditional transit (buses) with dedicated stops ride-hailing flexibility made the entire curb a potential pick up/drop off station. A 2021 study found that ride-hailing, taxis, delivery, and commercial vehicles violate curb parking regulations more than 60% in Austin, TX; Portland, OR; San Francisco, CA; Santa Monica, CA; and Washington, DC.[241] Delivery

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[238] Irene Figueroa-Ortiz, Vineet Gupta, Time Love, Jessica Robertson, Joshua Simoneau, Andrew Nahmias, *Boston Tactical Public Realm Guidelines* (Boston: A Better City, 2018), 18-19.
[239] Figueroa-Ortiz et al, , *Boston Tactical Public Realm Guidelines*, 9.
[240] McLeod, *Where We Ride*, 2.
[241] Anna Brown, Nicholas J. Klein, Calvin Thigpen, and, Nicholas Williams, "Impending Access: The Frequency and Characteristics of Improper Scooter, Bike, and Car Parking," *Transportation Research Interdisciplinary Perspective* 4 (March 2020): 1-2, 14.

trucks stop on crosswalks and block pedestrians, cyclists, and drivers' routes to be able to unload their trucks and deliver packages. Uber and Lyft double park to drop-off/pick up passengers. Coupled with pedestrian expansion of the curb and the increased introduction of bicycle lanes adjunct to the curb, complications continue to arise. Having no place to unload, delivery workers are constantly put at risk and are burdened with disrupting urban circulation due to the size of delivery trucks and lack of curb loading zones in most urban centers.

In 2019, FedEx incurred over 146,019 violations in New York alone, paying the city $9.8 million. UPS had triple the violation, 348,890 totaling at $23 million in fines. Overall, the city of New York made about $123 million from commercial parking fines. Fines for companies such as FedEx and UPS are reduced as part of the NYC Department of Finance Optional Stipulated Fine Program, which allows business to waive the right to challenge parking tickets for a reduced amount for each offense.[242] In many other cities around the United States, delivery vehicles parking violations are rarely ticketed but that does not mean that the disruption the violation caused is not meaningful. A truck blocking a crosswalk puts at risk every pedestrian attempting to cross that particular street, not just because it physically blocks the crosswalk but also because it limits the field of vision for other drivers. Pedestrians and cyclists alike are forced out of their dedicated infrastructure into vehicular roadways that are filled with large and heavy machines. Obstruction of bicycle lanes by private and delivery vehicles has grown steadily in the US since in the last few years. As most American bike lanes are painted and unprotected in any physical way, it is easy for drivers to ignore the reallocation of space and use it for parking/idling for a

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[242] Linda Baker, "New York City Hit UPS with $23M in Parking Fines in 2019," *Fright Waves*, February 13, 2020, https://www.freightwaves.com/news/ups-hit-with-22m-in-nyc-parking-fines.

host of reasons. A study conducted in NYC around 2018 found that bike lane obstructions by vehicles accounted for only about 18% of all obstructions. At more than 50%, the most common obstruction of bicycle infrastructure was objects (bags of trash, garbage cans, shopping carts).[243]

The curb, the road, and the sidewalk that it serves, is already filled with a collection of objects that are part of larger scale infrastructural systems, as well as specific spatial programming. There are benches, newspaper stands, and trashcans for pedestrian use but also mailboxes, parking meters, and traffic lights. While every street curb is managed differently depending on the context, its role as the adjacent circulation space for pedestrians has been overtaken by certain ideas about the future use of the street.

All around the US, a collection of delivery collaborations between AV focused companies and grocery stores /other commercial companies. UPS is collaborating with Waymo to deliver parcels in its self-driving Chrysler Pacifica in the metro region of Phoenix. The minivans will take parcels from various UPS locations and move them to a local sorting facility for processing. The pilot didn't include delivery to costumers. Waymo has also partnered with Walmart to test autonomous rides for grocery pickups. Walmart's online grocery business increased rapidly since its inception, with online sales in the third quarter of 2019 growing by 41%, bringing its earnings to $1.16 a share on revenue of $127.99 billion. It was Walmart's 21st quarter of growth in the United States.[244] All of this before COVID-19 precipitated greater reliance on online shopping. Walmart does not

[243] Corey H. Basch, Danna Ethan, and Charles E. Basch, "Bike Lane Obstructions in Manhattan, New York City: Implications for Bicyclist Safety," *Journal of Community Health* 44, no. 12 (December 2018): 397.
[244] Lauren Thomas and Courtney Reagan, "Walmart Earning Beat Estimates, Shares Rise on Higher Outlook Ahead of Holidays," *CNBC*, November 14, 2019, https://www.cnbc.com/2019/11/14/walmart-wmt-reports-q3-2020-earnings.html.

operate its own delivery service, relying on partners to facilitate deliveries. Offering more than 3,100 pickup locations, Walmart has collaborations with both Uber and Lyft and maintaining programs with Postmates, DoorDash, Roadie, AxelHire, Skipcart, and Point Pickup. These are all companies operating under the "uber" model, providing digital platforms for people (consumers) to use their own means to provide a service, in this case, delivery of goods from Walmart locations. But roads are busy, filled with traffic, and even if you remove the driver by using autonomous technology, companies are always in search of other spaces to use for delivery, which is where the non-flying sidewalk drone comes in.

The sidewalk-drone rides on four to six wheels and is about the size of a large picnic basket. The robot is autonomous, relying on technology similar to AV. Unlike the robodogs of MIT Boston Dynamic (shown as part of Continental CUbE proposal), these sidewalk drones complete the full length of a delivery from mailroom to consumer independently on pedestrian infrastructure, the sidewalk (robodogs often require a handler operating certain functions). There are two main companies dominating the sidewalk drone field. Starship Technologies, launched in 2014 from Estonia, and Amazon Scout, which debuted around 2019 after the company purchased Dispatch, an urban delivery robot startup in 2017.[245] Starship Technologies was co-founded by Janus Friis and Ahti Heinla, also of Skype; by 2016 their self-driving delivery robot drove more than 3,100 miles (5,000 km) around Europe, encountering more than a million people. It then began collaborating with American universities, including George Mason University in Fairfax, Virginia and

[245] Mark Harris, "Amazon Quietly Acquired Robotics Company Dispatch to Build Scout," *Tech Crunch*, February 7, 2019, https://techcrunch.com/2019/02/07/meet-the-tiny-startup-that-helped-build-amazons-scout-robot/.

Northern Arizona University in Flagstaff, University of Pittsburgh (PA), and University of Texas at Dallas. Starship Technologies robots at George Mason University, the first college campus to use the technology, could deliver items from a local pizza place or campus convenience store, as well as Dunkin' Donuts or Starbucks for a small fee.[246] Traveling at up to 4mph (6 km/h) at a weight of about 79 pounds (around 35kg) when empty and able to carry up to 20 pounds (10kg), the starship robot is small and allows easy engagement. University of Texas at Dallas interim director of food and retail service describes putting a hat on the robot and letting it roam. It appeared in the University homecoming parade and in a campus holiday scavenger hunt. A *Dallas Morning News* article on the robots reports that students link the robot to Wall-E, the Pixar movie character.[247]

In Toronto, a company called Tiny Mile designed its autonomous sidewalk delivery robot painted pink with heart eyes, playing to the perception of the robot not as a public nuisance but as an adorable object in public spaces. Gita, Italian for "short trip," is a storage robot that follows around its owner with computer sensor vision and can carry up to 40 pounds of cargo. The design of this sidewalk object is a collection of colors (red, citron, beige, blue, gray) and two sizes (a mini version that can carry up to 20lb).[248]

The Tiny Mile and the Starship robots spend their time on sidewalks. On Starship's website FAQs, the company notes that "the robot can travel anywhere a pedestrian can walk but mainly sidewalks."[249] The robot avoids obstacles, including people walking,

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[246]Mary Lee Clark, "There are Robots on Campus – Here's What You Need to Know," *George Mason University* news, January 22, 2019, News, https://www.gmu.edu/news/2019-01/there-are-robots-campus-heres-what-you-need-know.
[247] Melissa Repko, "On University of Texas at Dallas' Growing Campus, Meal-Delivering Robots Make Splashy Debut," *The Dallas Morning News*, December 26, 2019, https://www.dallasnews.com/business/technology/2019/12/26/on-university-of-texas-at-dallas-growing-campus-meal-delivering-robots-make-splashy-debut/.
[248] "Home," Gita website, accessed March 1, 2022, https://mygita.com.
[249] "Starship FAQ," Starship website, accessed February 26, 2022, https://www.starship.xyz/contact/faq/.

people on bicycles, dogs, or broken up sidewalks through a mix of GPS, sensors, cameras, and radars, just like AVs. In an interview with *Quartz*, James Roy Poulter, a co-founder of the food delivery service Pronto, described his vision for a future custom-built Pronto kitchen with "cat flaps" for robots to enter and exit. "We want hundreds of these now and thousands next year," he said, dreaming of an endless stream of automated, on-demand, delivery robots moving in streets on pedestrian infrastructure.[250]

This vision may become a reality, as Amazon ventured into the sidewalk drone field in 2019. According to TechCrunch, though Amazon, claimed to have developed Amazon Scout in its development lab in Seattle, it acquired an urban delivery robot startup, Dispatch, in 2017. Dispatch was the brainchild of three engineers who believed they had all the necessary skills to build a U.S rival to Starship Technologies' robot. By the end of 2016, the company grew to around ten employees, filed for its first patent application, and even had a pilot with two college campuses in California. Amazon bought the company for $204 million.[251] While it has yet to expand in urban areas on a large scale, these Amazon and Starship Technologies robots, are already on some streets and are definitely in visions of the future. In Virginia and Idaho, lawmakers passed a collection of laws in 2017 allowing delivery robots to operate statewide. The laws were written with the help of Starship Technology.[252] In 2020, the Pennsylvania General Assembly Senate also passed a bill classifying sidewalk drones as pedestrians, joining a couple of more states, Idaho, Virginia,

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[250] Joon Ian Wong, "Adorable Self-driving Robots Will Start Making Deliveries in Europe This Month," *Quarts*, July 6, 2016, https://qz.com/723627/adorable-self-driving-robots-will-start-making-deliveries-in-europe-this-month/.

[251] Mark Harris, "Amazon Quietly Acquired Robotics Company Dispatch to Build Scout," *TechCrunch*, February 7, 2019, https://techcrunch.com/2019/02/07/meet-the-tiny-startup-that-helped-build-amazons-scout-robot/.

[252] April Glaser, "A Robot-delivery Startup Helped Write State Laws That are Locking Out Competition," *Vox Recode*, April 22, 2017, https://www.vox.com/2017/4/22/15273698/robot-delivery-startup-starship-state-laws-lock-out-competitors.

Wisconsin, and Washington, DC where sidewalk-drones, or a Personal Delivery Devices (PDDs), are legally allowed to share sidewalks with people.[253]

To conclude, the curb is getting more complicated from all directions. From the roadway side, traditional usage of the curb remains with free parking and travel lanes for cars. Additionally, pick-up and drop off for TNC has increased alongside travel lanes for buses and people on bicycles. The introduction and increase in microtransit and micromobility experiments have only increased the need for a clear curb. Both for delivery and pick-up as discussed earlier in this section and for passenger's pickup and drop-off. For example, in the Keolis and AAA pilot in Las Vegas downtown (discussed in Subsection 3.3.2), AAA noted that keeping the shuttle curb location free of TNC vehicles (Uber and Lyft using the space as a drop-off stop) was difficult.[254] It is a conclusion that Sidewalk Labs seemed to have designed for in its Quayside program when it moved mobility hubs underground, while other visions assume smart technology (AI, automation, or autonomous) will manage any friction between systems.

On the sidewalk side, the curb is being pushed by an increased use of the sidewalk as a space for everything but people. It is not only the sidewalk robots and the existing infrastructure object (mailboxes, light-polls) and civic uses (bus stations) of the sidewalk, it is the assumption that sidewalk and the curb can be used to charge vehicles, as they will all be electric in the future.

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[253] Ryan P. Aument, "Regular Session 2019-2020: Pennsylvania Senate bill 1199," *Pennsylvania General Assembly*, accessed March 20, 2022, https://www.legis.state.pa.us/cfdocs/billInfo/billInfo.cfm.
[254] Kelley Coyner et al., *Low-Speed Automated Vehicles*, 106.

3.5 Summary

This chapter discussed the actors, technologies, policies, and modes of operations that have influenced the American urban street in the last two decades. The chapter began with a discussion of the actors with the loudest voice. These are companies with deep connections to the automobile system and the production of privately-owned vehicles traditionally understood by the public as car manufactures like Ford and General Motors, companies that are now also software developers and mobility services providers. At the same time, software development companies like Alphabet are now also car service providers. These shifting roles makes their proposed visions of the future of the urban street potentially duplicitous: as it apparent there is a hidden agenda to maintain the status quo of the urban street as it is beneficial for the company due to its role within the automobile system.

The chapter then explained type of elements currently on the American urban street. Beginning with electric and autonomous technology. Followed by two elements that are both objects and systems 1) micromobility, a term describing both object (bike and scooters for example) and a system of operation in which the objects are part of a service, and 2) microtransit, also a term describing a system of operation using a specific kind of object that is neither a traditional personal vehicle nor a bus. Subsection 3.3.3 discusses the role of ride-hailing and the spread of the concept of Mobility as a Service. Ride-hailing has had a significant impact on how the future of the urban street is perceived. It is also often mixed-up with ideas of ridesharing and MaaS which ends up creating car-focused visions. The final section of this chapter discussed elements that have to do with physical changes to the street. Unlike all the topics discussed beforehand, these are alternative attempting to break the barrier of the automobile system and propose an urban street that prioritizes people outside of cars first. I discuss the trends of pedestrianization, bicycification, red bus lanes, and curb design. These four types of urban interventions have grown from an ongoing process of reclaiming urban space away from the automobile system and toward other users' networks.

To conclude, the contemporary American urban street is a collection of networked infrastructure systems that are continually altered by actors. In the past two decades the urban street in the United States continued to evolve while also remaining the same. It is still a stroad, a street dominated by its roadway. At the same time, the urban street has been going through a transition. Pushed in part by the growing climate crisis, a collection of ideas on urban mobility have made themselves known on the American urban street including technological (electric and autonomous), types of services (micromobility, microtransit), and formal interventions (pedestrianization, bicycification, red bus lane, curbs redesign).

CHAPTER 4

METHODOLOGY

This is a qualitative study concerned with visions of the future of the American urban street. As discussed in the introduction, I draw from future studies, design discourse, and planning field to develop the conceptual framework of the study. The following chapter describes the data collection process I conducted between 2017 and 2020 to identify scenarios of alternative mobilities in the United States. I conclude the chapter with a discussion of the methodological limitations of the study and my own biases toward a slow low-carbon future sustainable and utopian future.

4.1 Data Collection

I collected scenarios using an adapted snowball-sampling method; with every scenario I identified, I looked for other mentioned scenarios. The risk of this data-collection method was identifying scenarios with similar traits and actors. However, I used multiple resources when searching for scenarios as well as a collection of terms. I collected scenarios from academic journals and local (and digital) newspapers[1], conferences and exhibits[2], and

[1] *The Dallas Morning News, Pittsburgh Post-Gazette, Next City, The New York Times, Los Angeles City Planning, Reimagining the Civic Commons, America Walks, David Zipper mailing list, Urban Mobility Weekly, McKinsey & Company Streetblog,* John Surico's *Streetbeat,* Alon Levy's *Pedestrian Observations, Transportist* newsletter, *Shareable,* Yale Environment 360, Joe Cortright City Observatory, Mobile Lives Forum, Project for Public Spaces newsletter.
[2] CoMotion LA 2019, CoMotion Miami 2020, 3 Revolutions Policy conference, Urban Mobility Company Autonomy conference 2019 and 2020, Consumer Electronics Show in Las Vegas, 2019 and 2020, Moving on Summit, Future Mobility Detroit, The Road Ahead: Reimagining Mobility exhibit.

social media. I used specific terms in my search for relevant scenarios alternating between future, planning, and various mobility terms.[3]

Overall, I collected 233 scenarios and created a brief "identification card" that included: who crafted/was involved in the creation of the scenario (organization and individuals); who financed the scenario and overall cost, the role of technology in the scenario; the intentional and unintentional system change proposed by the scenario; and the formal change occurring on the urban street due to the scenario. I began tagging each of the scenarios with its type (conference, company, pilot, or technology). In total, I identified 35 tags. By this point in my research, I had identified scenarios representing the ideas pertaining to the future of the urban street in the United States from 2017 to 2020.

Table 4.1 Tags Organized by Category.

CATEGORY	TAGS
Urban Interventions	Full future-city vision/street (corridor) vision, infrastructure system replacement, urban highway 2.0/ highway removal, automobile space reclaiming, tactical urbanism, pedestrianization, bike infrastructure, bus infrastructure.
Events	Conference, trade show, competition, temporary governmental/municipality sponsored event, temporary community event.
Organizations	Vehicle manufacturer: automobile and shuttles, technology company, startup, autonomous vehicle company, micromobility company, advocacy/activities organization, design lab/studio.
Services	Mobility service provider, autonomous vehicle shuttle operator, hailing company, bike program/initiative/pilot, micromobility service/program/pilot, delivery program/pilot, shared system, academic initiative/lab, academic program, governmental initiative/program, policy/legislation,
Technologies	Wayfinding/information, drone, micromobility vehicle, electric vehicle technology.

I organized the 233 alternative mobilities—the visions of what the American urban street might be like in the future—into a rubric (see table 4.4) that allowed me to identify commonalities. I selected cases representing each type (based on the rubric I developed) as

[3] Future city/cities with and without scenarios/visions; city/cities of the future with and without scenarios/visions; bicycles cities/visions/scenarios; pedestrian cities/visions/scenarios; city/cities of tomorrow with and without visions/scenarios; car-free cities/streets/visions/scenarios; autonomous future visions/scenarios; utopian futures/visions/scenarios, dystopian future of streets; Afrofuturism visions of the future/street.

a way to make sure this study provided a comprehensive image of the visions for the future of the urban street as they have been presented to the American public.

4.2 Scenario Selection

To select the scenarios to study in detail, I began organizing the tags. Table 4.2 distributes the types of scenarios into four classifications: urban interventions, events, services, and objects. These categories emerged from the 35 tags identifying the scenarios of the future of the American urban street. The final collection of scenarios, 12 in total, were chosen, as discussed in Chapter 3, to represent (and include) as many elements of the American urban street.

Table 4.2 Scenario Spectrum Types and Categories.

CATEGORY	TYPES
Urban Interventions. Scenarios under urban intervention are proposals that directly engage the physical urban conditions of street space.	Full future-city vision/street (corridor vision)
	Urban Highway 2.0
	Pedestrianization
	Bicycification
	Transification/ Bus Lane
Events. These scenarios are situations in which people gather to engage the future of the urban street.	Conferences
	Trade Shows
	Competitions
	Temporary programming
	Exhibits
Services. Another form of an assemblage, the service scenarios operate as suppliers with an intent to support, influence, and or produce the future of the urban street.	Mobility information provider
	Carshare
	Autonomous Vehicles Shuttle pilot
	Ride-hailing company
	Micromobility (+bicycle) service/program/pilot/initiatives
	Delivery program/pilot
	Policy/Legislation
Objects. Scenarios that center their vision of the future around a specific, usually technological, object.	Infrastructure object
	Drones (ground)
	Vehicles
	Micromobility Machines
	EV technologies

The first category is urban interventions. These scenarios are those that focus on editing the physical condition of the street. They include interventions that are already happening, such as reclaiming automobile space for people walking, riding bikes, and taking public transit. Large-scale programs, such as elevated highway-demolition projects, focused on recreating the urban fabric prior to the construction of urban highways (on-grade streets). There are also urban interventions that have not yet happened, including visions that imagine the street repaved as a smart surface, and those proposing how new technologies can co-exist in a street that accommodates people walking, cycling, and taking sophisticated transit options.

The second category is events-based scenarios. These are situations in which people come together to experience, discuss, view, or question the future of the urban street. These are scenarios that have had been designed to be temporary, which often results in limits to their influence. They are used to imagine the street not as a thruway but as a play street, a restaurant space, and just a space to stay. This is at the core of the pedestrianization movement. Temporary programming of urban street spaces includes hosting single day/several hour take-overs that occur across the country. But they are also in conferences, trade shows, and exhibits that offer situations for people to gather and engage specifically with the question of the future of the urban street or competitions that ask participants to engage with the same question directly and offer visions and technologies to achieve that vision.

The third category is service-focused scenarios. These are forms of assemblage in which intent, finance, and a collection of people have come together to operate/provide a service. These services are alternatives to the existing automobility setup of moving by a privately-owned car. There are companies that provide mobility data on road conditions (necessary for autonomous technology), and information for riders. Apps and other products offer the framework for what is known as Mobility as a Service (MaaS): a concept for centralizing access (and information) to different modes of transit in one place to allow for intermodally. There are also vehicle-sharing services—these include car, bicycle, and scooter-sharing programs. In these programs, multiple people use the same vehicle (car, bicycle, or scooter) individually, as needed, but the vehicle is stored in a public location. I combined bicycle and scooter sharing programs under a single category of micromobility. In addition, I also count other kinds of pilots as an alternate form of transportation if they also offer passenger or delivery services. Programs that provide AV shuttling services as defined as autonomous vehicle shuttle (AVS) pilots. Service scenarios also come in the form of delivery services such as those delivering goods, letters, packages, and wholesale products. These services influence the use of the urban street as well as its physical conditions.

Many of these service scenarios are supported by policies and legislation. Initiatives in service of management of the street or in service of a private/public organization. These policies/legislations only indirectly influence the physical conditions of the urban street. They are valuable in understanding what the contemporary urban street is and how it may be used in the future. Policies and legislation are also used as tools of decision-making, both for individuals and cities. Such initiatives, in service of society, are governmental programs that provide financial and legal frameworks for many of the scenarios under urban interventions and events. A policy provides the financial structure to produce physical changes to urban streets. Legislation also encourages or prevents behaviors, either by providing incentives (financial or social) or by creating enforcement of specific behaviors.

Finally, object-based scenarios are physical objects (mechanical or manual, electrical or autonomous) that have a physical presence on the street. These objects have little to do with the form of the urban street, but much to do with its use. EV technologies, various micromobility models and machines and vehicles (manufactured and marked by companies) have been presented to the public as the future of mobility. Some objects offer alternatives to contemporary individual mobility, such as various micromobility machines. There are also social objects, produced by the community for the community. These appear either as memories (such as Ghost Bikes) or as the joyful use of public spaces (such as guerilla pools), both of which reclaim space for human use away from the car and toward people's activities.

4.3 Data Analysis

Each selected scenario analysis followed a visual analysis of the urban street within the scenario and a narrative analysis focused on the role of sustainability and assumed level of sustainable development. I relay on Jan Gehl's work on measuring the social life of urban space and assessing the value of physical conditions according to livability standards. This approach also served as a way to measure sustainable development. In other words, each scenario analysis is intended to produce a measure of automobility and sustainability.

4.3.1 Street Analysis

The public space in this study is the urban street. The social life of the urban street can be organized by its users. Users occupy a physical space, so any study of public life includes examining both the space and how it is used. To study public life, I take four conditions into consideration: the spatial conditions of the public space, and the experiences of pedestrians, drivers, and riders (bike or transit). Understanding the physical setting of the urban street before, during, and after implementing any alternative mobility is integral to analyzing the social life of the space. However, the study of spatial environment presents practical challenges. The following is a summary of the research approaches I developed to investigate each scenario of the urban street and to identify its sustainability level (livability, walkability, bikeability).

First, I conducted an audit of the urban street presented in each scenario using available sources, including videos and photographs from published documents, or posted to social media. I used Google Street View to review existing urban conditions.[4] The audit is based on the Public Life Data Protocol developed by the Gehl Institute, which provides the data infrastructure needed to sustain a systematic public life survey. The protocol (open-source tool) is the culmination of Jan Gehl's decades of work in the study of public spaces; it was developed by Gehl Architects, the Municipality of Copenhagen, and the city of San Francisco, with support and input from the Seattle DOT.[5] It offers a collection of public life studies, including the tallying of age, gender, people moving, and activity mapping. In this study, I used the protocol as an analytical guide to investigate the urban conditions within each selected scenario.

The influence of each scenario on the urban street was measured by Gehl's quality criteria for a safe, comfortable, and delightful street (see Table 4.3).[6] These criteria created three lenses to analyze the street: safety, comfort, and delightfulness. Together these three

[4] Andrew G. Rundle, et al., "Using Google Street View to Audit Neighborhood Environments," *American Journal of Preventive Medicine* 40, no. 1 (2011): 94-95.
[5] Gehl Institute, *The Open Public Life Data Protocol Version: Beta* (The Gehl Institute online: Gehl Institute, 2017), 5.
[6] Jan Gehl, *Cities for People* (Washington, Covelo, London: Island Press, 2010), 238-239.

"streets" blended into a sustainable/livable street which is, in theory, the goal of most alternative mobilities. The following is a brief explanation of the nature of the three lenses and their role in the analytical process of studying each alternative mobility.

Table 4.3 Analytical Lenses for Spatial Conditions.

The lens of safety	Protection against traffic and collisions. Feeling safe by protecting pedestrians and eliminating fear of traffic. Protection against crime and violence. Feeling secure by having a lively public realm. 'Eyes on the street.' Overlapping of functions in day/night and good lighting. Protection against unpleasant sensory experiences by addressing wind, rain/snow/cold/heat, pollution, dust, noise, and glare.
The lens of comfort	Opportunities to walk by/having room for walking with no obstacles. Good surfaces. Accessibility for everyone and an interesting façade. Opportunities to stand and stay because of edge effect. Zones that are attractive for standing and staying. Opportunities to sit by utilizing advantages in views, sun, and good places to sit and benches for resting. Opportunities to see by having reasonable viewing distance of interesting views and lighting when dark. Opportunities to talk and listen by having low levels of noise and street furniture that provide "talk scapes." Opportunities for play and exercise by day and night, summer and winter.
The lens of delight	The scale of buildings and spaces is designed for human scale. Opportunities to enjoy the positive climate aspects such as sun/shade, heat/coolness, and breeze. Positive sensory experiences by having good materials, trees, plants, water, and attention to detail.

First, the safety lens refers to protection from traffic, violence, and sensory damage. Sensory damage, which Gehl calls "sensory unpleasantness," includes the noise made by the environment (wind, rain) and humans. Human-made noises include those caused by people yelling, talking, and singing, as well as those generated by machines. The noise created by cars (engine) and drivers (honking) accumulates into environmental noise pollution, a threat to the health and well-being of people. A growing body of work has found evidence that noise pollution results in a host of adverse health, social, and economic effects.[7] Part of the Bureau of Transportation Statistics (BTS) National Transportation Atlas Database includes a National Transportation Noise Map for aviation, road, and rail.[8] Streets that are urban highways, are often wider than other urban street types, producing more than 80 dBA (weighted decibel of noise), equal to the noise produced from garbage disposal but all the time. The speed of traffic, which for the FHWA is based on road type and average annual daily traffic, determines the level of noise produced in a typical urban street. Automobiles, medium-weight trucks, and heavy trucks all produce various levels when in motion and when idling at a curbside.[9]

Noise influences the wellbeing of an individual in the urban street in equal ways to the physical dangers of vehicles and the risk of crime. Traffic noise in particular has been associated with increased levels of stress, stroke, and heart disease.[10] Safety is also the result of what Gehl refers to as “eyes on the street,” in a callback to Jane Jacobs's influential 1961 book *The Death and Life of Great American Cities*. Jacobs wrote that a city street becomes safe when there are multiple eyes on it, such as the eyes of residents and strangers facing and occupying the street.[11] Safety produced by the presence of people is connected to the street's levels of comfort.

Comfort is the intermingling of physical urban conditions that enable walking without obstacles on smooth and unbroken surfaces, or places that allow one to talk and listen, play, and exercise regardless of the season or daylight conditions. These conditions

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[7] Lisa Goines and Louis Hagler, “Noise Pollution: A Modem Plague,” *Southern Medical Journal* 100, no. 3 (March 2007): 287-288.
[8] National Transportation Noise Map, “Noise in the United States for 2016-2018,” Department of Transportation, accessed March 20, 2022, https://maps.dot.gov/BTS/NationalTransportationNoiseMap/.
[9] Bureau of Transportation statistics, *National Transportation Noise Mapping Tool* (Cambridge, MA: United States Department of Transportation, March 2017), 2-3.
[10] Thomas Münzel et at., “The Adverse Effects of Environmental Noise Exposure on Oxidative Stress and Cardiovascular Risk,” *Antioxid Redox Signal* 29, no. 9 (March 20, 2018): 882.
[11] Jane Jacobs, *The Death and Life of Great American Cities* (New York: Vintage Books, 1992), 35.

are not common in the contemporary American urban street. Gehl's lens includes physical conditions for making an urban space comfortable: 1) good surface, both horizontal (the ground) and vertical (buildings facades); 2) spaces that utilize views, provide benches to sit, and lighting when dark; 3) low levels of noise. Comfortable spaces are also often delightful spaces, designed for human scale and experience: providing interesting sensory and visual backgrounds, including color, materials, textures, volumes, and programs. Several alternative mobilities are focused on transitioning the street into a comfortable and delightful place. A delightful place is one where the built environment in its entirety (including buildings) is designed for human scale. It is a place that includes all the elements that make a place comfortable and safe.

In this dissertation, I measured each scenario against these urban street conditions from the experience of drivers and the street's on-the-ground occupants: pedestrians and micromobility users. For example, safety for drivers in cars is not the same as safety for cyclists or pedestrians. A comfortable and delightful driving street is also not the same as a comfortable or delightful urban street for walking, biking, or playing. People in cars (drivers and passengers) do not have eyes on the street; they have eyes on the road, which creates a disconnect of experience on the urban street. Next, I will discuss how I studied the experience of drivers, riders, people walking, and people using micromobility vehicles.

The study of pedestrians is often the study of people in very specific kinds of public spaces, such as parks, squares, and less frequently, sidewalks. In *The Social Life of Small Urban Spaces*, William Whyte studied various public spaces in New York City including the Seagram Building Plaza and Bryant Park. He acknowledges the street but does not focus on the point of friction between the human scale and the car scale. Whyte and his team used a time-lapse camera, on-street observations, and manual tallying of individuals and their activities. He described the area where the street and public plaza meet as a key to the success or failure of public open space, arguing that the transition should be "such that it's hard to tell where one ends, and the other begins."[12] This has to do in part with the way the street is managed, constructed, and used, as discussed in Chapter 2. In this study I replaced Whyte counting and identifying circulation patterns with identifying conditions that created safety, comfort, and delight.

A growing amount of sustainable development literature has argued for investment in low-carbon infrastructure that supports walking and cycling and what is often called livability.[13] I draw on the composition of a space to assess its walkability, cyclability, and transitability, basing my analysis on ten-evaluative criteria (Table 4.4). All of these conditions are needed in order to have a human-scale environment in which safety, comfort, and delight exist (Table 4.3). The ten-evaluative criteria are based on the idea of the city as a feedback loop between built environments, users, and mobility practices. The built environment influences users' mobility and vice versa, users' mobility practices influence built environment development.[14]

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[12] William H. Whyte, *The Social Life of Small Urban Spaces* (Washington, D.C: Conservation Foundation, 1980), 57.
[13] Reid Ewing and Robert Cervero, "Travel and the Built Environment: A Meta-Analysis," *Journal of the American Planning Association*, 76, no. 3 (2010): 285.
[14] Esther Zipori, and Maurie J. Cohen. "Anticipating Post-Automobility: Design Policies for Fostering Urban Mobility Transitions," *International Journal of Urban Sustainable Development* 7, no. 2 (July 2015): 152-153.

Table 4.4 Ten-Evaluative Criteria of Urban Streets Livability.

Criteria	**Explanation**
Residential density and land-use variation	Highlights the socio-demographic composition of a place and the available housing and commercial diversity. It provides insight into the extent to which an active walking/cycling lifestyle can be implemented and whether municipal land-use laws allow for physical infrastructure to support walking/cycling.
Human dimension	Refers to both the built environment and the perceived environment and the physical services that the environment provides. This includes what a community needs (and wants). Services such as: convenience stores, place of worship, schools, recreational facilities, community centers, child-care services, pharmacies, restaurants, grocery stores, movie theaters, libraries, banks, and post offices. Human dimensions are also assessed by the actual physical environment in terms of, for example, architecture and its physical scale. The level of service provided by the built environment is what encourages individuals to remain in a community and to engage it.
Versatility and complexity of activities	For a place to be active and attractive for walking and cycling, it needs to provide versatility and have capacity for complexity. There needs to be an overlap of purposes such as walking, running, resting, shopping that allows for a mix of planned and spontaneous actions.
Availability of urban amenities	Measuring the quality of the cityscape and its ability to accommodate different uses. Issues of particular attention include access to bathrooms, seating, weather protections, storage spaces (bicycles or other micromobility vehicles), drinking water, trashcans, play-spaces, and lighting.
Adaptive reuse of existing infrastructure	Cities are ever-changing landscapes of people. The built environment and its durability are a function of public interest, private investment, and government (local or other) ability to adapt and reuse infrastructure to accommodate new requirements.
Level of flexibility	The capacity of a city for multifunctionality and to allow different user groups to simultaneously occupy and coexist in the same space. The concept of the complete street (or the woonerf) is an example of such flexibility.
Safety and health	Entails several aspects with respect to urban mobility. First, the incidence of traffic accidents involving pedestrians and cyclists requires attention. Second, planners need to consider the prevailing activity levels of people and their state of physical fitness. Finally, the quality of the physical environment in terms of ambient air pollution and available green space is critical. In aggregate, these factors provide an indication of the actual practices that are reasonable and point to opportunities for improvement.
Social inclusion	Social inclusion (and exclusion) is a function of both social dynamics and built environmental conditions. This is primarily a matter of vehicular infrastructure taking precedence over walking and cycling infrastructure but can also entail cycling being privileged over walking. Beyond physical segregation, there are questions pertaining to socially dynamic practices surrounding walking and cycling.
Travel speed and experiential quality	Travel speed refers to the amount of time it takes to transit between primary origins and destinations. The quality of the travel experience, especially in the context of journeys that need to be made within a specific timeframe (such as commuting to work). Other trips can extend for longer periods of time, especially if the experience itself is deemed to be positive.
Ease of intramodality	The ease with which users can transfer between different urban mobility systems and the provisions that are in place to enable travelers to seamlessly navigate trips involving different modes.

Zipori, Esther, and Maurie J. Cohen. "Anticipating Post-Automobility: Design Policies for Fostering Urban Mobility Transitions," International Journal of Urban Sustainable Development 7, no. 2 (July 2015): 163-165.

First, *residential density and land-use variation* captures the socio-demographic composition of a place, including available housing and commercial diversity. Human dimension refers to both what the community needs (and wants) and what the existing built environment provides. *Versatility and complexity of activities* denotes the ability of people to use a space for overlapping purposes. *Availability of urban amenities* refers to the scope and quality of both travel, commercial, and leisure activities. *Adaptive reuse of existing infrastructure* is a criterion that detriments a place flexibility in retrofitting existing systems for contemporary uses. *Level of flexibility* reflects the availability of multiples mobilities including complex public transit systems and non-motorized transportation options. *Safety and health* include both safety from traffic collisions, crime and pollution. *Social inclusion* aims to capture the ways where planning is used to affect socioeconomically and politically disadvantages communities in their use of the built environment. *Travel speed and experiential quality* refers to the travel experience of commuters and leisure travelers in different forms of mobility including trains and bicycles. *Ease of intramodality* is an indicative of a user's ability to transfer between different types of mobilities available to its full potential.[15] Further detail on each criterion is provided in Table 3.4.4.

Table 4.5 represents the synthesized lenes of safety, comfort, and delights as livable, sustainable spaces. It is a compilation of Table 4.3 and 4.4 as a scorecard to evaluate each scenario for the future of the urban street. Certain lenses (cells) are left uncolored and indicated with an X when they are irrelevant, such as 'lighting at night' in a vision that only exists in daylight or 'interesting facades' for a vision that excludes the development of architectural form from its scope.

[15] Zipori and Cohen, "Anticipating Post-Automobility," 163-165.

Table 4.5 Lens Analysis of Urban Street Users.

<table>
<tr><th></th><th colspan="2">Pedestrians</th><th colspan="2">Micromobility</th><th colspan="2">Riders (Public Transit)</th></tr>
<tr><td rowspan="3">Lens of safety</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td><td rowspan="2">Protection against traffic & collisions</td><td rowspan="2">Eliminating fear of traffic</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td></tr>
<tr><td>Protection against crime & violence</td><td>Lively public realm</td><td>Protection against crime & violence</td><td>Ability to safely wait for transit</td></tr>
<tr><td>Overlapping functions</td><td>Protection from light, weather, pollution, dust, noise, & glare</td><td>Protection against crime & violence</td><td>Ability to safety store, & maintain micromobility devices</td><td colspan="2">Protection from weather, pollution, dust, noise, & glare</td></tr>
<tr><td rowspan="3">Lens of comfort</td><td>Opportunities to walk with no obstacles</td><td>Accessibility for everyone</td><td rowspan="2">Opportunities to roll with no obstacles</td><td rowspan="2">Accessibility for everyone</td><td rowspan="2">Opportunities to travel with no obstacles</td><td rowspan="2">Accessibility for everyone</td></tr>
<tr><td>Interesting facades</td><td>Opportunities for standing & seating</td></tr>
<tr><td>Spaces for play & “talkscapes”</td><td>Lighting at night</td><td>Spaces for commute, leisure, & repair</td><td>Lighting at night</td><td>Opportunities for standing & seating</td><td>Lighting at night</td></tr>
<tr><td rowspan="2">Lens of delight</td><td>Buildings scale</td><td>Opportunities to enjoy positive climate</td><td>Lane size</td><td>Opportunities to enjoy positive climate</td><td colspan="2" rowspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
<tr><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
</table>

Overall, pedestrians are overrepresented in the table (six criteria under safety, six criteria under comfort, and seven criteria under delight). It is a purposeful decision as everyone is a pedestrian before or after using a micromobility vehicle or public transit. The safety lens is the dominate critical lens representing more than 42% of the table (compared to 29% comfort lens and 19% for the delight lens). It is a representation of the nature of the safety, comfort, and delight lens—a delightful street is a comfortable street which is a safer street.

Scoring was done on a scale of three ratings, sufficient (green), passable (yellow), and unsatisfactory (red). Sufficient means to reflect that the scenario has addressed the cell. This does not intend to reflect innovation but an existing consideration by the scenario. Passable rating is given when the scenario addressed the cell but in a minimal and superficial way. Lastly, unsatisfactory, indicate that the cell was not address, even though it is within the scope of the scenario, or that the way the cell was addressed is unsuitable. After color coding, I used a point-based scoring system: +1 for sufficient, 0 for passable, and –1 for unsatisfactory. The totals of these calculations are discussed for each scenario and in the concluding chapter.

4.4 Methodological Limitations

This study expands on the contemporary understanding of the urban street and its future under sustainable development ideals. Ideals that are still being debated about.[16] The scale of the project, touching on various contested concepts—sustainability, development, and urban streets—provided its own limitation. Focusing on the United States has given the study a manageable size but maintain the complexity of a country spanning over a diverse and vast cultural geography. The geographical distribution of this study and the seasonal nature of some cases dictated a certain level of digital analysis, relying on digital recordings (pictures, videos, and maps) of places. Additionally, the COVID-19 pandemic, and public shutdown between March 2020 and the beginning of 2021, has necessitated more digital analysis than originally planned, as I was unable to conduct site visits. Being unable to

[16] David Harnesk and Ellinor Isgren, "Sustainability as a Real Utopia—Heuristics for Transformative Sustainability Research," *Environment and Planning E: Nature and Space* 5, no. 3 (September 2022): 1678-1679.

experience the spaces or have conversations with users and operators presented its own limitation. Finally, while I have done my best to represent the various interventions that have been underway in the United States during the 21st century the topic itself is in motion, making it harder to pin down.

Finally, it must be said that the United States is not from an international standpoint a sustainable mobility leader. Thus, this is not a study of sustainable development innovation, but of transition, a transition that began before onset of COVID-19 and has continued into the post-pandemic period.

4.5 Summary

This dissertation takes a multidisciplinary approach to study the urban street and its proposed future. I discussed the process of data collection and analysis framed by the systems of automobility and a sustainable development (utopian) perspective. This chapter provided the rubric of analysis which follows the dominant qualities currently influencing the American urban street (discussed in Chapter 3). These categories influence the movement, use, and form of the urban street. Urban interventions are proposals that directly engage the physical urban conditions of street space and events are situations in which people gather to engage the future of the urban street. Services are cases that operate as suppliers (of services) created with a collection of objects. Objects that engage the street at the surface level only with no (temporary or permanent) changes to the existing street.

In the following chapter I discuss each scenario through technology, systemic change, and formal conditions. An analysis of each scenario relationship to a safe, comfortable, and delightful street is conducted for three users, pedestrians, micromobility users and public transit riders. A coded (green, yellow, red) table gives a summary of the street conditions and grades it according to sustainable ideals that support low-carbon urban conditions.

CHAPTER 5

SCENARIOS OF ALTERNATIVE MOBILITY

Alternative mobilities are expressions of cultural priorities through technical, technological, civic, and physical changes. Some alternative mobilities are reactive and are attempts to provide solutions to selected problems such as crowded sidewalks (and curbs), stormwater surges, and adequate livability standards. Others are more proactive and seek to look beyond a particular problem by proposing a complete system change.

In this dissertation, I studied each alternative mobility through three lenses: technology, (reviewing the role of software or hardware in the alternative mobility); formal condition (considering the physical influence or alteration of the alternative mobility on the urban street, if any); and systematic change (identifying the alternative mobility affect in social, cultural, or civic systems). These adjustments were then analyzed to identify the level of public life proposed in the urban streets in terms of safety, comfort, and delight to various users. As I discussed in Chapter 4, I then score each scenario on a scale of sufficient (green, +1 point), passable (yellow, 0 point), and unsatisfactory (red, -1 point). A sufficient rating reflects a scenario engaging the mentioned cell. It is not a reflection of innovative proposals. A passable rating was given when a cell topic was addressed in a minimal and superficial way. It reflects a choice made by the vision creators that have not fully considered its indented system—for example, designing a bike lane surface with paving stones. Lastly, unsatisfactory was given when the cell topic was not addressed or was addressed in an unacceptable way under the sustainable ideals of a post-automobility city).

Figure 5.1 organizes the alternative mobilities on a spectrum of different categories. Conceptually, if I were to zoom into the spectrum, each alternative mobility would contain layers with a secondary spectrum of its type. First, the left edge of the spectrum (urban interventions) comprises installations that physically change the form of the urban street. Second, urban interventions are sometimes also events, temporary changes supporting programming that last for a few hours, days, or months. Third, services often do not require infrastructure changes to the urban form, but they need a collection of objects to operate. Finally, objects, as an alternative mobility category, are installed on the street without changing its physical conditions. They are superficial interventions in the sense that they do not change the street.

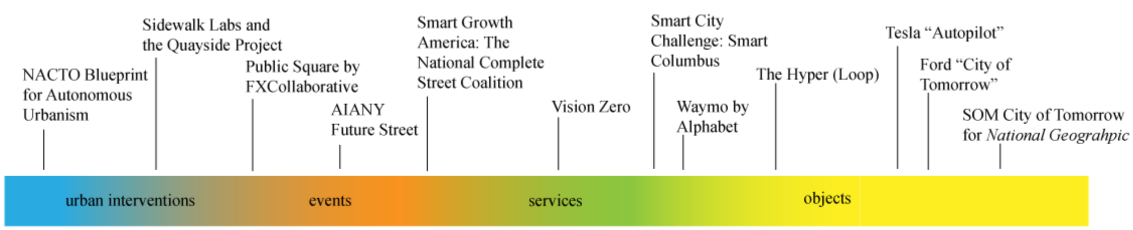

Figure 5.1 Alternative Mobility Scenarios Spectrum.

The following cases offer (or allude to) scenarios of what the future urban street should/could be. They are organized to be read as individual narratives, with each section providing a review of the historical context, social and cultural roles, technology used, and the physical change (or lack thereof) to the urban street. At the end of each section, a table summarizes the proposed street analysis. The order of the sections follows the framework discussed in the previous section: urban interventions, events, services, and objects (see Table 4.3).

I begin with a discussion of three scenarios dominated by urban interventions. The National Association of City Transportation Officials *Blueprint for Autonomous Urbanism*, a how-to guideline for street design that assumes wide adoption of autonomous vehicle technology. Sidewalk Labs, an Alphabet subsidiary, proposal for a data-driven sustainable development in Quayside, Toronto, and FXCollaborative's *Public Square*, an architectural company's vision for reclaiming urban street space made of 8'x8' platforms installed on the existing road infrastructure.

Second, I discuss two event scenarios: a temporary installation by the American Institute of Architects in New York City and Smart Growth America's Complete Streets program, a program that relies on a collection of events by both community organizations and governmental agencies. Third, are three service scenarios. Vision Zero, a program aiming to achieve zero road deaths and injuries on American urban roads and Smart Columbus, the winning entry in the United States Department of Transportation's Smart City Challenge, and Waymo, an autonomous vehicle service.

Lastly, I discuss four object scenarios, 1) the Hyperloop, a super-speed transit system intended to replace high-speed rail, and 2) Tesla's "Autopilot," an autonomous technology software. 3) Ford's vision for the City of Tomorrow and the company's development of Detroit's, Central Station as a test bed for the future of mobility, and 4) Skidmore, Owings & Merrill's City of Tomorrow for *National Geographic*, a vision of a city built from scratch with innovative technologies.

Table 5.1 Scenarios of Alternative Mobility (Continued)

Type	**Name**	**What is it**	**Location; Organizational structure / owners**	**Technology. System change. Form.**
Urban intervention	NACTO Blueprint for Autonomous Urbanism	The National Association of City Transportation Official (NACTO) report laying out guidelines for the design of future streets.	Worldwide; Professional organization	**Technology**: Part of the vision but not the focus. NACTO sees technology as a tool to make transit more accessible and efficient. **Systemic change:** MaaS and significant reduction in car-ownership. **Form**: Remake the street to accommodate transit corridors and more complex pedestrian and cycling systems. Permeant. To be implemented over time.
Urban intervention + organization	Quayside Project by Sidewalk Labs	Alphabet (Google) urban design branch failed smart-city project in Toronto.	Toronto; Corporation/private company	**Technology**: The vision heavily relays on technology as a way of management. **Systemic change:** Reduction in car ownership and reliance on shard systems through MaaS. **Form**: Retrofit and new construction. Introduction of two main types of streets: a transit street and a pedestrian street, on which micromobility items can also be used.
Urban intervention + event	*Public Square* by FXCollaborative	Winning entry in the 2017 Driverless Future Challenge. A modular proposal toward a shared urban street.	New York City; Architecture firm	**Technology**: Not explicit but assumed based on certain urban conditions proposed (traffic and water management). **Systemic change:** Reduction in car ownership and street activities. **Form:** Remake the street for more greenery, pedestrian, and cycling systems. Modular, to be implemented over time on existing infrastructure.
Event + urban intervention	AIANY Future Street	American Institute of Architects New York vision for the future of streets during NYC 2019 Car Free day.	New York City; Professional organization	**Technology**: Not explicit and not needed for the temporary installation. **Systemic change:** A car-free street with new surface materiality away from solid surfaces. **Form:** Complete change of street geometry and function.
Event + urban intervention/ service	Smart Growth America: Complete Streets	A theoretical framework and design strategy to make streets serve multiple users (ped, bike, driver) equally.	United States; Municipalities & advocate organizations	**Technology**: Minimal, most complete street tools relay on paint or geomatical changes to the urban street. **Systemic change:** The street, if it's a "complete" one, is supposed to serve all users, people walking, people on bicycles, and people in cars, in that particular order. **Form:** Changes to the urban street is often achieved through road-diets and introduction of bicycle lanes.

Table 5.1 (Continued) Scenarios of Alternative Mobility

Type	Name	What is it	Location; Organizational structure / owners	Technology. System change. Form.
Service + urban intervention	Vision Zero	Policy guidelines to stop all traffic related deaths.	United States; Municipalities & advocate organizations	**Technology**: Heavy reliance on technology as a means to achieve safety. **Systemic change:** Safe systems approach. **Form:** Relies on complete streets concepts.
Service + event/urban intervention	Smart City Challenge	A 2015 federal challenge asking mid-sized cities across America to developed ideas to for smart transportation systems.	Columbus, Ohio; Governmental program	**Technology**: Autonomous vehicles and safe systems approach. **Systemic change:** MaaS, microtransit shuttles. **Form:** Mostly no change to the urban street. Installation of technology for better management.
Object/service	Waymo by Alphabet	Alphabet (Google) AV Arm.	Arizona and California; Corporation/private company	**Technology**: Almost only focused on technology (software development). **Systemic change:** Maintains the status quo. **Form:** No change to the urban street except for installation of technology.
Object/service	The Hyperloop	An above-terrain tube for highspeed travel.	Las Vegas; Corporation/private company	**Technology**: Focused on technology development (hardware development). **Systemic change:** Maintains the status quo. **Form:** No change to the urban street.
Object	Tesla "Autopilot"	An Electric vehicle company autonomous software program	North America; Corporation/private company	**Technology**: Focused on technology development (software and limited hardware development). **Systemic change:** Maintains the status quo. **Form**: No change to the urban street.
Object/urban intervention	Ford "City of Tomorrow"	Ford's short-lived vision for the City of Tomorrow from 2017.	Unites States and Detroit; Corporation/private company	**Technology**: Both software and hardware, everything is smart. **Systemic change:** Maintains the status quo. **Form:** None, only the "smartification" of existing infrastructure.
Object/urban intervention	SOM City of Tomorrow for *National Geographic*	A vision for the future of cities produced by SOM for *National Geographic*.	N/A; Architecture firm	**Technology**: Both software and hardware, everything is smart. **Systemic change:** Bicycle network but mostly maintains the status quo. **Form:** City from scratch. Includes highways and public spaces but no visions of streets.

5.1. Urban Interventions

Urban intervention scenarios, as discussed in Chapter 4, include both small and large-scale offers to reclaim automobile space for people walking and riding. In the following section, I discuss three scenarios in which urban interventions play a dominant role.

5.1.1 NACTO Blueprint for Autonomous Urbanism

The National Association of City Transportation Officials (NACTO) *Blueprint for Autonomous Urbanism* is a how-to guide based on the organization's decade-long work to reclaim the design of the street from transportation engineers who focus exclusively on driver convenience. The *Blueprint* proposes the creation of spaces for walking, biking, and taking public transit. It is an urban intervention that attempts to accommodate many other visions within its future street: autonomous shuttles, comprehensive bicycle systems, and expanded public realms for pedestrians.

NACTO is a professional non-profit association with over 90 member cities and transit agencies in North America.[1] The association is a body formed to exchange transportation ideas, insights, and practices to cooperatively approach national transportation issues. It is chaired by Janette Sadik-Khan, known for her work as the commissioner of the New York City Department of Transportation (NYCDOT) between 2007 and 2013, and a board of directors that includes the Executive Director of the Denver DOT, the Deputy Managing Director of the Philadelphia Office of Transportation and Infrastructure Systems, and the Chicago DOT Commissioner. The organization programs, initiatives, and visions for designers, cities, and transit agencies to inform their decision-making and implement in their streets. NACTO's mandate is "to build cities as places for

[1] As of August 2020. For the complete list of NACTO cities, transit agencies, and international members at https://nacto.org/member-cities/.

people, with safe, sustainable, accessible, and equitable transportation choices that support a strong economy and vibrant quality of life"[2] through four pillars: fostering community, centering justice, striving for impact, and leading with imagination. NACTO regularly publishes policy reports and papers covering mobility topics, including the state of shared micromobility in the United States; strategies to build relationships with communities; during the COVID-19 pandemic it issued, a set of guidelines for temporary street design. *The Blueprint for Autonomous Urbanism* follows a collection of earlier NACTO design guidelines including, *The Urban Street Design Guide* (2013), *The Urban Bikeway Design Guide* (2011), and *NYC Street Design Manual* (2009). All of this is to say that NACTO has been a prominent actor shaping the urban street during the last decade. After NACTO published *The Blueprint for Autonomous Urbanism* in 2017, the FHWA distributed copies to all its Division and Federal Lands Highways Offices.[3] Thus giving it a level of authority without undermining the existing street design framework. As discussed in Section 2.2, street design in the United States in the past few decades has been dictated by two main manuals: the AASHOT *Policy on Geometric Design of Highways and Streets* and the *MUTCD*. *The Urban Street Design Guide* emphasizes city-street design through a series of sections that do not need to be read consecutively. It is a highly graphic guide, with perspective sketches of urban conditions and critical recommendations clearly identified for the reader to find.

Technology: The *Blueprint for Autonomous Urbanism* was a response to the increasing interest in AVs. It assumes an autonomous age is ahead of us, an era that

[2] NACTO, "About NACTO," accessed March 22, 2022, https://nacto.org/about/.
[3] Federal Highway Administration, "Questions & Answers about Design Flexibility for Pedestrian and Bicycle facilities," *United States Department of Transportation*, 2014, https://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design_flexibility_qa.cfm.

NACTO describes as one where “technology will enhance transit's competitiveness, adding more riders and creating new jobs through strong service growth.”[4] NACTO’s autonomous age street is one where AV technologies allow for significant reductions of miles traveled, emissions, and spatial pollution. It is a street where decision making is data-driven, and technology is used to improve safety by moving people rather than cars. It is a street for public transit, urban freight, and cyclists routes.[5] The authors of NACTO’s principles for future streets argue for an *Act Now!* approach, considering that “cities that are proactive now will ensure the people-focused future they want, with more efficient and sustainable land-use patterns and redesigned streets for safety and efficiency.”[6] Basically, the guide provides instructions through a *What Cities Should Do* checklist to shape future streets of the autonomous age. Recommendations call for engaging allies early to create a just transition and to enshrine a city’s priorities in concrete. The *Blueprint* authors argue that if cities leveraged tools of physical street change, the AV revolution would be a force for good. Providing actions for city councils and transportation departments, NACTO argues for reducing speeds; changing zoning; encouraging bus ridership; enhancing walking and cycling and creating a welcoming urban space. Design solutions to make these changes are organized around quick-build tools, curb management, and various smart-data and technology-supporting policies.[7]

Systemic Change: NACTO, as a transportation organization, has resulted in a vision of future streets that maintains their role as thruways. The *Blueprint* provides visions

[4] NACTO, *Blueprint for Autonomous Urbanism: Second Edition* (New York: National Association of City Transportation Officials, 2019), 52.
[5] NACTO, *Blueprint for Autonomous Urbanism*, 16-19.
[6] Ibid, 17.
[7] Ibid, 27, 47, 59, 71, 81.

of future streets as transit corridors with dedicated bus lanes and bus stations that include roofs, sitting areas, lighting, and bike storage.[8] Congestion pricing also has an important role in future streets. Though mostly invisible in the built form, it is a tool for cities to reimagine space and the curb. The policy has the potential to result in curb reclamation for better management of delivery services and the introduction of a more expansive pedestrian and cycling infrastructure simply by reducing the number of people choosing to travel into that area with a vehicle. Referencing induced demand and the increase in use that comes with improving transportation infrastructure, NACTO encourages readers to consider pricing as a core policy of the autonomous age, as "new technologies could allow governments to gauge traffic in real-time and accurately price travel demand to influence traveler behavior."[9] Without pricing the future street for certain vehicular users, NACTO warns, there will be a dystopian scenario of increased travel, traffic, and pollution. Pricing the use of street space can ensure revenue for cities to maintain the improvements necessary for the autonomous age street. Less glamorous (and invisible) than other aspects of the autonomous future, a data-driven approach for pricing in real-time can improve congestion, safety, and sustainability outcomes.[10] Data is the key element of NACTO's visions for the future street, a key part of reimagining urban freight, the curb, and street redesign.

[8] Ibid, 51.
[9] Ibid, 58.
[10] Ibid, 59.

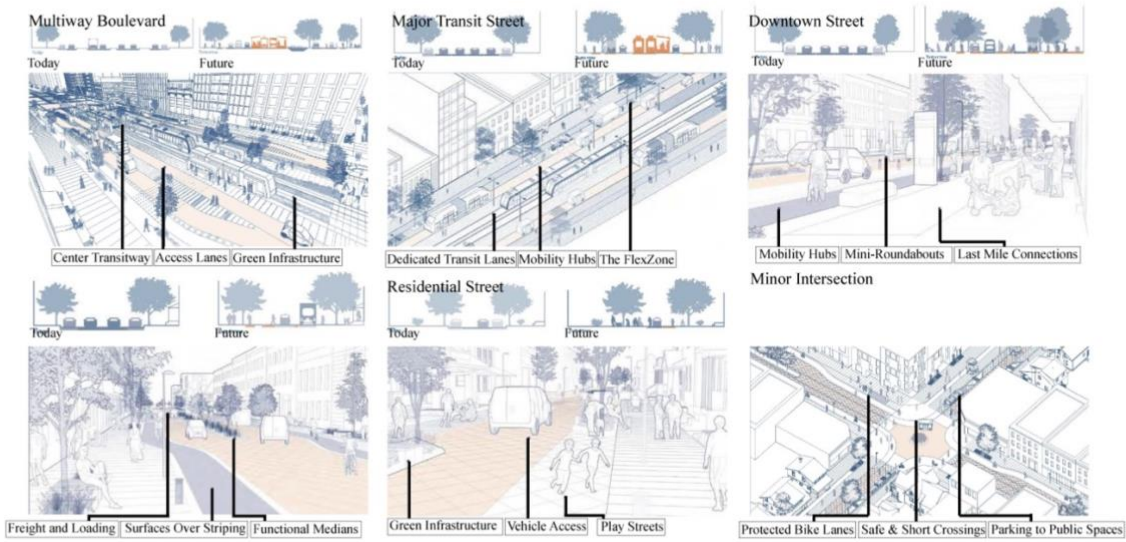

Figure 5.2 NACTO Autonomous Age Street types: Multiway Boulevard, Major Transit Street, Downtown Street, Neighborhood Main Street, Residential Street, and Minor Intersection.
Source: NACTO. "Blueprint for Autonomous Urbanism: Second Edition," 2019, 108-113.

Form: NACTO's vision for the future of urban streets is designed for immediate interventions that can be expanded on in the future. The street of today is organized (in the interim) to accommodate expanded pedestrian space, assigned offloading and pickup spaces, dedicated bus lanes, and reduced on-street parking space. All of these measures are preparation for a future where the bus is replaced by a light rail, the temporary pedestrian space has been paved and planted with trees, and vehicle-travel space has been supplanted with a bicycle lane. NACTO's scenario for the future of the urban street (see Figure 5.2) is described through five distinct urban streets (and intersections).

These five streets, almost exclusively thruways, are: 1) a multiway boulevard with a central transitway, pickup lanes, and stormwater/green infrastructure; 2) a major street with dedicated transit lanes, various mobility hubs, and a flex zone (flexible space for freight/delivery and other uses); 3) a downtown street with protected bike lanes and expanded public spaces; 4) a neighborhood main street with an extended median for small freight and delivery; and 5) a residential street that allows for play and local vehicular access. In all these typologies, NACTO provides details for specific street conditions and design guidelines. These specifications include uninterrupted transit lanes in the center of the street for light rail and buses; protected bike lanes; and rebalancing road-usage distribution by transitioning on-street parking lanes into expanded sidewalks and café spaces. Also included are access lanes that provide space for pickups, drop-offs, and deliveries; a flex zone for freight and small deliveries that includes dynamic pricing for loading/unloading; short crosswalks that are facilitated by new lane types and extended public spaces; green infrastructure that is incorporated into median design and that can absorb stormwater and help keep streets cooler; and speed limits of 10 miles per hour and the introduction of mini roundabouts. The sidewalk and curb are important spaces in the autonomous age of future streets. Managed by data to provide priorities for buses, transit, bike, freight, and delivery, the curbside is a space for cities to make decisions about user priorities as they pertain to revenue and public benefit.[11] As discussed in Section 2.1, currently, urban street curb space in the United States is almost always exclusively for the use of drivers in single-occupancy vehicles. The future street curb serves as a sidewalk next to a managed transit lane and/or a flex zone that allows for bike-share stations, parklets, vendors, and freight loading. Each curb space offers a collection of amenities that can be managed with the use of data and advanced technologies.

Analysis: NACTO's vision spread beyond the professional transportation field into public awareness when it was featured in the exhibit *The Road Ahead: Reimaging Mobility* at the Smithsonian Institutions' Copper Hewitt Museum in 2018-2019.[12] Showcased

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[11] Ibid, 117.
[12] The Road Ahead: Reimagining Mobility ran between December 14, 2018, and March 31, 2019.

among various design projects and speculative technologies by MIT, Waymo (Alphabet AV arm), and Arup (an architectural design firm) was NACTO's *Blueprint for Autonomous Urbanism*. Multiple copies of The *Blueprint* were available for review on a GO OutdoorTable, a shelter providing power access and lighting for an outdoor work environment and transit stops.[13] Besides the copies available on the table, a color rendering of NACTO's multiway boulevard vision of the future was the face of the exhibit. Easier for the public to read than the collection of more than 135 objects in the exhibit, it was the image that graced the Winter 2018 issue of *Design Journal* that served as the exhibit's program.

Per Table 5.2, NACTO *Blueprint for Autonomous Urbanism* scores a total of 12 points. It scores well both in the safety (5 points) and comfort lenses (7 points) across all three users. As discussed above, NACTO streets still lack a collection of design features to create comfortable and/or delightful streets. Protection from weather, pollution, and noise are few and far apart while overlapping mobility functions prevent the opportunity to travel with no obstacles. The objective of the NACTO *Blueprint* urban street is accessibility for everyone. At the same time, there is no micromobility infrastructure other than the bike lane, a lane that remains narrow and unprotected.

[13] Landscape form, "GO OutdoorTable: A Transformative Design for the Future of Urban Environments," accessed March 22, 2022, https://www.landscapeforms.com/enlighten/pages/1-1/Cooper-Hewitt.aspx.

Table 5.2 NACTO Blueprint for Autonomous Urbanism Lens Scorecard

<table>
<tr><th></th><th colspan="2">Pedestrians</th><th colspan="2">Micromobility</th><th colspan="2">Riders (Public Transit)</th></tr>
<tr><td rowspan="3">Lens of safety</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td><td rowspan="2">Protection against traffic & collisions</td><td rowspan="2">Eliminating fear of traffic</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td></tr>
<tr><td>Protection against crime & violence</td><td>Lively public realm</td><td>Protection against crime & violence</td><td>Ability to safely wait for transit</td></tr>
<tr><td>Overlapping functions</td><td>Protection from light, weather, pollution, dust, noise, & glare</td><td>Protection against crime & violence</td><td>Ability to safety store, & maintain micromobilit y devices</td><td colspan="2">Protection from weather, pollution, dust, noise, & glare</td></tr>
<tr><td rowspan="3">Lens of comfort</td><td>Opportunities to walk with no obstacles</td><td>Accessibility for everyone</td><td rowspan="2">Opportunities to roll with no obstacles</td><td rowspan="2">Accessibility for everyone</td><td rowspan="2">Opportunities to travel with no obstacles</td><td rowspan="2">Accessibility for everyone</td></tr>
<tr><td>~~Interesting facades~~</td><td>Opportunities for standing & seating</td></tr>
<tr><td>Spaces for play & “talkscapes”</td><td>Lighting at night</td><td>Spaces for commute, leisure, & repair</td><td>Lighting at night</td><td>Opportunities for standing & seating</td><td>Lighting at night</td></tr>
<tr><td rowspan="2">Lens of delight</td><td>~~Buildings scale~~</td><td>Opportunities to enjoy positive climate</td><td>Lane size</td><td>Opportunities to enjoy positive climate</td><td rowspan="2" colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
<tr><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
</table>

See Table 4.4 (page 153) for comprehensive lens analysis overview. Green: sufficient. Yellow: passable Red: unsatisfactory. Total Score: 12 points.

5.1.2 Sidewalk Labs: The Quayside Project

In Sidewalk Labs’ vision, the urban street is essentially focused on techno-livability. When the company was founded in 2015, it declared a mission “to combine forward-thinking urban design and cutting-edge technology to radically improve urban life” by “producing precedent-setting levels of sustainability, affordability, mobility, and economic and social opportunity."[14] The company's proposal for Quayside in Toronto was an attempt to do just that.

Sidewalk Labs was selected in 2017 as the lead designer of a Toronto waterfront-redevelopment project named Quayside. The proposal for the redevelopment of the Toronto waterfront was going to be the future of urban development. A private-public collaboration that would bring to life several urban mobility ideas of the twenty-first century: smart and autonomous technology and pedestrianization. Sidewalk Lab's vision for the future of the urban street is an urban intervention for alternative mobility that, like the NACTO *Blueprint for Autonomous Urbanism*, attempts to combine many other visions within its future street, including autonomous technology, bike infrastructure, expanded pedestrian curbs, and sophisticated autonomous delivery-management systems.

Waterfront Toronto 2017 request for proposals (RFP) called for private enterprise, technology providers, investors, and academic institutions to collaborate with Toronto local government to create "a new global benchmark for sustainable, inclusive and accessible urban development."[15] This was a big undertaking for a two-year-old company like Sidewalk Labs, and the task grew to include 2,000 acres of the city's downtown lakefront by the time Waterfront Toronto signed the initial redevelopment agreement with the Google subsidiary in October of 2017. The final proposal included five sites and ten structures/buildings that offered more than 1,680,000 square feet for residential units,

[14] Sidewalk Labs, "Mission," accessed August 4, 2021, https://www.sidewalklabs.com/mission/.
[15] Sidewalk Labs, *Toronto Tomorrow Volume 0: Overview* (Master Innovation and Development Plan: Sidewalk Labs, 2019), 51.

400,000 square feet for commercial spaces, 260,000 square feet of loft space, and 260,000 square feet of what Sidewalk Labs called "stoa," a flexible loft-like space.[16]

Sidewalk Labs pledged $50 million toward the initial planning phase. Two years later, in June 2019, it unveiled a $2.8 billion (US) master plan detailed in a 1,524-page three-volume plan called the *Quayside Master Innovation and Development Plan (MIDP).* The street in Quayside was going to be surrounded by buildings constructed of mass timber going up to 30 stories. Floors designed as loft space allowed for adaptable uses through a flexible wall system "supported by flexible interior panels and a real-time code-monitoring system."[17] About 10% of each building would be loft space, but only between the third and twelfth floors. Sidewalk Labs' ground floor is an adaptable loft space designed with a flexible structure to house short-term, long-term, and seasonal activities.[18] Named stoa, after the ancient Greek word for covered walkways around public commercial squares, the space is supplemented by a digitally managed leasing and operational platform. Retractable facades, movable kiosks, and "raincoats" (retractable awning) then transform the ground-floor into versatile spaces operational in all seasons.[19]

Form: In terms of the urban street and public space, Sidewalk Labs' proposal was presented through a collection of hand-drawn visions and selected photorealistic renderings. The spaces in Figure 5.3 are visual representations of the "solutions" presented in the *MIDP*. In Queens Quay, a traditional light rail system would connect to the existing King Street transit corridor (A). Parallel but separated by trees (59 trees per hectare),[20]

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[16] Sidewalk Labs, *Toronto Tomorrow Volume 1: The Plans* (Master Innovation and Development Plan: Sidewalk Labs, 2019), 57.
[17] Sidewalk Labs, *Toronto Tomorrow Volume 2: The Urban Innovation* (Master Innovation and Development Plan: Sidewalk Labs, 2019), 205.
[18] Sidewalk Labs, *Toronto Tomorrow Volume 2*, 44, 150.
[19] Sidewalk Labs, *Toronto Tomorrow Volume 2*, 151. 154.
[20] Sidewalk Labs, *Toronto Tomorrow Volume 2*, 135.

there would be a two-way bike lane (B). Protected on both sides by greenery, the lane in the plan is crossed by a traditional pedestrian crosswalk created with decorative lighting (C). Other types of bike lanes appear throughout the *MIDP*. A bike lane in Parliament Plaza would be completely merged with pedestrian traffic, small delivery trucks, and a traditional transit curb. The same infrastructure typology—of a painted, at-grade, 5-6 feet wide bike lane crossed by pedestrians and delivery/autonomous vehicles—can be seen in many of the spaces throughout Quayside. These lanes are what Sidewalk Labs calls a slow zone, which distinguished it from an adjacent bike lane. The difference between the two is that the slow zones exist within public spaces that are not streets. More than 4,000 bicycle-parking spaces planned for throughout Quayside: both traditional racks for bikes, bike-shares, or e-bikes, as well as e-scooter racks, bike boxes, long-term bicycle storage, and bike hubs.[21] A bike hub, which is really a mobility hub, includes bike parking for bike-shares, e-bikes, and e-scooters. The hubs exist underground and are part of a larger facility for car storage (parking), car-sharing, and ride-hailing services. This is where all the various AVs can drop off and pick up people/deliveries free of charge.[22] In Sidewalk Labs Quayside streets, pedestrians, cyclists, transit, delivery vehicles, and AVs co-exist seamlessly, unless they are underground. There is public WiFi and weather-protected outlets. The community would also have mechanical and electrical connection points throughout public spaces; water playscapes, including fountains, mist machines, and splash pads; as well as an array of speakers for announcements throughout all of Quayside's public spaces.

[21] Sidewalk Labs, *Toronto Tomorrow Volume 1: The Plans* (Master Innovation and Development Plan: Sidewalk Labs, 2019), 98.
[22] Sidewalk Labs, *Toronto Tomorrow Volume 1*, 117.

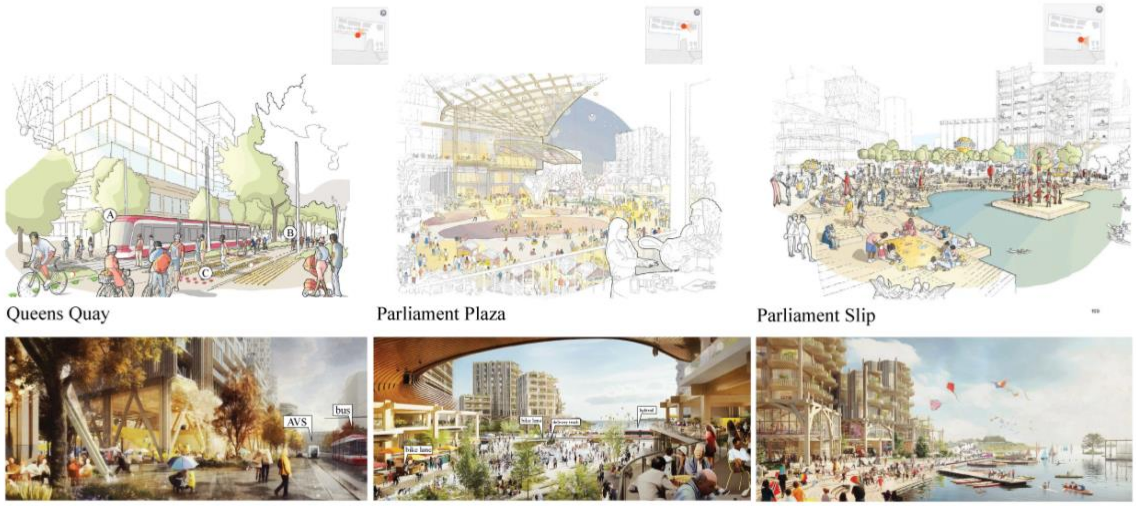

Figure 5.3: Sidewalk Labs Quayside Proposal vision for streets, from left to right: Queens Quay, Parliament Plaza, and Parliament Slip.
Source: Sidewalk Labs Master Innovation and Development Plan.

The curb in Quayside includes several traditional features like an elevation change between the road and the sidewalk/pedestrian space and less-traditional features; it is a flat continuous surface made from modular hexagon pavers that can be removed and replaced as needed. As mentioned above, these pavers create heated sidewalks. They also provide lighting through a built-in LED and are connected to open access channels underground. Other pavers of the same shape are made permeable to absorb melted snow and stormwater.[23] A prototype of the pavers was shown at Sidewalk Labs 307 workspace as well as at Cooper Hewitt's *The Road Ahead*. Per the *MIDP*, the modular pavers would have cost 13% less than traditional pavers due to their longevity and ability to withstand wear and tear. The curb in Quayside was to be priced with a dynamic model, meaning that pricing would be dependent on the demand of the curb, increasing the longer people wait with their vehicle at the curb location. Free drop-off/pickup would be available in the various underground mobility hubs discussed above. Quayside included more than 1,200

[23] Sidewalk Labs, *Toronto Tomorrow Volume 2*, 137.

square meters of heated sidewalks and 1,500 square meters of heated bike paths intended to encourage all-year usage.[24]

Technology: Sidewalk Labs' proposal presented self-driving vehicles as a ubiquitous feature of urban spaces.[25] AVs and ride-hailing had a big role in the *MIDP*, with about 7% of all trips in Quayside intended to be completed with AVs.[26] These are not all private vehicles, but rather part of a ride-hailing program and a car-share system. A monthly subscription—including access to the light rail, bike-share, and other micromobility systems—was part of the *MIDP* mobility plan and included credits to be used with the ride-hailing and ride-share providers at a price of $270 a month.[27] Beyond AVs for private and public mobility, Sidewalk Labs had several technological solutions for Quayside's public areas. One of these would become a logistics hub for delivery, waste, and storage, built in a similar format as the mobility hub and hidden underground.

Sidewalk Labs' proposal argued for the centralization of urban delivery using smart containers a center to which delivery carriers would bring parcels before distributing them to individual addresses similar to the Amazon Scout, a sidewalk-delivery robot that I discussed in Chapter 3, these smart containers would occupy the street alongside pedestrians, cyclists, and a host of other AVs for public, private, and civic use. Smart containers are Sidewalk Labs' solution for last-mile shipping. At the time of *MIDP* publication, Sidewalk Labs planned to develop a standardized storage compartment "inspired by the shipping container,"[28] meaning that the dimensions of the container would

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[24] Sidewalk Labs, *Toronto Tomorrow Volume 2*, 52.
[25] Ibid, 56.
[26] Ibid, 55.
[27] Ibid, 65.
[28] Ibid, 77.

allow the boxes to be stacked and handled by any delivery vehicle, cargo bike, or autonomous delivery truck. Each smart container would be fitted with location-based tracking technology and be available for package delivery, waste, and storage. Sidewalk Labs imagined the smart containers to become lockers and carriers and fitted with software connecting them to a vast network of smart technology in Quayside for personal use and logistical needs.[29] Sidewalk Labs also proposed 24-hour underground freight systems of electric and autonomous dollies that would communicate with the rest of the dolly and delivery network to navigate from one place to another. Most of the proposed smart dollies and containers in circulation were intended to happen through a complex underground-tunnel network, away from the street. Each building would connect to the tunnel system allowing the autonomous dollies to carry smart containers into building lobbies. Sidewalk Labs believed that “the most radical change to delivery service over the next decades is likely to be the use of drones for local deliveries.”[30] Landing pads on each building rooftop would remove drones from the street space, keeping it looking like any other street, filled with people, cyclists, vehicles, and transit systems. But in reality, the street would be overlaid with technology coordinating behind the scenes and producing invisible tracking.

The *MIDP* also included a proposal for a real-time management system for urban mobility. Named the Waterfront Transportation Management Association (WTMA), the organization's work was similar to duties often taken up by transportation and waste departments. In Quayside, its duties would include replacing the modular street-pavement systems, providing travel credits across modes of transit, operating the hardware and software for parking, the curb, and traffic, and enforcing and setting fees for the use of

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[29] Ibid, 78.
[30] Ibid, 82.

these spaces. Sidewalk Labs argued that to achieve all these things, the WTMA would need access to real-time data on traffic volume, vehicle speed, transit delays, emergency dispatches, and weather patterns. WTMA would also need to be able to gather data on pedestrian flow and transit-boarding patterns.[31] So while the smart dollies and containers are not seen on the surface in Sidewalk Labs' vision for Quayside, its "invisible" technology is everywhere: in the pavers of Villiers East at the River District, Bonnycastle Street, McCleary Street, Parliament Plaza, Keating East, and all other Quayside streets. It is also in the information kiosks to call for a pickup.

Systemic change: The *MIDP* summary began with the following statement: "the *MIDP* proposes a comprehensive planning and partnership model that sets a new standard for urban development in the 21st century. It is a work-in-progress meant to be refined by further consultation — not a finished product."[32] The 60-page *Discussion Guide* published in February 2020 by Waterfront Toronto rejected only several Sidewalk Labs proposals, including an "ultra-efficient" housing concept that called for flexible walls, multipurpose furniture, and communal eating/co-working spaces. Waterfront Toronto also disregarded a classification system designed to combine residential, commercial, and industrial sectors by citing not the shared characteristics but the size of the units (578 square feet). Out of 160 alternatives submitted, 144 were ultimately accepted, which is not a bad performance for a proposal that encountered numerous objections from the public.

Before the publication of the *MIDP*, Sidewalk Labs spent 18 months on public consultation that included town halls, roundtables, and public talks. In June 2018, the

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[31] Ibid, 89.
[32] Sidewalk Labs, *Toronto Tomorrow: A New Approach for Inclusive Growth* (Master Innovation and Development Plan: Sidewalk Labs, 2019), 38.

company also opened an office and workshop "where Torontonians can continue to learn about, provide feedback on, and experiment with different elements of the vision."[33] Here they hosted of participation exercises for visitors to engage with the design process during Sunday afternoons. Shannon Mattern, a professor of anthropology at the New School University in New York City and the author of *A City is Not a Computer*, describes the space as "resolutely low tech, sort underground-arts-venue-meets-elementary-school. Analog media like post-it notes, index cards, and rough architectural models decorate the scaffoldings of plywood, chipboard, and cork."[34] Designed by Architect Luc Bouliane, a Toronto-based architect, it suggested transparency with high-ceilinged white walls and concrete floors. The space featured a series of user stations, tables that had comment cards with feedback from earlier visitors and stacks of colorful blank cards to be filled in by visitors. Some stations offered prompts such as "A question I have about facial recognition is: ____?" Another station offered a cardboard mock-up of an apartment, where visitors could affix various post-it notes stating likes and dislikes. A feedback wall was documented each weekend by Sidewalk Lab employees synthesizing and documenting comments to share with the rest of the team. Screens allowed visitors to zoom in on interactive maps and to use Sidewalk Labs' various design tools. CommonSpace, an application for conducting "public life studies," had a separate kiosk where the collected data were inputted into Gehl Institute's Public Life Data Protocol. Another station allowed visitors to generate a map of a virtual neighborhood using wooden knobs to shift building height, shape, density,

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[33] Will Fleissig and Daniel Doctoroff, "Letter to Toronto," June 26, 2018, https://storage.googleapis.com/sidewalk-toronto-ca/wp-content/uploads/2019/06/13221545/Sidewalk-Toronto-Engagement-Update-June2018.pdf.
[34] Shannon Mattern, "Post-It Noe City," *Places Journal*, February 2020, https://placesjournal.org/article/post-it-note-city/.

distribution of green space, elements of the street grid. The feedback from the mapmakers was measured with a happy-or-sad-face button.[35] The efforts were met with concerns from privacy advocates over the large number of sensors and data-collection processors that the company seemed to believe were the way forward.

In April 2019, the Canadian Civil Liberties Association (CCLA) sued all three levels of the Canadian government to try to stop the Quayside Sidewalk Labs project. CCLA Executive Director Michael Bryant, a Liberal member of the Legislative Assembly of Ontario between 1999 and 2009 and Attorney General under Premier Dalton McGuinty, argued that the project set a terrible precedent with potential privacy breaches violating Canadians' constitutional rights. The suit, which names the federal, provincial, and municipal governments and Waterfront Toronto, was filed prior to the publication of the *MIDP*, which is why most politicians at the time refused to make any statements on the issue. A few weeks before filing the suit, the association sent letters to Prime Minister Justin Trudeau, Ontario Premier Doug Ford, and Toronto mayor, John Tory, warning it was considering legal action over the Sidewalk collaboration. At its core, the suit looked to nullify the partnership between Waterfront Toronto and Sidewalk Labs, arguing that it infringed on civil liberties stipulated in the Canadian Charter of Rights and Freedoms, part of the Canadian Constitution that "sets out those rights and freedoms that Canadians believe are necessary for a free and democratic society."[36] The charter protects any person in Canada with selected exceptions (such as voting) for Canadian citizens only.[37]

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[35] Shannon Mattern, "Post-It Noe City," *Places Journal*, February 2020, https://placesjournal.org/article/post-it-note-city/.
[36] Government of Canada, "Guide to the Canadian Charter of Rights and Freedoms," June 8, 2020, https://www.canada.ca/en/canadian-heritage/services/how-rights-protected/guide-canadian-charter-rights-freedoms.html.
[37] Government of Canada, "Guide to the Canadian Charter."

Bianca Wylie and Saadia Muzaffar, longtime critics of the Quayside project formed Block Sidewalk (along with 30 concerned citizens) to halt the project. The organization, citizen-run, and volunteer-based, focused on the need for a democratic process to determine how the land would be developed. Sidewalk Labs' CEO, Dan Doctoroff, maintained that the project was the "first true articulation of what's really possible when you combine cutting-edge innovation and forward-looking urban design [that's] inclusive community [is] highly responsive to issues many cities are facing today."[38] But for Block Sidewalk it did not make sense that in order to create an equitable city, Sidewalk Labs would need a park bench that counted how many people sat on it. The problem with the vision was that between curbside trash-containers that alerted the Department of Sanitation when it neared capacity to heated pavements, there was a lot of surveillance. In an appearance on *The Agenda*, Bianca Wylie, the Toronto activist, argued that having a monopoly on data collected in public spaces, where opting out is not an option, will come at the expense of democracy. "Is A.I. and technology going to help us have a more equitable city?" she asked, cautioning against Silicon Valley giants throwing technology at urban problems.[39] In response, Sidewalk Labs proposed that all the data that were being collected was going to be controlled and managed by an independent Civic Data Trust. The trust was later renamed the Urban Stat Trust, making me wonder if Alphabet has a distaste to the term *civic*. Sidewalk Labs offered several guidelines that were to be applied to the various entities operating in the development through Responsible Data Use (RDU) instructions

[38] Jessica Mulholland, "Sidewalk Labs Releases 'Toronto Tomorrow' Master plan," *Government Technology*, June 24, 2019, https://www.govtech.com/smart-cities/Sidewalk-Labs-Releases-Toronto-Tomorrow-Master-Plan-.html.

[39] Brian J. Barth, "Death of a Smart City," *One Zero Medium*, August 12, 2020, https://onezero.medium.com/how-a-band-of-activists-and-one-tech-billionaire-beat-alphabets-smart-city-de19afb5d69e.

and assessment. As part of the *MIDP*, the RDU guidelines were framed by Sidewalk Labs as a set to be shared and followed by a host of vendors operating different data-collecting schemes. Guidelines would require that the data collected must have a "clear purpose and value...as well as a clear, direct connection to the ways in which the project and proposed data collection activity would benefit individuals or the community."[40] Individuals must be made aware of data-collection activities with only a minimum amount of information collection; once data has been de-identified, it must be made available to the public according to open data standards. Data cannot be sold or used for advertising purposes,[41] a promise the public found hard to believe when coming from a business with the goal of making money.

Analysis: Sidewalk Labs Quayside project presents an example of the ongoing push and pull between the public and businesses when it comes to sustainable urban development. For certain businesses, data, represents a tool toward achieving sustainable goals (while being financially successful), for the public, it is an invasion of privacy that has nothing to do with sustainable design. The tension between values of sustainability and the goal of having a successful business is at the core of the objections against the Sidewalk Labs Quayside project. Especially when those sustainability goals require huge amounts of data (and energy). Even with all the challenges, the Sidewalk Labs Quayside project seemed to be on its way forward. But in May 2020, amid the COVID-19 crisis, CEO Daniel Doctoroff announced that the company would no longer pursue the Quayside project due

[40] Sidewalk Labs, *Toronto Tomorrow Volume 2*, 424.
[41] Sidewalk Labs, *Toronto Tomorrow Volume 2*), 425.

to “unprecedented economic uncertainty.”[42] What Doctoroff failed to mention was that the project had continuously been criticized by activists, businesspeople, and civic leaders over the planned mass collection of citizens’ data.

While Sidewalk Labs Quayside is no more its ideas have lived on in Sidewalk Labs’ subsequent ventures and in public awareness. By the end of June 2020, Doctoroff announced the company intended to take some of the smart city ideas it developed for Quayside and create separate business entities.[43] One of those entities ended up being a prototype program called Collab. A collaboration between Sidewalk Labs and Digital Public Square, Collab is a technology company focused on creating a digital platform for communication between governments and communities to stimulate participation and input. In 2020, Sidewalk Labs moved from prototyping Collab to collaborating with Civil Space, another company focused on a digital framework for community engagement. The software is not publicly available.[44] Another Sidewalk Labs collaboration with the city of Portland, where the company used its Replica software (a data platform able to track how people move around the city), was abandoned by the city in 2021, citing privacy, accuracy, and transparency. Replica became its own separate company at some point during the collaboration, but according to a spokesperson for Portland Metro, the city did not pay Replica for any services.[45] In 2022, Doctoroff stepped down from Sidewalk Labs for health

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[42] Daniel L. Doctoroff, “Why We’re No Longer Pursuing the Quayside Project – And What’s Next for Sidewalk Labs,” *Sidewalk Talk Medium*, May 7, 2020, https://medium.com/sidewalk-talk/why-were-no-longer-pursuing-the-quayside-project-and-what-s-next-for-sidewalk-labs-9a61de3fee3a.
[43] Emil Protalinski, “Sidewalk Labs Plans to Spin Out More Smart City Companies,” *Venture Beat*, June 24, 2020, https://venturebeat.com/2020/06/24/sidewalk-labs-plans-to-spin-out-more-smart-city-companies/.
[44] Ariel Kennan, Farhann Ladhani, and Sean Willett, “Collab: A New Digital Tool for Community Participation,” *Medium*, May 14, 2019, https://medium.com/sidewalk-talk/collab-a-new-digital-tool-for-community-participation-adcbdb6700df.
[45] Martin Coulter, “Alphabet’s Sidewalk Labs Has Abandoned Another US Smart City Project after Reported Fights about Transparency,” *Business Insider*, February 24, 2021,

reasons, and the company's remaining projects were folded into Alphabet's urban sustainability division.[46]

Sidewalk Labs presents its urban street as a safe, delightful, and comfortable place for all users. Design considerations extended to opportunities to walk with no obstacles and no fear of traffic or collision; a lively public realm with interesting building facades, and opportunities for seating along with attention to detail (water and plants). The urban street in the Quayside vision is designed as a positive sensory experience if you are walking or cycling, in daytime or nighttime. But this vision of a comfortable and delightful urban street is an illusion made possible by an underground infrastructure network that Sidewalk Labs argued will be fully autonomous and electric even though the required technologies do not yet exist.

Sidewalk Labs' vision for the urban street is created in a reality where the climate crisis has been addressed (through smart design), but consumption is still heavily designed for through its 24-hour freight-dolly system. As an exercise in sustainable urban development, the Sidewalk Labs' vision fails by relying on surveillance data instead of community as a way to create safe environments, what Jane Jacobs called eyes on the street—by people in shops, businesses, and the activity of people.[47]

Sidewalk Labs Quayside project scores well for pedestrians (8 points) but does not do as well with micromobility users (1 points) or riders (4 points), see Figure 5.3. Many of the strategies planned for micromobility users and riders are still mixed with few provisions

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https://www.businessinsider.com/second-sidewalk-labs-smart-city-project-shutters-portland-oregon-2021-2.

[46] Daniel L. Doctoroff, "My Next Chapter: Fighting ALS," *Medium*, December 16, 2021, https://medium.com/sidewalk-talk/my-next-chapter-fighting-als-207ce7ca69c8.

[47] Jane Jacobs, *The Death and Life of Great American Cities* (New York: Vintage Books, 1992), 33-35.

made for dedicated spaces that will accommodate large-scale use. If everyone is going to bike, ride a scooter, or take a bus, more lanes, safe storage and waiting stations need to be provided. Sidewalk Labs proposal fails most, as discussed above, is in its data-collection obsession. The concept of data as the tool to produce safe and comfortable environments do the opposite. Making public spaces places filled with surveillance causing fear of misuse of information and fear of invasion of privacy.

Table 5.3 Sidewalk Labs: Quayside Project Lens Scorecard

<table>
<tr><th></th><th colspan="2">Pedestrians</th><th colspan="2">Micromobility</th><th colspan="2">Riders (Public Transit)</th></tr>
<tr><td rowspan="3">Lens of safety</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td><td rowspan="2">Protection against traffic & collisions</td><td rowspan="2">Eliminating fear of traffic</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td></tr>
<tr><td>Protection against crime & violence</td><td>Lively public realm</td><td>Protection against crime & violence</td><td>Ability to safely wait for transit</td></tr>
<tr><td>Overlapping functions</td><td>Protection from light, weather, pollution, dust, noise, & glare</td><td>Protection against crime & violence</td><td>Ability to safety store, & maintain micromobility devices</td><td colspan="2">Protection from weather, pollution, dust, noise, & glare</td></tr>
<tr><td rowspan="3">Lens of comfort</td><td>Opportunities to walk with no obstacles</td><td>Accessibility for everyone</td><td rowspan="2">Opportunities to roll with no obstacles</td><td rowspan="2">Accessibility for everyone</td><td rowspan="2">Opportunities to travel with no obstacles</td><td rowspan="2">Accessibility for everyone</td></tr>
<tr><td>Interesting facades</td><td>Opportunities for standing & seating</td></tr>
<tr><td>Spaces for play & “talkscapes”</td><td>Lighting at night</td><td>Spaces for commute, leisure, & repair</td><td>Lighting at night</td><td>Opportunities for standing & seating</td><td>Lighting at night</td></tr>
<tr><td rowspan="2">Lens of delight</td><td>Buildings scale</td><td>Opportunities to enjoy positive climate</td><td>Lane size</td><td>Opportunities to enjoy positive climate</td><td colspan="2" rowspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
<tr><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
</table>

See Table 4.4 (page 153) for a comprehensive lens analysis overview. Green: sufficient. Yellow: passable Red: unsatisfactory. Total Score: 13 points.

5.1.3 *Public Square* by FXCollaborative

Public Square, part of FXCollaborative's winning proposal for the online architecture planform Blank Space, offers a vision of an urban street that is a place for people. Its proposal is for a modular transition over time where pieces of urban infrastructure are installed on platforms. While *Public Square* is an urban intervention alternative mobility, unlike the NACTO *Blueprint for Autonomous Urbanism* (which is intended to be read as a planning guideline document), or the Sidewalk Labs Quayside project (which was intended for implementation), *Public Square* is a paper project and was designed as a competition entry. It is significant because, to a certain level, it embraces the existing conditions of urban streets and attempts to bridge the complexities of sustainable development with a kit-of-part library that can be installed over time.

In 2017, Blank Space launched the *Driverless Future Challenge* with AIA New York and the NYC Mayor's Office, the Department of Planning and Transportation, and the Economic Development Cooperation.[48] The challenge focused on producing ideas that will shape the impact of autonomous transportation on NYC streets. The winning entry, called *Public Square,* was intended "to create a launchpad for entrepreneurs, innovators, designers, engineers, architects, and futurists to enact real change in New York City."[49] Produced by FXCollaborative[50] with Sam Schwartz Engineering, *Public Square* is a plug-and-play scheme transforming streets through a set of nine interlocking platforms of green

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[48] Other partners in the *Driverless Future Challenge* were NewLab, a technology center with a hardware shared workspace in the Brooklyn Navy Yard; Arch Daily, a weblog covering architecture projects, events, and material news; and *Fast Company*, a monthly American business magazine.
[49] Blank Space, *The Driverless Future Challenge Brief* (2017), 14.
[50] At the time of the competition the firm was known as FXFowle. It rebranded as FXCollaborative in 2018.

spaces, play equipment, and a public restroom. The parking spot provides the initial space of installation.

Systemic change: As shown in Figure 5.4, the squares are intended to create urban streets that include retail space, travel lanes, and water management infrastructure. A video made by FXCollaborative as part of the competition entry provides the audience with its deployment strategy, which is based on the assumption that privately-owned vehicles will disappear from urban streets over time.[51] This reduction will happen as manual vehicles are replaced by AVs. The proposal takes advantage of the newly available parking spaces (from fewer people owning cars) by proposing an incremental design approach of "one space at a time."[52] The space is a platform with built-in power, water, WiFi, and "smart street technology" infrastructure. Nine platforms in total, each with a different occupancy type, can be mixed in endless variety over time. The supposedly flexible modular nature of the plug-in system is meant to allow "streets to change as cities change."[53] The nine modules proposed by FXCollaborative are a 1) bike-share station and green space, 2) seating, 3) a retail kiosk, 4) a playground, 5) digital information and communication station, 6) bioswale, 7) an urban garden, 8) a public restroom, and 9) a circulation module made of porous surfaces. In the perspective vision of *Public Square* future proposal (Figure 5.4), the public restroom and the playground are not visible. The public restroom is also not found in the extended plan vision (C in Figure 5.4).

[51] FXFOWLE Architects with Sam Schwartz Engineering, "Public Square – Reclaiming the Street," Vimeo video, June 22, 2017, BlankSpaceNYC video entry, 03:31, https://vimeo.com/222721632.
[52] FXFOWLE Architects, "Public Square – Reclaiming the Street," 00:39.
[53] FXFOWLE Architects, "Public Square – Reclaiming the Street," 00:45 and 01:20.

Figure 5.4 *Public Square* by FXCollaborative. The top image shows a perspective view of a possible street with the fully deployed system of interlocking frames. A: the proposed nine 8'x8' frames. B: A view of four types of themed configuration. From L-R: bike travel and water infrastructure theme, children play area theme, urban agriculture theme, public services (restroom and retail) theme. C: A plan view with the deployed squares, including detailed views of several of the proposed frames.
Source: FXCollaborative. Public Square. http://www.fxcollaborative.com/projects/186/Public%20Square/

Technology: At first glance, this does not seem like a technology-driven vision of the future. Trees, tables, and various pavers create vital open space for children to play and for people to sit, walk, run, bike, and scoot. It gives the illusion of a low-tech local urban street in a large, dense city. A perpendicular street for vehicular traffic is the only vehicle artery in the vision that includes a dedicated painted bike lane, a dedicated painted bus lane, and one vehicular lane (see image D in Figure 5.4).

The designed bike lane is a two-way track framed by a traditional sidewalk coupled with a collection of modules: green space and seating; playground; information and communication stations; bioswales; urban gardens; and circulation from pervious surfaces. On the bike lane's other side is a second strip of occupiable green space (Module 7) and additional permeable space (Module 6). The bike lane itself seems to be the traditional 10 and 12 feet lane, which means that each cycling direction has an average of five feet. This is not a lot of space for a vision that assumes no one will own a personal vehicle. Protected from vehicular traffic and parked cars or trucks, the bike lane halves the pedestrian space, making it a dangerous and frustrating lane to ride and cross. Apart from the bicycle lane, created with paint and no additional barriers, and the uncovered bike-share-docking station (Module 1), there does not seem to be any additional bicycle infrastructure. There are additional issues, such as the bus lane is framed by a second vehicular lane, and the occupiable green space (Module 7) coupled with a collection of bioswales (Module 6) has no curb stops for rider pickup/drop off. The communication and information kiosk, which could be argued to be a form of transit stop, is located near the traditional sidewalk, not near the travel lane of the bus. To the left of the travel lane, though, we can see several curb cutouts for dropping off/picking up people and goods. Additional pedestrian space, gardens (Module 7), seating spaces (Module 2), and multiple kiosks (Module 3) are merged into the existing sidewalk.

Form: FXCollaborative chose to showcase a street containing no traditional roadway lanes, but the street perpendicular to the showcased one seems designed for vehicular circulation. Neither street is designed with elevation changes maintaining traditional sidewalks at the street edge. Painted bike lanes, textured and porous surfaces, and planters make up the rest of the street. Unfortunately, the design also includes some traditional automobile-street features (like crosswalks) exclusively placed at street intersections. Mid-block crosswalks are visible in Image C, but in a supposedly fully pedestrianized street, one wonders why a crosswalk marking is still necessary. The use of smart technology and autonomous technology is integrated into the proposal in a way that does not take center stage. It is hidden in the operational assumptions of the image where bicycles, pedestrians, buses, delivery trucks, and ride-hailing vehicles co-exist seamlessly. It is also hidden in the materiality of the ground surface, requiring a sophisticated water-management system for it to be maintained.

Analysis: Public Square offers a vision for a comfortable, delightful, and slightly safer alternative to the urban street of the contemporary city. The design of the street prioritizes a level of comfort and delight above several safety features, including the street-pavers choices and program organization. Safety of pedestrians and cyclists (as well as other micromobility users) is jeopardized in order to produce play spaces and a pleasant sensory experience. There are little opportunities to travel without obstacles or any consideration to wind, rain, heat, or noise across activities.

Overall, the project's incremental design offers its most successful feature in responding to sustainable development goals of a safe, delightful and comfortable urban street. The diverse modules offer a flexible development framework that can respond to specific needs of a particular urban street. Overall, the *Public Square* scenario scores a total of one point (see Table 5.13). Its most successful features, designing for a lively pedestrian realm with space to talk and enjoy positive climate, become muted due lack of attention to detail with material selection and spatial distribution of program. Having a playground and an unprotected micromobility lane in the same environment prevents smooth travel for commuters and dangerous conditions for those there for pleasure. Micromobility users score the lowest in *Public Square* (–2 points) lacking sufficient lane space or supporting infrastructure such as safe storage or intersection waiting areas.

Table 5.4 *Public Square* Lens Scorecard

	Pedestrians		Micromobility		Riders (Public Transit)	
Lens of safety	Protection against traffic & collisions	Eliminating fear of traffic	Protection against traffic & collisions	Eliminating fear of traffic	Protection against traffic & collisions	Eliminating fear of traffic
	Protection against crime & violence	Lively public realm			Protection against crime & violence	Ability to safely wait for transit
	Overlapping functions	Protection from light, weather, pollution, dust, noise, & glare	Protection against crime & violence	Ability to safety store, & maintain micromobility devices	Protection from weather, pollution, dust, noise, & glare	
Lens of comfort	Opportunities to walk with no obstacles	Accessibility for everyone	Opportunities to roll with no obstacles	Accessibility for everyone	Opportunities to travel with no obstacles	Accessibility for everyone
	~~Interesting facades~~	Opportunities for standing & seating				
	Spaces for play & "talkscapes"	~~Lighting at night~~	Spaces for commute, leisure, & repair	~~Lighting at night~~	Opportunities for standing & seating	~~Lighting at night~~
Lens of delight	~~Buildings scale~~	Opportunities to enjoy positive climate	Lane size	Opportunities to enjoy positive climate	Positive sensory experience: materials, plants, water, attention to detail (human dimensions)	
	Positive sensory experience: materials, plants, water, attention to detail (human dimensions)		Positive sensory experience: materials, plants, water, attention to detail (human dimensions)			

See Table 4.4 (page 153) for a comprehensive lens analysis overview. Green: sufficient. Yellow: passable Red: unsatisfactory. Total score: 1 point.

5.2. Events

Alternative mobility events are happenings in which people come together to experience, discuss, view, or question the future of the urban street. The following two scenarios have had their temporary status integrated into their format.

5.2.1 AIANY Future Street

The Center for Architecture (AIANY)[54] Future Street was a temporary installation during a New York City car-free day in 2019. This event's vision for the street included temporary potted plants, moveable tables and chairs, a grassy play area, and places for musicians. It was intended as an "immersive experience focused on public right-of-way design," engaging the public on the question of the street's function as a public space that privileges the pedestrian.[55] New York City's Car-Free Earth Day is an annual event that coincide with Earth Day (April 22). The event closes Broadway from Times Square to Union Square to cars, opening it for walking and bike (or any other micromobility) only.[56]

Figure 5.5: AIANY "Future Street" vision.

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[54] American Institute of Architects.
[55] AIANY Calendar, "Future Streets at Car free Earth Day," *American Institute of Architects New York*, April 27, 2019, https://calendar.aiany.org/2019/04/27/future-streets-at-car-free-earth-day/.
[56] NYCDOT, "Car Free Earth Day (Broadway)", accessed March 22, 2022, New York Department of Transportation, https://www1.nyc.gov/html/dot/summerstreets/html/carfree/carfree.shtml.

Source: Belen Ayarra, AIANY calendar, https://calendar.aiany.org/2019/04/27/future-streets-at-car-free-earth-day/

Form: As can be seen in Figure 5.5, the AIANY future street is unlike the typical street seen in American cities. A meadow-like space takes over most of the roadway leaving a central meandering path surrounded by landscape. Traditional sidewalks at both sides of the street allow for continued circulation, but the rest of it has become a place for staying and playing. The design reflects the temporality of the car-free event and the Future Street installation by using potted plants, sheets of turf, and chairs and tables only.

AIANY presented another variation of this vision near its New York City storefront and building in 2018. It included covering a small part of the entire roadway with grass and setting up a long dining table on the remaining paved space of the block (see Figure 5.6). Another combination of green surface (infrastructure) and seating furniture, it is how most non-vehicular visions of urban streets end-up looking like: as a park or plaza space that expands the pedestrian realm. From this scenario of the future, of a street turned park with seating space, vital question arises, over the nature of the urban street as a thruway for vehicle circulation or as a space for other social needs. The AIANY urban intervention/event alternative mobility presents a clear question to those who experienced it: Who and what is the street for?

Systemic change: The AIANY event was only several hours long so all the greenery was installed on top of the asphalt (turf), or potted, to allow for easy removal. It is noteworthy that any longer installation of a green street would require some construction to allow for better water drainage and introduction of soil in certain situations. In cities facing increasing water threats, concepts like sponge parks, that allow for controlled management of water runoff and still allow for pedestrian circulation,[57] are being used to help communities live with the water. A longer installation would have probably allowed for a more impressive vision than the one that was presented to the public during New York City's 2019 Car-Free Earth Day. As seen in Figure 5.6A, the existing road overwhelms the interventions, thus, offering a less immersive experience than the one intended in the vision. This is not to say that the intervention is not lovely; and it improves the existing conditions to make a more pleasant environment for people, but it falls short of making any significate visual changes to the experience of the street: a difficult thing to achieve in a temporary capacity.

Figure 5.6 Top row: AIANY Future Street in 2018. Second row: AIANY Future Street during New York City car-free Earth Day 2019.
Note: Photos by the author.

[57] DLAND studio, Gowanus Canal Sponge Park Masterplan, accessed March 22, 2022, https://dlandstudio.com/Gowanus-Canal-Sponge-Park-Masterplan.

Analysis: The AIANY urban street vision is intended to create a positive sensory experience by contrasting the built environment with green space by adding plants, spaces for play, seating and tables, the experience is meant to instill a sense of calm while providing leisure space. It is the transition of an urban street into an urban park. The nature of the street as a slow space (park) makes it a safer space where interception is limited to people walking or riding a micromobility device. The activity of the new space creates a lively public domain.

The design relies on the existing density of its location. By keeping the painted bike lane free of plants, the space becomes circulation for walkers and cyclists, reflecting the origin of the street as a thruway, but limiting it to a smaller scale than the contemporary automobile. It is a design that opens questions about the nature of street surfaces and programs. The road becomes a pervious landscape, while the sidewalk and curb maintain their transit-oriented role.

The AIANY Future Street scenario scores well with pedestrians (8 points), designed as it is for a fully accessible street for those walking or using a wheelchair (see Table 5.5). The scenario does not take advantage of its pedestrian focus addressing only a single weather condition, a slightly sunny day. There is no planning for rain (canopy) or cold weather (outdoor heaters). The scenario does not do as well with micromobility users (–2 point). The scenario accommodates micromobility users but does not dedicate any design features for them. Spaces for commute or leisure are left unprotected preventing any chance to roll with no obstacles.

Table 5.5 AIANY Future Street Lens Scorecard

<table>
<tr><th></th><th colspan="2">Pedestrians</th><th colspan="2">Micromobility</th><th colspan="2">Riders (Public Transit)</th></tr>
<tr><td rowspan="3">Lens of safety</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td><td rowspan="2">Protection against traffic & collisions</td><td rowspan="2">Eliminating fear of traffic</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td></tr>
<tr><td>Protection against crime & violence</td><td>Lively public realm</td><td>Protection against crime & violence</td><td>Ability to safely wait for transit</td></tr>
<tr><td>Overlapping functions</td><td>Protection from light, weather, pollution, dust, noise, & glare</td><td>Protection against crime & violence</td><td>Ability to safety store, & maintain micromobility devices</td><td colspan="2">Protection from weather, pollution, dust, noise, & glare</td></tr>
<tr><td rowspan="3">Lens of comfort</td><td>Opportunities to walk with no obstacles</td><td>Accessibility for everyone</td><td rowspan="2">Opportunities to roll with no obstacles</td><td rowspan="2">Accessibility for everyone</td><td rowspan="2">Opportunities to travel with no obstacles</td><td rowspan="2">Accessibility for everyone</td></tr>
<tr><td>Interesting facades</td><td>Opportunities for standing & seating</td></tr>
<tr><td>Spaces for play & “talkscapes”</td><td>Lighting at night</td><td>Spaces for commute, leisure, & repair</td><td>Lighting at night</td><td>Opportunities for standing & seating</td><td>Lighting at night</td></tr>
<tr><td rowspan="2">Lens of delight</td><td>Buildings scale</td><td>Opportunities to enjoy positive climate</td><td>Lane size</td><td>Opportunities to enjoy positive climate</td><td colspan="2" rowspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
<tr><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
</table>

See Table 4.4 (page 153) for a comprehensive lens analysis overview. Green: sufficient. Yellow: passable Red: unsatisfactory. Total score: 6 points.

5.2.2 Smart Growth America: The National Complete Street Coalition

Complete Streets is a design concept based on the idea that streets are “whole” only when they serve all users equally, regardless of age or ability. Complete Streets have been implemented in a variety of ways in the United States, but not all of them have to do with physical interventions on the urban street. Complete Streets can be policies about funding allocations, the introduction of a crosswalk or a bike lane; they can also be temporary installations before the introduction of permanent physical infrastructure or cultural events to engage communities about proposed changes to their streets. Complete Streets, as a concept, is an urban intervention alternative mobility that is comprised of temporary physical interventions (event alternative mobility) and policies (service alternative mobility).

Systemic change: The National Complete Street Coalition, an organization dedicated to advocating for Complete Streets through policy and education in the United States, is part of Smart Growth America. Founded in 2000, Smart Growth America is an advocacy non-profit organization spreading word about the smart growth approach to local and state governments. In 2008, through a large multi-year grant, it established Transportation for America, a national campaign focused on transportation reform. Four years later, in 2012, the National Complete Streets Coalition became part of the organization, along with the National Brownfields Coalition. The National Complete Street Coalition advocates for the adoption of a Complete Streets approach. Beyond the organizations mentioned above, Smart Growth America facilitates numerous programs, including the Governors' Institute on Community Design, a Form-Based Codes Institute, a Local Leaders Council, and LOCUS, a national coalition of real estate developers advocating for a "sustainable, equitable, walkable development in America's metropolitan areas."[58] Smart Growth is a design and planning approach that advocates for urban development that is more diverse and sustainable, but maintains the traditional form that has been set in place. Its ten principles[59] of design and planning are based on giving "a shot

[58] Smart Growth America, "Our Work," *Smart Growth America*, accessed March 22, 2022, https://smartgrowthamerica.org/what-we-do/programs/.
[59] (1) Mix land uses, (2) take advantage of compact building design, (3) create a range of housing opportunities and choices, (4) create walkable neighborhoods, (5) foster distinctive, attractive communities with a strong sense of place, (6) preserve open space, farmland, natural beauty, and critical environmental

at the American Dream of opportunity to all."[60] The Complete Streets Coalition helped develop a number of urban street design strategies that are now being used more frequently by local planning offices.

Form: Complete Streets is related to, but not the same as the notion of the Dutch *Woonerf*. Translated as the Residential Yard or Living Street, the Woonerf was an effort started in Delft in the late 1960s when a group of residents got tired of cars speeding down their street. To slow down the vehicles, the neighbors took out the roadway brick surface and repaved it as a winding road. Car traffic was limited to 10 mph and various amenities—such as street furniture, trees, and planters—were added. The Woonerf design is intended to make drivers feel that it is natural to drive slowly in certain areas by creating both physical and visual cues. Designs include creating a distinctive entryway to the Woonerf, adding curves to the travel lanes breaking the line of sight; using street furniture such as benches, play equipment, and landscaping to slow traffic; eliminating the curb; and providing intermittent spacing for parking. In 1976, the Dutch Parliament passed a regulation making the Woonerf—as a shared street for pedestrians, cyclists, and cars—a national design standard. Around the world, the concept of the Woonerf has been adapted into a traffic-calming tool, a way to slow traffic, but not necessarily to improve the sociability of a street. In addition to the Complete Street (United States),[61] adoption of Woonerf related policies include: the Home Zone (United Kingdom), the Shared Zone (Australia and New Zealand), Zone de rencontre (France), and Zona 30 (Europe and

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areas, (7) strengthen and direct development toward existing communities, (8) provide a variety of transportation choices, (9) make development decisions predictable, fair, and cost effective, (10) encourage community and stakeholder collaboration in development decisions.

[60] Dan Emerine et al., "This is Smart Growth," *Smart Growth Network*, accessed March 22, 2022, https://www.epa.gov/sites/default/files/2014-04/documents/this-is-smart-growth.pdf.

[61] Bruce Appleyard and Lindsey Cox, "At Home in The Zone: Creating Livable Streets in The United States," *American Planning Association* 72 (2006): 30-35.

Mexico), and a dozen more from around the world. In one way or another, all aim to calm vehicular traffic and create equity for users, be they pedestrians, cyclists, or drivers.

The concept and implementations of Complete Street policies and design features gained momentum in the United States through the National Complete Streets Coalition. Defining a Complete Street as "the integration of people and place in the planning, design, construction, operation, and maintenance of transportation networks," it allowed for a diverse method of implementation. In principle, according to the Coalition, a Complete Street takes many forms. As a design strategy based on a toolkit of diverse interventions, it allows various cities and towns to introduce Complete Streets elements into streets—improving them, but not necessarily completing them. The strategy includes the introduction of sharrows and bike lanes. Sharrows are bicycle markings on streets intended to inform vehicle drivers that it is a shared road for both riders on bikes and drivers in cars. The reduction of car lanes through road diets and curbside management seeks to improve transit operations. A Complete Street policy/design can include any of these elements or none, which is why in 2018 Smart Growth America and the National Complete Streets Coalition published a revised grading framework for the definition of a Complete Street. As of June 2021, more than 1,400 Complete Street policies have passed in the United States, including more than 761 Complete Streets resolutions. There are an additional 443 policies, 287 ordinances, 95 plans, and 46 design manuals and guides. Overall, this intentional collection of paperwork influences the lives of close to 600 million people.[62]

[62] Smart Growth America, "Complete Streets Policies," *Smart Growth America*, accessed November 17, 2020, https://smartgrowthamerica.org/program/national-complete-streets-coalition/publications/policy-development/policy-atlas/.

As shown in Figure 4.2.2, some Complete Streets remain very much automobile streets but with additional non-automobile features for pedestrians and cyclists.

Figure 5.7 Examples of Complete Streets in North America. Top left, Philly Free Streets Pop-up pedestrian plaza (Philadelphia, PA), Downtown Improvements Projects (Bonita Springs, FL). Bottom left, City of South Bend Main Street, City of Rochester bike lane and trees. Four images to the right, King Street Project (Alexandria, VA).
Source: Smart Growth American and National Complete Streets Coalition, The Best Complete Streets Initiatives of 2017, Liz Lankenau., 20, City of Bonita Springs, City of South Bend, 41, Stantec and City of Rochester, 39, and 31, City of Alexandria, 34.

A Complete Street policy/design is often a result of community-engagement programs that introduce people to new ideas about the role of the urban street, such as the Better Block events. Better Block is a placemaking non-profit organization that helps communities and cities figure out rapid urban planning through a community-block party and various tactical urbanism tools. Founded by Jason Roberts, a civic activist and urban designer, the organization received a grant from the John S. and James L. Knight Foundation in 2015 that allowed it to expand to a full open source dataset of design files for outdoor entertainment (chairs, benches, tables) and roadway retrofits (pedestrian islands, ramps).[63] The organization also offers a guided 90- or 120-day Better Block

[63] Better Block Foundation, "Wikiblock. 2019," accessed November 17, 2020, https://www.betterblock.org/wikiblock.

Process that starts with community members selecting what needs to be reimagined on a chosen block. The engagement process includes reaching out to local stakeholders to form committees to manage the Better Block: dealing with municipalities, volunteer recruitment, and public art, for example. Through surveys and stakeholder engagement, Better Block drafts a design for the approval of the community, which then gets built a week before the block party. The rapid prototypes are fabricated using Computer Numeric Controller (CNC) routers, 3D printers, and laser cutters to produce objects quickly and at a low cost. Finally, after the block party, the organization passes responsibility and resources to the community with a report mapping a "route to permanency."[64]

On the USDOT website, Complete Streets has been categorized under evidence-based policies, strategies, and interventions that can be used by transportation professionals to address health issues.[65] The FAST Act of 2015 was the first law to ever include Complete Streets language requiring the National Highway System to account for all modes of transit. The bill does not require states to adopt or use Complete Streets standards, it only encourages them. [66] The Complete Streets Act of 2019 was read twice and then referred to the Committee on Environment and Public Works.[67] It was introduced again in 2021 by Senators Edward J. Markey (D-MA), Richard Blumenthal (D-CT), and Brian Schatz (D-HI).[68] The Complete Streets Act would require states to set aside only 5% of federal

[64] Better Block, "Our Approach," accessed November 17, 2020, https://www.betterblock.org/about.
[65] United States Department of Transportation, "Strategies," accessed November 17, 2020, https://www.transportation.gov/mission/health/strategies-interventions-policies.
[66] Smart Growth America, "Safe streets provisions in FAST Act represent a huge step forward in the effort to strengthen local communities," *Smart Growth America*, December 4th, 2015, https://smartgrowthamerica.org/safe-streets-provisions-in-fast-act-represent-a-huge-step-forward-in-the-effort-to-strengthen-local-communities/.
[67] Edward J. Markey, *S.2077- Complete Streets Act of 2019*, Congress, accessed March 22, 2022, https://www.congress.gov/bill/116th-congress/senate-bill/2077.
[68] In the House of Representatives, the legislation has been co-sponsored by Adriano Espaillat (NY-13) and Ruben Gallego (AZ-07).

highway funding to create a grant program to fund Complete Streets projects. The grants would be available for local and regional entities in need of capital funding or technical assistance for safe street projects. Sidewalks, bike lanes, crosswalks, and bus stops are not mentioned in the legislation's text, which makes it a much less effective policy.[69]

Analysis: The Complete Street vision for urban streets is based on the idea that streets should be safe spaces. Comfort and delight are not particularity top priority but due to the nature of safe streets design it is unavoidable. A Complete Street is a street that protects micromobility and pedestrian users from vehicular traffic with protected infrastructure, including the introduction of lighting and attention to materiality. As discussed in this chapter, many of the Complete Street policies improve the safety of streets for different users while maintaining the street role as a thruway. In turn, complete streets lack a lively public realm or spaces for leisure. The safety of the street is therefore also minimal.

The Complete Street scenario scores a total of zero points (see Table 5.6). The most poorly performing category is for pedestrians (–3 points). As discussed above, Complete Streets are travel streets, they do well for public transit riders (2 points) but fail to create a complete system for micromobility users (0 points) or pedestrians. Any positive effort to protect people against traffic and collisions is undone by unprotected micromobility lanes and lack of design beyond the commute. Having a safe crosswalk over a multi-lane intersection without spaces to sit or wait protected from weather, sun or rain results in a scenario that is not sustainable but is not-actively harmful to sustainability goals. Specific

[69] Edward J. Markey, *Complete Streets Act 2021*, Congress, accessed March 22, 2022, https://www.markey.senate.gov/imo/media/doc/(2.24.2021)%20Bill%20--%20Complete%20Streets%20Act%202-22-21.pdf.

Complete Streets may score higher when the surrounding built environment accommodates a lively public realm with opportunities to stand, sit, and enjoy positive weather.

Table 5.6 Complete Streets Lens Scorecard

<table>
<tr><th></th><th colspan="2">Pedestrians</th><th colspan="2">Micromobility</th><th colspan="2">Riders (Public Transit)</th></tr>
<tr><td rowspan="3">Lens of safety</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td><td rowspan="2">Protection against traffic & collisions</td><td rowspan="2">Eliminating fear of traffic</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td></tr>
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</table>

See Table 4.4 (page 153) for a comprehensive lens analysis overview. Green: sufficient. Yellow: passable Red: unsatisfactory. Total score: –2.

5.3. Services

Service scenarios are visions when intent, finance, and groups of people come together to operate/provide a service. In this section, three scenarios are discussed, each offering different kinds of services, civic and business in nature.

5.3.1 Vision Zero

Vision Zero is a policy concept based on the idea that there should be zero traffic-related deaths in streets. Inspired by the Swedish policy of the same name, Vision Zero interventions in the United States have invested in technological and human enforcement. As a service alternative mobility, it supports the production of a safer urban street through an urban intervention and event alternative mobility.

Systemic change: The first Vision Zero was adopted in Sweden in 1997 as an ethical long-term goal: that no one should be killed or seriously injured in a road crash. Vision Zero proposed a paradigm shift from the traditional view of faulting individual road users over road-safety mistakes resulting from design. Vision Zero places responsibility on those who design the transport system. Sweden's Vision Zero challenged the tradition of road-safety management, shifting away from accident prevention and the "perfect human" that does not or cannot make mistakes, toward a transport system that cannot lead to serious injuries even if a person did make a mistake.[70] In Sweden vision zero has become a "common expression of political direction for the whole society."[71] With a focus on road safety, its implementation includes interventions in physical infrastructure, technology and

[70] Road Safety Sweden, "Vision Zero – no fatalities or serios injuries through road accidents," Government Offices of Sweden, accessed January 25th, 2021, https://www.roadsafetysweden.com/about-the-conference/vision-zero---no-fatalities-or-serious-injuries-through-road-accidents/.
[71] Trafikverket, "Origin and background Vision Zero," *Vision Zero Academy*, accessed January 26, 2021, https://www.trafikverket.se/en/startpage/operations/Operations-road/vision-zero-academy/Background-Vision-Zero/.

evidence-based governance and management, like: speed cameras and speed limits, median barriers and roundabouts, introduction of bicycle infrastructure, and parking spaces exclusively for commercial drivers.

Since 2014, when New York City became the first American city to adopt a Vision Zero policy, more than 40 other cities have implemented their own versions.[72] But Vision Zero in the United States has not become a formal national federal policy as it has in Sweden. In terms of safety dedicated programs that echo some Vision Zero goals, FHWA partners with external organizations and administrates a performance-based Highway Safety Improvement Program (HSIP).[73] The program, as its name indicates, is focused mostly on highway-safety improvements and not urban streets and does not establish any specific injury mandate or goals similar to Vision Zero. In 2019, Earl Blumenauer (D-OR), introduced the Vision Zero Act, to allow states to use federal money for local surface-transportation programs, including the implementation of Vision Zero plans.[74] While it is intended to help support development of bicycle and pedestrian infrastructure, the language of the Act states, "all user[s]" and does not detail specific distribution of funding. This will be discussed in detail below, but first, it is necessary to explore Vision Zero in the United States, and the organization taking a role in shaping this alternative mobility.

Other organizations that FHWA collaborates with that have explicit Vision Zero goals are Toward Zero Deaths (TZD), The Vision Zero Network, and Road to Zero. These organizations all focus on reducing and eliminating traffic-related fatalities and injuries.

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[72] Leah Shahum, *Vision Zero: Building from the Ground Up* (Trafikverket: Vision Zero, 2019), 2.
[73] Federal Highway Administration, "Zero Deaths – Saving Lives through a Safety Culture and a Safe System," United States Department of Transportation, accessed January 26th, 2021, https://safety.fhwa.dot.gov/zerodeaths/.
[74] Earl Blumenauer, "H.R. 4819 – Vision Zero Act of 2019," Congress, accessed January 26, 2021, https://www.congress.gov/bill/116th-congress/house-bill/4819/text.

Each program promotes a slightly different multi-disciplinary approach offering a collaborative platform for a host of actors. For example, TZD develops and advocates for a National Strategy on Highway Safety, that includes urban highways. The organization identifies the driver as the main contributor to vehicular-related injury[75] and proposes short, medium, and long-term strategies (5-15 years) to address risky behaviors, such as drunk driving, and protective behavior, like seatbelt use. Strategies address drivers, pedestrians, bicyclists, vehicle technologies, and infrastructure design and management and come in the form of education programs, increased enforcement, and improved design and policy. Some of the strategies still maintain a strong auto-centric perspective, like the strategy to enforce bicycle-helmet laws for cyclists of all ages. Helmet laws have repeatably been proven repeatably to discourage cycling.[76] This in turn reduces the number of people biking on the streets and, making them less safe.[77] Helmet laws, which have been compared to a two-wheeled "stop and frisk," also result in discrimination, i.e., who gets a ticket for violations. In Dallas, 96% of the people who were arrested or cited outside the downtown area for not wearing a bike-helmet were minorities.[78] In Miami, 86% of 460 bike-licensing citations between 2010 and 2013 were given to Black people despite the African American community comprising only 31% of the area's population.[79] Other auto-centric strategies

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[75] Hugh McGee, *Toward Zero Deaths: A National Strategy on Highway Safety* (Toward Zero Deaths, 2014), 9.
[76] Piet De Jon, "The Health Impact of Mandatory Bicycle Helmet Laws," *Risk Analysis* (February 24, 2012): 1-2.
[77] Peter Lyndon Jacobson, "Safety in Numbers: More Walkers and Bicyclists, Safer Walking and Bicycling: Correction," *Injury Prevention* 9 (September 2003): 207.
[78] Caitlin Na Giddings, "Do Helmet Laws Unfairly Target Minorities?" *Bicycling*, April 21, 2015, https://www.bicycling.com/news/a20015616/bike-laws/.
[79] Sarah Goodyear, "White Privilege, on a Bicycle," *City Lab*, January 19, 2015, https://www.bloomberg.com/news/articles/2015-01-19/white-privilege-on-a-bicycle

that are common under Vision Zero include reactive tools such as crash cushions, centerline-rumble strips, and signage.

Several TZD strategies rely on increased police enforcement, increases in certain fines, and use of automated speed-management infrastructure. Policy enforcement is a problematic strategy that often disproportionally impacts Black, brown, indigenous, and immigrant individuals. Automated speed management, by contrast, has proven to be a successful tool to reduce and manage speeding. Automation of certain enforcement, the introduction of various safety features to vehicles, and the use of data-analysis strategies are not common but do make an appearance in the 120-plus strategies that TZD provides.[80] Data-analysis strategies call for advancement of methods to support data-driven decision making, but TZD does not expand on what strategies are those. Education and awareness are also common strategies advocated by TZD, which ties into the organization's emphasis on traffic safety culture (TSC). The TSC model focuses on addressing the social and cultural factors that influence how people behave. It is a descriptive and predictive model that defines traffic-safety as the relationship between physical environment, attitudes, and the values and norms of the socio-cultural environment.[81] Through the transformation of a critical number of cultural elements, the TSC model aims for fundamental change that sustains a new behavior through experiences (a quasi-experimental design program). The TSC model is similar to the Theory of Planner Behavior model which argues that a person's

[80] Hugh McGee, *Toward Zero Deaths: A National Strategy on Highway Safety* (Toward Zero Deaths, 2014), 76-81.
[81] McGee, *Toward Zero Deaths*, 62.

behavior stems from the attitudes and perceived behavioral and normative beliefs of her peers.[82]

A primer prepared by the Montana State University Center for Health and Safety Culture for Montana DOT Vision Zero efforts (funded by FHWA) supports the argument TZD is making: that the TSC model is critical in preventing crash fatalities and serious injuries. The authors of the primer call for a shared responsibility of all road users through the transformation of personal belief systems, and therefore, behavior. But at the time, the

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[82] See for example (1) "buckle up for those who love you" Zero Fatalities Campaign, "Zero Fatalities: If You Love Someone Theater PSA," August 7, 2015, YouTube, 00:32, https://www.youtube.com/watch?v=PFoY9YBDzcM&feature=emb_title; (2) Alcohol free on the road in the Netherlands, running since 1997. The program focuses on young adults (18-24) and aims to enhance awareness of the effect of drunk driving by experiencing it. The program occurs over a single afternoon in groups, with twelve participates maximum, and consists of a series of driving performance "tests" while sober and when inebriated. The afternoon starts with a moderated discussion on the effects of alcohol on performance and traffic. The participants are then instructed through a computer screen simulating car-traffic related tasks, like braking suddenly. The reaction time of participants is measured to the millisecond and recorded. Participants then go through individual test track consisting of driving in narrow lanes, weaving, and backwards parking. The performance in this test is also graded. During a break, participates are given drinks (beer or orange juice and vodka) until they attain a 0.8% in a breathalyzer test. Once all participants are sufficiently buzzed, the program repeats, moderated discussion, computer screen simulation, and track driving tests. The performance of the participants is tracked in the exact same method as the first half of the program. A final discussion confronts participants with their results, showing the deterioration on one or more aspects related to driving performance. See Brookhuis, K. A., D. de Waard, F. J. J. M. Steyvers, and H. Bijsterveld. "Let Them Experience a Ride under the Influence of Alcohol; a Successful Intervention Program?" *Accident Analysis & Prevention* 43, no. 3 (2011/05/01/ 2011): 906-10; (3) Swedish Speed Lottery pilot program, conducted in 2012, fined speeding drivers, but also rewarded (through a lottery) non-speeding drivers. See https://www.itsinternational.com/its2/feature/speed-reduction-measures-carrot-or-stick; (4) Positive Community Norm approach (PCN) on identifying and cultivating positive and healthy factors in a community to generate collective impact and reduce harm. It is an approach based on the principle that positive norms grow through skill areas of transformational leadership development, norms communications, integration of prevention strategies, and structured reflection. PCN operates on multiple community levels and factors at once, including media interventions, school or workplace workshops, and reflection opportunities. See Linkenbach, Jeffrey W., Phyllis L. Bengtson, Jaimie M. Brandon, Al J. Fredrickson, Jason R. Kilmer, Darren T. Lubbers, Jordan D. Ooms, Valerie S. Roche, and Sara J. Thompson. "Reduction of Youth Monthly Alcohol Use Using the Positive Community Norms Approach." *Child and Adolescent Social Work Journal* 38, no. 1 (2021/02/01 2021): 3, 5. (5) The Pinkie Campaign in Australia The campaign, with the tagline "Speeding. No one thinks big of you", was aimed at young men (age 17-25) through a humorous portrayal of women's social judgment (raising a pinky between themselves) toward speeding. Watch a Pinkie campaign commercial https://www.youtube.com/watch?v=5hWxU_ICoHM&ab_channel=lokeypoke.

primer references impaired driving and seatbelt use, both issues that pertain almost exclusively to the behavior of vehicle drivers and not all street users.[83]

Form: In 2018, four years after the first Vision Zero program, The Road to Zero Coalition released a report laying out the organization's strategies for ending roadway deaths in the United States by 2050. Written by the RAND Corporation and supported by the National Safety Council (NSC), which manages The Road to Zero Coalition, the report offers three main initiatives to address traffic fatalities: the use of evidence-based strategies; the advancement of technology in vehicles and infrastructure; and the prioritization of a Safe System approach. Founded in 1913, NSC is a non-profit advocacy organization for roadways and workplace safety. Their work includes overseeing vehicle recalls, ensuring child-passenger safety and seatbelt use, and preventing distracted and drowsy driving, and speeding by young and older drivers. Unlike many other organizations, the NSC distinguishes between occupant protection (seatbelts) and road users' (drivers and pedestrians) protection. In terms of policy, NSC has supported numerous traffic-related strategies, including automated enforcement of red lights and speed limits.[84] Similar to the Complete Streets narrative, this approach focuses on preventing human error on roadways instead of accommodating it.[85] It is a far cry from the NSC 1989 Position/Policy Statement on Pedestrian Safety, which mostly focused on enforcement and education of pedestrians as a way to prevent serious injury and fatalities.[86] The Road to Zero Coalition has more than 800 members, including legal associations, police forces, DOTs, and community-

[83] Nicholas Ward, Jay Otto, and Kari Finley, *Traffic Safety Culture Primer* (Montana State University: Center for Health and Safety Culture, 2019), 28.
[84] National Safety Council, *Support of Automated Enforcement* (NSC: 2008).
[85] Liisa Ecola et al., *The Road to Zero: A Vision for Achieving Zero Roadway Deaths by 2050* (Santa Monica, CA: RAND Corporation, 2018), 7.
[86] National Safety Council, *Position/Policy Statement #62*: *Pedestrian Safety* (NSC: 1989), 1.

based centers. While every comment made by the coalition or the NSC is not necessarily a statement made by each one of its member organizations, every announcement reveals shifting perspectives on traffic-safety advocacy.

NSC's approach to Safe Systems focuses on five areas: safe roads, safe speeds, safe road use, safe vehicles, and effective post-crash care. The Safe Systems approach "rejects the notion that individuals bear the sole responsibility for road safety"[87] and presumes that "system designers, policymakers, and road users share responsibility for safety."[88] This means that the road user is not solely responsible for a crash; those who might have prevented the situation through improved roadway and vehicle design, as well as behavior also share responsibility. Under the Safe System approach, these include policymakers, designers, and engineers. In terms of actionable strategies to meet these concepts, NSC's 2019 Position/Policy Statement on Safe Systems offers a collection of approaches in each category.

These strategies show a transition toward a road design that is focused on non-motorized-vehicular users, people who walk or roll, as well as drivers. While earlier policies were still mostly auto-centric (focused on the driver and vehicle occupant's protection), recent strategies offer a more evenly distributed set of policies that attempt to anticipate human error. This is still not acknowledging that human error is frequently a result of street design, but it is still an improvement on previous strategies that ignored any other street users.

Physical infrastructure design in the Safe System approach takes the form of separating users in space and time. This is accomplished by providing a dedicated right-of-

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[87] National Safety Council, *Position/Policy Statement #149: Safe Systems* (NSC: 2019), 2.
[88] National Safety Council, *Position/Policy Statement #149: Safe Systems* (NSC: 2019), 2.

way for different users, specifically pedestrians and cyclists, and controlling the number of interactions between vehicles and vulnerable users. Beyond the dedicated lane (the separation of users in space), users are also separated in time, reducing the interactions between drivers in vehicles and vulnerable users. One tool that is often recommended under the Safe System approach is the scramble phase at intersections, in which pedestrians have exclusive access to the entire intersection. Other techniques to increase the attentiveness and awareness between drivers, pedestrians, and cyclists, include "daylighting" intersections by removing parking to allow greater visibility as well as reducing speeds.[89]

Technology: Alongside the physical infrastructure changes, the Safe Systems framework calls for the adoption of various technologies as a means to achieve traffic safety. The use of AVs, or automated features within vehicles, is something the Coalition often references, both for average drivers using AV and in relationship to emergency providers and senior groups. Advanced Driver Assistance Systems (ADAS), which automate driving but are different from autonomous systems (which include artificial intelligent software), take a prominent role in the road to zero vision of NSC and the Coalition. In *The Road to Zero: A Vision for Achieving Zero Roadway Deaths by 2050* automatic braking, speed control and management, and land-centering and warning systems (blind-spot detection) are given a prominent place as traffic-safety strategies. Often the first to be adopted and supported through various state or local policies, these strategies tend to overshadow more complex, expensive, and time-consuming approaches to reduce traffic fatalities and injuries, like redesigning the street. To summarize, while the

[89] Road to Zero Coalition and the RTZ Safe System Working Group, "Safe Systems Explanation" Institute of Transportation Engineers, accessed February 10, 2021, https://www.ite.org/technical-resources/topics/safe-systems/.

Road to Zero Coalition encourages the adoption of specific strategies, it does not necessarily provide a clear and actionable list of strategies to achieve zero roadway deaths. What the NSC and the Road to Zero Coalition do instead is argue for a fundamental cultural and mindset shift in federal, state, and local jurisdictions and including government officials, auto manufacturers and technology developers, insurance companies, business communities and fleet owners, law enforcement, and the judicial system.

In 2014, Leah Shahum[90] launched the Vision Zero Network, a campaign focused on advancing the Vision Zero agenda across communities the United States. The Vision Zero Network is supported by an advisory committee of six people.[91] The Network is financially funded by Community Initiatives, a partner that offers expert services to nonprofit organizations, as well as by Kaiser Permanente, an Oakland-based non-profit health plan provider; Craigslist; and San Francisco restauranteur Bill Russell-Shapiro. GM, Waymo, and Uber all provide corporate backing.[92] The Network offers support to U.S. communities working towards in Vision Zero. This support takes various forms including peer-to-peer networking and exchange, informational webinars, calls, and forums, and

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[90] In the past, Shahum served on the Steering Group of the Road to Zero Coalition and was a policy maker in the Alliance for Biking and Walking.

[91] (1)Nicole Ferrara, the advisory committee chair, is part of the City of Oakland DOT as well as a board member of the Alliance for Biking and Walking. (2) Bob Dallas, chairs Georgia Pedestrians Educating Drivers on Safety (PEDS) organization. (3) Niko Letunic, principle of a planning firm based in the Bay Area and a founding board president of the San Francisco Bicycle Coalition as well as a member of the board of directors of Walk San Francisco, a pedestrian advocacy organization. (4) Juan Martinez, who lobbies to advance NYC transportation and infrastructure policies, and was once the General Counsel & Legislative Director at Transportation Alternatives and has led the campaign for NYC speed camera program. (5) Martha Roskowski, the Vice President of Local Innovation at PeopleForBikes who has also worked on the America Bikes campaign that created the Safe Routes to School Program. (6) Dr. Destiny Thomas the Chief Executive Officer at Thrivance Project an Oakland based Cultural Anthropology organization who has also worked for the Los Angeles DOT.

[92] Vision Zero Network, "Network Supporters," accessed February 11, 2021, https://visionzeronetwork.org/about/support-our-work/.

hand-on resources to promote successful strategies.[93] Collaborative in its nature, the Network claims to have helped grow the number of U.S. committees from two to more than 30 in 2020.[94] Being part of the Network, or recognized as a "Vision Zero Community" by the Network, allows a community to participate in its various activities. *The Vision Zero Network* defines a Vision Zero Community as one that has a clear goal of eliminating traffic fatalities and severe injuries; where the mayor of the community has publicly and officially committed to Vision Zero, including implementing a strategy or plan that involves key departments like public health and transportation. The mayor must also have committed to a clear time frame to achieve the community Vision Zero strategy.[95] In 2016, the Network launched its Vision Zero Focus Cities program, which set up ten cities[96] as "pioneers who will save lives by modernizing our approach to traffic safety."[97] In the United States any jurisdiction can pick and choose which strategy they want as part of their local Vision Zero. Also, unlike the Swedish approach, the American Vision Zero relies heavily on non-formal interventions. Its policies and techniques focus on changing the behavior of drivers rather than making the street a space that prioritizes other users. Many of the cities that have adopted Vision Zero have not yet lived up to the challenge of zero fatalities. Pedestrian and cyclist fatalities continue to increase in the United States.[98]

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[93] Vision Zero Network, *Consideration for Recognition as a Vision Zero Community* (Vision Zero Network; 2018), 2.
[94] Vision Zero Network, "Networking Cities Together to Take Action," accessed February 10, 2021, https://visionzeronetwork.org/about/vision-zero-network/.
[95] Vision Zero Network, "Vision Zero Communities," accessed February 11, 2021, https://visionzeronetwork.org/resources/vision-zero-communities/.
[96] Austin, TX; Boston, MA; Chicago, IL; Fort Lauderdale, FL; Los Angeles, CA; New York City, NY; Portland, OR; San Francisco, CA, Seattle, WA, Washington DC.
[97] Leah Shahum, *Vision Zero Focus Cities Press Release* (Vision Zero Network: 2016), 1.
[98] GHSA, Pedestrian Traffic Fatalities by State 2020 Preliminary Data, 2021, 5.

Analysis: At the beginning of 2021, the Road to Zero Coalition and a host of Vision Zero advocacy organizations—including Towards Zero Deaths, The Vision Zero Network, and Families for Safe Streets—called on newly inaugurated President Biden to commit to zero traffic fatalities by 2050. The call asked for a federal commitment of funding and policies through three actions: the use of evidence-based strategies; advancement of life-saving technology in vehicles and infrastructure and prioritization of the Safe Systems Approach; and support for crash victims, like victims of any crime.[99] As of February 2022, there has been no federal commitment to adopt a federal Vision Zero policy.

Vision Zero, implemented in the United States, assumes safety is a product of individual behavior and has less to do with the designing of built environment. Policies have focused on protection against traffic and collisions but fail to recognize that a space that allows for risky behavior will result in risky behavior.[100] There are little to no interventions focused on creating safety through comfortable and delightful streets for non-car users. Safety is a product of environmental conditions. A comfortable (and delightful) street for pedestrians and cyclists is a street that facilities social activities and prevents high-speed vehicular traffic, improving both safety from cars, crime, and other adverse health conditions aggravated by the automobile urban street.

The Vision Zero scenario score a total of –4 points (see Table 5.7). The scenario's focus on protection against traffic and collisions across users is undone by not addressing any other experience but that of vehicular travel. Safety in the Vision Zero scenario is a product of policing existing streets, rather than transforming them toward sustainable

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[99] National Safety Council, "Call on President Biden to End Traffic Deaths," accessed January 27th, 2021, https://www.nsc.org/road/resources/road-to-zero/call-on-president-biden-to-end-traffic-fatalities.
[100] Jessie Singer, *There are no Accidents: The Deadly Rise of Injury and Disaster- Who Profits and Who Pays the Price* (New York: Simon & Schuster, 2022), 205.

spaces. Protection (in the name of safety) is limited to traffic with no regard to environmental conditions making the prioritization of “safety” a barrier toward adoption of wider sustainable practices in the name of traffic safety.

Table 5.7 Vision Zero Lens Scorecard

<table>
<tr><th></th><th colspan="2">Pedestrians</th><th colspan="2">Micromobility</th><th colspan="2">Riders (Public Transit)</th></tr>
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</table>

See Table 4.4 (page 153) for a comprehensive lens analysis overview. Green: sufficient. Yellow: passable Red: unsatisfactory. Toral score: -4 points.

5.3.2 Smart City Challenge: Smart Columbus

The Smart City Challenge was a policy initiative launched in December 2015 by the United Stated Department of Transportation (USDOT). The challenge asked mid-sized cities across the country to develop ideas for an “integrated, first-of-its-kind smart transportation system that would use data, applications, and technology to help people and goods move more quickly, cheaply, and efficiently."[101]

Systemic change: When the Smart City Challenge launched in December 2015, it followed a $350 million federal investment in private and public funds to advance what the USDOT called "smart city and advanced transportation technologies."[102] A Smart City according to the USDOT does multiple things: First, smart cities improve **how we move** (emphasis by USDOT) by supporting a diverse set of affordable and sustainable mobility choices. Thus, smart cities improve the quality and reliability of transit services, pedestrian and bicycle infrastructure, and allocation of parking spaces. The Smart City promotes efficiency, reliability, and safety of **how we move things** (emphasis by USDOT) with smart traffic signals that prioritize freight, apps that give truck drivers information about preferred routes and parking, and automated trucks and low speed fright-delivery systems that make consolidation of deliveries possible. A Smart City is a city with electric vehicle infrastructure installed and buses and public fleets of EVs on the roads.[103] The challenge was concerned with what USDOT identified as the modern-day challenges of travelers in cities: heavy traffic, lack of parking, the complexity of trip planning, and last, unsafe cycling and walking conditions.[104]

More than 78 cities proposed a vision for the Smart City Challenge. Detroit's vision included access to electric car shares and on-demand delivery trucks that could be managed by an app. New Orleans proposed dynamic on-demand minibuses that would provide "last

[101]United States Department of Transportation, "Smart City Challenge," accessed March 23, 2022, https://www.transportation.gov/smartcity.
[102] United States Department of Transportation, *Smart City Challenge* (Washington DC: USDOT, 2017), 2.
[103] United States Department of Transportation, *Smart City Challenge*, 6.
[104] Ibid, 7.

mile" transportation in underserved communities. Las Vegas's vision included a new transit system of autonomous shuttles and electric charging stations.[105] Many mid-sized cities applying for the challenge were facing similar issues such as providing first/last-mile service between communities and jobs, facilitating urban delivery, coordinating data collection, and managing parking systems and payment. Forty-four cities proposed AVS pilots, while only eleven proposed smart curb space management systems. Fifty-three cities proposed using Dedicated Short-Range Communication (DSRC) to connect vehicles both to infrastructure and each other. Only 17 proposed using the Smart Challenge money to install inductive wireless charging stations for buses, shuttles, and other vehicles. Forty-five cities proposed a unified traffic or transportation data-analytics platform to help city departments make better decisions.[106]

Seven cities were chosen as finalists: Austin, TX; Columbus, OH; Denver, CO; Kansas City, MI; Pittsburgh, PA; Portland, OR; and San Francisco, CA. Each finalist received $100,000 for public outreach to produce pitch videos and further concepts proposed in the original vision statements. Some cities received additional funds to pursue some of their proposed goals. Pittsburgh, for example, received almost $11 million to deploy smart traffic-signal technology. San Francisco also received about $11 million to implement a shared, electric, AVS and a signal system to detect red-light violations. Denver received $6 million to upgrade its traffic-management center and install automated pedestrian-detection technology.[107] The winner, Columbus, Ohio, received a total of $50 million in two grants: $40 million from the USDOT and $10 million from the Paul G. Allen

[105] Ibid, 3.
[106] Ibid, 4-5.
[107] Ibid, 21.

Family Foundation. The money provided the seed funding for Smart Columbus, a region-wide Smart City initiative co-led by the City of Columbus and the Columbus Partnership. An organization with a mission statement "to accelerate human progress through open mobility," the partnership focuses on four foals: driving economic growth, improving people's quality of life, fostering sustainability, and improving safety.

Smart Columbus included pilot projects focused on creating access to jobs through smart logistics connecting residents and visitors through sustainable transportation.[108] This vision is achieved through an operating system known as SCOS, what Smart Columbus refers to its heartbeat. SCOS is a web-based dynamic data-delivery platform that uses agile project management to "enhance human services."[109] Data from SCOS is used to support eight projects under the Smart Columbus framework. These eight projects are organized under three pillars: enabling technologies, enhancing human service, and emerging technologies.

Smart Columbus, following the USDOT vision for a Smart City, proposed programs that leverage emerging technologies to enhance the human experience of moving throughout the city. While they do not explicitly describe these programs as Mobility as a Service (MaaS), many of the Smart Columbus initiatives fit well into the concept, even actively working to establish urban mobility as a seamless system. Part of Smart Columbus is a commitment to improve existing public transit in Ohio by growing the Central Ohio Transit Authority (COTA) ridership and the types of mobility options available. To achieve these goals, COTA, with the support of Smart Columbus, launched the C-Pass program, a

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[108] Ibid, 19.

[109] Smart Columbus, "Essentials of the Smart Columbus Operating System," accessed March 22, 2022, https://smart.columbus.gov/playbook-assets/smart-columbus-operating-system/essentials-of-the-smart-columbus-operating-system.

free bus-pass program for 45,000 downtown Columbus employees. But by the end of 2018, COTA rides increased about 3%.[110]

Technology: Smart Columbus also partnered with large regional employers to encourage use of EVs and reduce driving. Working with 70 local employers, the Acceleration Partners Program included installing EV charging infrastructure at workplaces with 200+ employees, educating employees on driving less and driving electric, and incentivizing employees to change behavior using a mobility benefit package.[111] Smart Columbus aimed to host 12,000 EV test drives by 2020 through public and workplace events: a goal unmet with only 69 events held. Surveying the 7,000 test drives, Smart Columbus found more than 16% of participants were likely or very likely to purchase an EV as their next car before testing a vehicle. After driving an EV, the likelihood increased to 46%.[112]As part of its EV agenda, Smart Columbus also wanted to deploy 755 EVs into public and private fleets (single occupancy vehicles, trucks, and vans). It introduced the Smart Columbus Transportation Service Provider, Better Electric Vehicle Rebate Program, which provided 40 $3,000 incentives for transportation-service providers purchasing new EVs. The City of Columbus has been leading the region's electrification efforts with about 125 vehicles purchased.[113] For private users, Smart Columbus partnered with 25 central Ohio car dealers to promote EV sales. Smart Columbus provided training for dealerships and requested making live EV chargers and charged EVs available on the

[110] Smart Columbus, "Expansion and Adoption of Multimodal Transit," accessed March 22, 2022, https://smart.columbus.gov/projects/expansion-and-adoption-of-multimodal-transit.
[111] Alex Slaymaker and Donna Marbury, *Acceleration Partner Program Impact Report* (Smart Columbus, 2020), 5.
[112] Smart Columbus, "Smart Columbus Ride & Drive Roadshow," accessed March 22, 2020, https://smart.columbus.gov/projects/smart-columbus-ride-drive-roadshow.
[113]Smart Columbus, "Fleet Electric Vehicle Adoption," accessed March 22, 2020, https://smart.columbus.gov/projects/fleet-electric-vehicle-adoption.

lot and in the showroom.[114] A vehicle guide on the Smart Columbus website provides an EV101 for consumers and a list of all available EV models in dealerships, price before tax credits, and vehicle-mile range.[115]

Smart Columbus planned to deploy more than 900 EV charging ports through the Columbus region, at workplaces as mentioned above, but also at residential buildings and in public spaces. Partnering with the Mid-Ohio Regional Planning Commission and the Ohio energy company, AEP Ohio, Smart Columbus installed EV Level 2 and DC fast charging stations (for more on EV port types see section 5.2 Electric Vehicles). AEP Ohio also created an incentive program to help property owners cover the cost of installation. As of 2020, Smart Columbus, installed 534 ports (about 50% of its 900 EV charging port goal). Only 36 ports were installed in multi-unit residential buildings; the bulk of charging ports (247) were installed in workplaces.[116]

Beyond the various programs focused on EVs, Smart Columbus also launched the Multimodal Trip Planning Application to make bus commutes easier. Because many of the routes in Columbus required riders to transfer between multiple buses and other modes of transit, Smart Columbus created the pivot app. This app (launched in 2019) suggests routes based on the preference and budget of the user. Using SCOS, the pivot app is able to provide real-time data regarding bus schedules, bike/scooter availability in sharing stations, and ride-hailing services.[117] Other modes of transit introduced to Columbus through Smart

[114]Smart Columbus, "Electrified Dealer Program," accessed March 22, 2020, https://smart.columbus.gov/projects/electrified-dealer-program.
[115] Smart Columbus, "Your Path to Driving Electric," accessed March 22, 2020, https://smart.columbus.gov/get-involved/drive-electric/ev-dealers-offers#intro.
[116] Smart Columbus, "Electric Vehicle Charging infrastructure," accessed March 22, 2020, https://smart.columbus.gov/projects/electric-vehicle-charging-infrastructure.
[117]Smart Columbus, "Multi-Model Trip Planning Application," accessed March 22, 2020, https://smart.columbus.gov/projects/multi-modal-trip-planning-application.

Columbus efforts included Zipcar, Bird, Lime, and Chariot. Chariot, Ford Motor Company introduced a microtransit service, but shut it down one year after it launched.[118] The local startup EmpowerBus (which like Chariot, offered microtransit services for office workers) was also part of Smart Columbus efforts to increase the types of available transit systems. It too shut down in 2020 due to loss of clients during the COVID-19 crisis.[119] Lime, Bird, and Zipcar continue to operate in Columbus as of December 2022.

Another layer of the Smart Columbus program has to do with autonomous technology. Smart Columbus, following USDOT, assumes that connected vehicle technology, also referred to as Connected Vehicle Environment (CVE) and AVs will prevent crashes, improve on-time bus arrival, and decrease emergency vehicle-response time. Smart Columbus partnered with DriveOhio (a division of the Ohio DOT) in December 2018 to launch Smart Circuit, an AV shuttle (AVS). Smart Circuit circulated the Scioto-Mile in downtown Columbus connecting the Center of Science and Industry, the National Veterans Memorial and Museum, Bicentennial Park, and the Smart Columbus Experience Center. The Center included an interactive showroom showcasing the program AVS line, the Scioto-Mile, hands-on technology demonstration, and access to EV test drives. Setting a goal of welcoming more than 10,000 people and introducing them to the Smart Columbus program, the progress to-date has stalled at 9,639 visitors when COVID-19 began.[120]

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[118] Carrie Ghose, "Ford Shutting Chariot Micro-Transit Service, Including Columbus Routes," *Columbus Business First*, January 11, 2019, https://www.bizjournals.com/columbus/news/2019/01/11/ford-shutting-chariot-micro-transit-service.html.

[119] Carrie Ghose, "Columbus Microtransit Service Shuts Down as Riders Stay Home During Pandemic," *Columbus Business First*, April 8, 2020, https://www.bizjournals.com/columbus/news/2020/04/08/columbus-microtransit-service-shuts-down-as-riders.html.

[120] Smart Columbus, "Smart Columbus Experience Center," accessed March 23, 2020, https://smart.columbus.gov/projects/smart-columbus-experience-center.

Smart Columbus faced a number of technological and managerial issues with its AVS pilots. It collaborated with the software company May Mobility, for its Socio-Mile; a 1.2-mile loop connecting the city's cultural buildings and the Smart Columbus Center. May Mobility used retrofitted GEM Polaris vehicles, which were plagued with technical problems. Overall, the Scioto-Mile pilot ended up costing about $120 per passenger.[121] The city of Columbus then hired EasyMile, a May Mobility competitor, for its second route, the Liden LEAP AVS. The shuttle service did not run into technical difficulties navigating the urban environment, but it did have to halt all passenger operations after an unexplained stop by the AVS caused passengers to fall off their seats. When the COVID-19 pandemic prevented any return to passenger service between July and April 2020 the vehicles were used to distribute 3,598 food pantry boxes.[122]

As part of "enhancing human-experience" agenda, Smart Columbus launched a CVE pilot program it's in October 2020 with more than 300 private vehicles installed with on-board units. The units allow vehicles to "talk" to one another and receive in-car alerts to warn the driver of a blind spot or rear-end collision. Other alerts and vehicles communication include information on red/green lights and when a driver should slow down. The pilot runs through four main urban corridors with 85 intersections. All are street-based environments. Figure 5.8 shows the map of the corridors that comprise Smart Columbus CVE. It is supplemented by images of the streets extracted from Google Street view. The pilot corridors are: High Street from 5th Avenue to Morse Road (along Cleveland Avenue); from 2nd Avenue to Morse Road; along Morse Road from High Street

[121] Kyle Wiggers, "How May Mobility's Autonomous Shuttle Ambitions Backfired," *Venture Beat*, July 6, 2020, https://venturebeat.com/2020/07/06/how-may-mobilitys-autonomous-shuttle-ambitions-backfired/.
[122] Smart Columbus, "Self-Driving Shuttles," accessed March 23, 2020, https://smart.columbus.gov/projects/self-driving-shuttles.

to Steltzer Road; and along Alum Creek Drive from SR-317 to I-270 to serve the freight corridor.[123] The invisibility of Smart Columbus actions is clear with most of the streets looking traditional. The software makes appearances in the urban form through dispersed objects, including monitors and servers installed on polls and traffic controls to communicate with traveling vehicles.[124]

Figure 5.8 Smart Columbus Connected Vehicle Environments (CVE).
Source: The City of Columbus, "CVE Concept of Operations – Final Report," Smart Columbus Program. Figure 2: Connected Vehicle Environment Corridors, 15 and Google Maps.

[123]Smart Columbus, "Connected Vehicle Environment," accessed March 23, 2022, https://smart.columbus.gov/projects/connected-vehicle-environment.
[124] Smart Columbus, *Connected Vehicle Environment System Design Document* (Smart Columbus: City of Columbus, 2020), 44-45.

Smart Columbus CVE does not include Smart Mobility Hubs (SMH); which provide EV charging points, public WiFi, interactive kiosks, dockless micromobility parking, or ride-hailing/car-sharing pick up areas. But SMH, unlike the CVEs, were only proposed along Westerville Road in Columbus.[125] Like the CVE infrastructure, most of the SMH amenities are invisible with only an interactive kiosk and some on-the-ground markings for micromobility vehicles appearing in the street. There is no place to sit or protection from the elements. Six SMHs opened under the Smart Columbus program: at Columbus State Community College, Linden Transit Center, St. Stephens Community House, Columbus Metropolitan Library – Linden Bran, Northern Lights Park and Ride, and the Easton Transit Center.[126] Smart Columbus also regards the management of parking as a way to enhance human experience. As part of its efforts to reduce driver and rider frustration as well as exhaust emissions, Smart Columbus launched a third app for parking availability, parking-spot reservations, and payments in Downtown and Short North parking garages and surface lots. ParkColumbus launched in November 2020 with on-street parking made available using SCOS predictive analytic technology.[127]

Analysis: In June 2021, Columbus concluded delivery of the Smart City Challenge grants. Final reports were made available detailing the technical efforts taken by the city. Ohio State University estimated that the USDOT Smart Challenge grant generated more than $173.39 million gross metropolitan product and created more than 2,366 jobs.[128]

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[125] Smart Columbus, *Smart Mobility Hubs Concept of Operations* (Smart Columbus: City of Columbus, 2019), 37.
[126] Smart Columbus, *Smart Mobility Hubs*, 2.
[127]Smart Columbus, "Event Parking Management," accessed March 22, 2022, https://smart.columbus.gov/projects/event-parking-management.
[128] Smart Columbus, "Columbus Delivers Community Impact through the Smart City Challenge, Announces Smart Columbus' Future Direction as Collaborative Innovation Lab," June 15, 2021, https://smart.columbus.gov/news/columbus-delivers-community-impact-through-the-smart-city-challenge-announces-smart-columbus-future-direction-as-collaborative-innovation-lab.

Smart Columbus was re-conceptualized as an agile collaborative but its future remains unclear with only general (technological-based) goals “ensuring Columbus continues to lead in smart mobility” and “accelerating the adoption of climate technologies to achieve carbon neutrality by 2050.”[129] No connection is made to the role of urban form and the street in the road for carbon neutrality.

The Smart City Challenge does not make any significant changes to urban streets to make a safer, comfortable, or delightful space. The policies that have been included in the scheme are automobile-centric and intended to maintain existing conditions as they are. Overall, the Smart City Challenge and Smart Columbus failed to see the urban street as an urban place and not only a thruway and instead focused on technological efficiencies within the existing automobile regime, which has poor results when the goal is sustainable urban streets.

The Smart Columbus scenario scores a –21 as its final score (see Table 5.8). In the scenario, protection against traffic and collisions takes the form of technological solutions, which offer only a limited gain in safety when introduced without creating a lively public realm with opportunities to walk, stand, sit, and enjoy positive weather. The scenario proposals exist within the system of automobility (parking management, CVE) and many of the strategies have an adverse effect on pedestrians, micromobility users, and public transit riders. Even the AVS program to connect city’s cultural spaces failed to consider the riders’ sensory experience and ability to wait for the vehicle during different weather conditions.

[129] Smart Columbus, “The Future of Smart Columbus.”.

This is not to say that there is no value of the technological efforts that the Smart Columbus scenario proposes, but in order to leverage these technologies toward sustainable development they must be accompanied by additional interventions relevant to the public realm in relationship to people walking, using micromobility devices, and riding public transit.

Table 5.8 Smart Columbus Lens Scorecard

<table>
<tr><th></th><th colspan="2">Pedestrians</th><th colspan="2">Micromobility</th><th colspan="2">Riders (Public Transit)</th></tr>
<tr><td rowspan="3">Lens of safety</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td><td rowspan="2">Protection against traffic & collisions</td><td rowspan="2">Eliminating fear of traffic</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td></tr>
<tr><td>Protection against crime & violence</td><td>Lively public realm</td><td>Protection against crime & violence</td><td>Ability to safely wait for transit</td></tr>
<tr><td>Overlapping functions</td><td>Protection from light, weather, pollution, dust, noise, & glare</td><td>Protection against crime & violence</td><td>Ability to safety store, & maintain micromobility devices</td><td colspan="2">Protection from weather, pollution, dust, noise, & glare</td></tr>
<tr><td rowspan="3">Lens of comfort</td><td>Opportunities to walk with no obstacles</td><td>Accessibility for everyone</td><td rowspan="2">Opportunities to roll with no obstacles</td><td rowspan="2">Accessibility for everyone</td><td rowspan="2">Opportunities to travel with no obstacles</td><td rowspan="2">Accessibility for everyone</td></tr>
<tr><td>Interesting facades</td><td>Opportunities for standing & seating</td></tr>
<tr><td>Spaces for play & “talkscapes”</td><td>Lighting at night</td><td>Spaces for commute, leisure, & repair</td><td>Lighting at night</td><td>Opportunities for standing & seating</td><td>Lighting at night</td></tr>
<tr><td rowspan="2">Lens of delight</td><td>Buildings scale</td><td>Opportunities to enjoy positive climate</td><td>Lane size</td><td>Opportunities to enjoy positive climate</td><td colspan="2" rowspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
<tr><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
</table>

See Table 4.4 (page 153) for comprehensive lens analysis overview. Green: sufficient. Yellow: passable Red: unsatisfactory. Total score: –21 points.

5.3.3 Waymo by Alphabet

Waymo is Google's AV division which operates as a taxi-like service in Arizona as part of the company's effort to achieve full autonomous driving. As an alternative mobility, Waymo is a service, but it can also be considered an object given the company's earlier attempts at AV technology. Founded in 2009 as Google's Self-Driving Car Project, Waymo has evolved into one of the most consistent AV developers. Google, restructured as a subsidiary of Alphabet in 2015, is a global giant of technology, data, and information infrastructure. Waymo manages several programs: Waymo One, an AV ride-hailing service currently running in Phoenix, Arizona; Waymo Driver, an autonomous software subsidiary; and Waymo Via, which focuses on commercial autonomous trucks.

Systemic change: In the early days of the company's self-driving project (known as project Google X), the team developed an AV known as the Firefly protype, a small two-seat vehicle with no steering wheel. As the same time, the company tackled the goal of autonomous driving of more than 100,000 miles on public roads. To achieve that milestone, Google retrofitted Toyota Prius cars with autonomous technology. Developed for highway travel, the software's early goals were simple: maintain speed, do not hit the car in front of you, and stay in your lane. Once this was achieved, the company took the Firefly vehicle for an autonomous test drive on the streets of Austin, Texas, taking Steve Mahan, a legally blind individual, to a doctor's appointment.[130] Since starting with roughly a 20-person operation in a 53,000-square-foot office in Novi, Michigan, Waymo has grown into 1,500 employees and an annual budget of approximately $1 billion.[131] The vision of a

[130] X Development LLC, "Waymo Transforming Mobility with Self-Driving cars," accessed March 23, 2020, https://x.company/projects/waymo/.
[131] Kyle Wiggers, "Waymo Begins Mapping Streets in Los Angeles," *The Machine*. 2019. https://venturebeat.com/2019/10/07/waymo-begins-mapping-streets-in-los-angeles/.

different kind of vehicle did not survive that growth. In 2017, Firefly was shut down and the prototypes ended up at the Arizona Science Center in Phoenix, the Computer History Museum in Mountain View, California; and the Design Museum in London, England.[132]

Technology: In 2017, Waymo partnered with Fiat Chrysler Automobiles (FCA) to introduce a modified version of the Chrysler Pacifica Hybrid minivan[133] for AV testing on public roads, in Chandler, Arizona. The same year Google began manufacturing its own LiDAR technology, reducing the cost of its operations from $75,000 per off-the-shelf unit to $7500 in-house manufacturing.[134] At the time, Google engineers were using a fake secret city in the California desert known as Castle, after a nearby Air Force base was not unlike a Hollywood backlot. Rather than buildings, children, cyclists, or taco stands, it had props and roads simulating driveways and intersections.[135] The same year, Waymo was ready to launch its Early Rider Program, also in Phoenix, where it launched Waymo One in 2018 (Waymo also has a permit to operate on California public roads but has yet to take advantage of it). In December 2019, Waymo One launched its iOS app allowing anyone in the US the ability to use the app, even if they did not participate in the Early Rider pilot. The app allows riders to hail a Waymo One taxi 24/7 in Phoenix. On the app's one-year anniversary, Waymo One announced it was serving over 1,500 riders and that it had totaled more than 100,000 rides since its 2017 launch. In 2021, Waymo introduced its ride hailing

[132] YooJung Ahn and Jaime Waydo, "From Post-It Note to Prototype: The Journey of our Firefly," Waymo Medium, June 12, 2017, https://medium.com/waymo/from-post-it-note-to-prototype-the-journey-of-our-firefly-30569ac8fd5e

[133] They are produced in Windsor, Canada and shipped to Novi, where they are outfitted with the Waymo and Chrysler needed hardware and software for autonomous usage such as sensors, radar, and cameras.

[134] Andrew J. Hawkins, "Google's New Self-Driving Minivans Will Be Hitting the Road at the End of January 2017," *The Verge*, January 8, 2017, https://www.theverge.com/2017/1/8/14206084/google-waymo-self-driving-chrysler-pacifica-minivan-detroit-2017.

[135] Mark Austin, "Google Built an Entire Fake City to Test the AI of its Driverless Cars," *Digital Trends*, August 27, 2017, https://www.digitaltrends.com/cars/google-fake-city/.

services for a small group of users in San Francisco, following a staged launch similar to the Phoenix roll-out between 2017 and 2020.[136] Waymo also deployed vehicles from its Chrysler Pacifica fleet in Los Angles, Washington DC, and Miami. In Chandler, Arizona, the company has expanded its full-service center to 60,000 square feet, including fleet technicians, dispatch, response, and rider support. The company also pledged to open an additional 85,000-square-foot technical service center in Mesa and to increase its fleet of Chrysler minivans to 62,000.[137]

As discussed in Chapter 3, autonomous technology (machine learning and artificial intelligent) has been estimated to be worth billions of dollars of potential revenue. In 2018, the investment bank Morgan Stanley, estimated Waymo's market valuation to be as high as $175 billion.[138] Since 2017, Lyft and Waymo have worked together on pilot projects and product development to make AV technology mainstream.[139] One of those pilots began in 2019 in Phoenix as part of the Waymo One program. When ten Waymo vehicles were deployed on Lyft with eligible passengers able to order the AV when they order a Lyft ride.[140] In 2020, Waymo and UPS piloted the use of Waymo Chrysler Pacifica minivans for parcel delivery.[141] With Walmart, Waymo launched a grocery delivery service in

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[136] Waymo, "Waymo Story," accessed March 23, 20222, https://waymo.com/company/.
[137] Kyle Wiggers, "Waymo Plans to Open 85,000-Square-Foot Technical Service in Mesa, Arizona," *VentureBeat*, March 19, 2019, https://venturebeat.com/2019/03/19/waymo-plans-to-open-85000-square-foot-technical-service-center-in-mesa-arizona/.
[138] Graham Rapier, "Waymo is Worth $100 Billion More than Previous Estimates, Morgan Stanley Says," *Markets Insider*, August 7, 2018, https://markets.businessinsider.com/news/stocks/google-stock-price-waymo-worth-100-billion-more-than-before-morgan-stanley-2018-8.
[139] Mike Isaac, "Lyft and Waymo Reach Deal to Collaborate on Self-Driving Cars," *New York Times*, May 14, 2017, https://www.nytimes.com/2017/05/14/technology/lyft-waymo-self-driving-cars.html.
[140] John Krafcik, "Partnering with Lyft to Serve More Riders in Metro Phoenix," *Waymo Medium*, May 7, 2019, https://medium.com/waymo/partnering-with-lyft-to-serve-more-riders-in-metro-phoenix-a9ce8709843e.
[141] Kristen Korosec, "Self-driving Company Waymo Teams Up with UPS for Package Delivery," *Tech Crunch*, January 29, 2020, https://techcrunch.com/2020/01/29/self-driving-company-waymo-teams-up-with-ups-for-package-delivery/.

Chandler, Arizona. Subsequently, they initiated a joint for online orders for the 400 Waymo early riders, and later launched an autonomous delivery pilot with Ford and GM Cruise. [142]

In April 2019, Waymo announced a partnership with American Axle & Manufacturing, a maker of automobile driveline and drivetrain components and systems, to repurpose its factory in Detroit to outfits cars with driverless systems. The factory began operation in mid-2019 with investment of $13.6 million from Waymo, an $8 million grant from the Michigan Strategic Fund, and a $25,000 investment from MichAuto, the automotive economic development division of the Detroit Regional Chamber.[143] In early March 2020, at the cusp of the COVID-19 pandemic, Waymo announced that it had secured $2.25 billion in financing from outside investors Silver Lake, Canada Pension Plan Investment Board, and Mubadala Investment Company (the sovereign wealth fund of Abu Dhabi), as well as auto-parts supplier Magna International, Andreessen Horowitz, and auto retail giant AutoNation. In the last several years, according to an analysis by *The Information,* Alphabet/Waymo alone has spent more than $3.5 billion on the development of autonomous driving technology.[144] This is the equivalent of funds allocated by the federal government for the Department of Homeland Security to strengthen climate resilience in the 2023 budget.[145] The plan, it seems, is to turn the contemporary automobile autonomous, thus keeping the urban street has it has been in the decade.

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[142] Dale Buss, "Walmart-Waymo Mashup: Autonomous Ride Meets Curbside Grocery Pickup in Arizona Test," *Forbes*, July 27, 2018, https://www.forbes.com/sites/dalebuss/2018/07/27/walmart-waymo-mashup-autonomous-ride-meets-curbside-grocery-pickup-in-arizona-test/

[143] Kyle Wiggers, "Waymo Will Build its Driverless Cars in Detroit," *Venture Beat,* April 23, 2019, https://venturebeat.com/2019/04/23/waymo-will-build-its-driverless-cars-in-detroit/.

[144] Amir Efrati, "Money Pit: Self-Driving Car's $16 Billion Cash Burn", *The Information,* February 5, 2020, https://www.theinformation.com/articles/money-pit-self-driving-cars-16-billion-cash-burn

[145] Office of Management and Budget, "Budget of the United States Government Fiscal Year 2023," *The White House*, 27.

Figure 5.9 Screenshots from Waymo March 2, 2020, ad "Reimagining transportation with the Waymo Driver."
Source: Waymo. Reimagining transportation with the Waymo driver. https://www.youtube.com/watch?v=xjoWJ3XZFNk&t=60s&ab_channel=Waymo.

Analysis: In 2019, Dmitri Dolgov, Waymo's chief technology officer, told *Bloomberg CityLab* "We're not building a car, we're really building a driver."[146] The driver, also known as Waymo Driver,[147] is the software that has been driving across test roads and urban streets since 2009. It has racked up billions of simulated miles driven plus millions of actual miles driven. A cheerful Waymo ad titled "Reimagining transportation with the Waymo Driver," presents a vision of the future. The ad follows a Waymo Driver on a two-lane roadway with a few dense blocks surrounded by built sprawl and trees. The sidewalks have only a handful of people walking on them, all young able adults; there are no children, people pushing carts or strollers, people walking with canes, or elderly people. The street has no parked or moving cars. The Waymo Driver car is the only vehicle visible moving along an urban street. As noted in Figure 5.9, multiple parking garages can be

[146] Rob Pegoraro, "Waymo Doesn't Mind Being Boring," *Bloomberg CityLab*, May 10, 2019, https://www.bloomberg.com/news/articles/2019-05-10/meet-waymo-the-boring-autonomous-vehicle-company
[147] Waymo, "Waymo Driver," accessed March 23, 2022, https://waymo.com/waymo-driver/.

spotted in the background. There is no visible bike infrastructure and there are no traffic lights at any intersection, a frequent issue in visions that consider car-related-technology as the most consequential determinant of the shape urban street usage.

Waymo's future urban street is a safe street for drivers because there are only Waymo cars on the street. The street is unchanged from its current automobile-focused design; the only thing that has changed is the driver's ability to become passenger. Comfort and delight of the former driver has to do with being able to travel without obstacles, car traffic, or people walking and cycling. There are no interventions for play or interactive spaces, only software-driven networks between the vehicles and environmental data.

Autonomous technology takes center stage in the Waymo's scenario. Its vision for the built form does not include anything but the road space for vehicular traffic. Safety results from not having anyone else in that space. Its total score is –18 points (see Table 5.9). There is no category in which the scenario was awarded points because it is a vision that prioritizes vehicular travel through automation as the sole tool toward sustainable development. Autonomous technology may offer benefits toward safer road conditions, but as discussed in Chapter 3, it is the form of the street that creates the behavior of drivers. A wide street dedicated for vehicular traffic will only result in higher traffic speeds then a wide street with dedicated (protected) space for micromobility traffic and only limited vehicle travel space (one-two lanes).

Table 5.9 Waymo Lens scorecard

	Pedestrians		Micromobility		Riders (Public Transit)	
Lens of safety	Protection against traffic & collisions	Eliminating fear of traffic	Protection against traffic & collisions	Eliminating fear of traffic	Protection against traffic & collisions	Eliminating fear of traffic
	Protection against crime & violence	Lively public realm			Protection against crime & violence	Ability to safely wait for transit
	Overlapping functions	Protection from light, weather, pollution, dust, noise, & glare	Protection against crime & violence	Ability to safety store, & maintain micromobility devices	Protection from weather, pollution, dust, noise, & glare	
Lens of comfort	Opportunities to walk with no obstacles	Accessibility for everyone	Opportunities to roll with no obstacles	Accessibility for everyone	Opportunities to travel with no obstacles	Accessibility for everyone
	Interesting facades	Opportunities for standing & seating				
	Spaces for play & "talkscapes"	Lighting at night	Spaces for commute, leisure, & repair	Lighting at night	Opportunities for standing & seating	Lighting at night
Lens of delight	Buildings scale	Opportunities to enjoy positive climate	Lane size	Opportunities to enjoy positive climate	Positive sensory experience: materials, plants, water, attention to detail (human dimensions)	
	Positive sensory experience: materials, plants, water, attention to detail (human dimensions)		Positive sensory experience: materials, plants, water, attention to detail (human dimensions)			

See Table 4.4 (page 153) for comprehensive lens analysis overview. Green: sufficient. Yellow: passable Red: unsatisfactory. Total score –18 points.

5.4. Objects

Alternative mobilities in the object category are strictly physical artifacts—mechanical or manual, electrical or autonomous with a physical presence on the street. In this section, the alternative mobilities discussed have little to do with the form of the urban street and much to do with its use. These are scenarios that are concerned with representing their own products/services regardless of the intended and unintended consequences included or omitted from the visions. I discuss four scenarios of varying scales, a proposed large-scale transit system, a software, and two visions for the city of tomorrow.

5.4.1 The Hyper (Loop)

The spectrum of alternative mobility moves away from urban intervention until all that remains is an object using the existing street as it is. One of those objects, the hyperloop, is a transit-system concept like high-speed rail but with a different technological operation system. The hyperloop is only semi-urban, as it is intended to connect urban centers. It is included in this dissertation because hyperloop connections (its stations, or entrance points) are at the urban street. As an alternative mobility, the hyperloop straddles the line between being a service (from its ambition to be a transit system) and an object (due to the actual nature of the proposed system).

Technology: The hyperloop, a proposed high-speed inter-city transportation system meant to alleviate traffic, consists of a reduced pressure tube with a passive magnetic levitation system and a linear electric motor that propels capsules carrying passengers. Elon Musk popularized the idea with a 57-page white paper titled *Hyperloop Alpha* published on the Tesla blog in 2013. The hyperloop is a solution meant to replace the approved California high-speed rail and reduce traffic.[148] In the paper, Musk argues that his plans could transport passengers faster than rail by traveling up to 800 mph. He detailed the technological challenge of maintaining high speed in a low-power loop offering general solutions in the form of compressor fans to reduce friction. Friction will cause power loss within the hyperloop, so it must be minimized to a point that the prototype

[148] Elon Musk, "Hyperloop," *Tesla Blog*, August 12, 2013, https://www.tesla.com/blog/hyperloop.

will have to float. As a system, Musk details a tube design with sealed capsules carrying 28 passengers, each leaving a station every two minutes from Los Angeles to San Francisco. Built on the median of California highway I-5, supposed stations could be added by a split in the tube.[149] The price for the Hyperloop system was estimated at $6 billion for a passengers-only model or $7.5 billion to also transport cars (three cars per pod). Musk argued that if he was to give priority to the project, he would be able to complete it in "one or two years."[150] Nonetheless, a few days before he published the paper, Musk stated he was not interested in the development of a hyperloop system.[151]

In the years that followed the *Hyperloop Alpha* publication, multiple companies pursued the concept. Hyperloop Transportation Technologies (HTT) focused its efforts outside the United States,[152] but did conduct a feasibility study for a hyperloop in the Great Lakes corridor. The study, prepared for the Northeast Ohio Areawide Coordinating Agency (NOACA), cost $1.3 million, with about $600,000 coming from the Cleveland Foundation, the Ohio Department of Transportation, the Ohio Turnpike and Infrastructure Commission and the Richard K. Mellon Foundation of Pittsburgh at the behest of HTT.[153] Published in December 2019, the 156-page document evaluates a hyperloop route from Pittsburgh to

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[149] Elon Musk, "Hyperloop Alpha," *Whitepaper* (Tesla Blog, 2013), 209-210.
[150] Russell Brandom, "Elon Musk Reveals Plans for High-Speed Hyperloop," *The Verge*, Aug 12, 2013, https://www.theverge.com/2013/8/12/4614940/elon-musk-reveals-plans-for-high-speed-hyperloop.
[151] Adi Robertson, "Elon Musk Has 'No Plans' to Actually Build his Hyperloop Design," *The Verge*, Aug 8, 2013. https://www.theverge.com/2013/8/8/4602644/elon-musk-has-no-plans-to-actually-build-his-hyperloop-design.
[152] HyperloopTT has its R&D center in Toulouse, France and two ongoing projects. A commercial hyperloop prototype in Abu Dhabi, United Arab Emirates and a hyperport in the port of Hamburg, Germany. The commercial prototype in Abu Dhabi is a 3-mile passenger track with an experience center. In Hamburg, the company is working on analytical models, calculations, 3D models, overall design optimizations and integrations. A VR demonstration will be shown at the ITS World Congress in October 2021.
[153] Aaron Gordon, "Hyperloop is the Midwest's Answer to a Question No One Asked," *Jalopnik*, December 18, 2019, https://jalopnik.com/hyperloop-is-the-midwests-answer-to-a-question-no-one-a-1840515757.

Chicago via Cleveland to be constructed between 2023 and 2028 through a public-private partnership. Transportation Economic & Management Systems concluded in their financial and economic analysis of the proposal that land values along the route will increase by $74.8 billion, add income of $47.5 million, and create 37,000 new jobs.[154] The method of analysis raises concerns about the validity of those numbers. The project methodology for the economic evaluation framework is described in a single half page and offers no empirical base. The calculations used and the starting point for this positive financial impact is missing. Ohio is not famous for superb public transit service, its fleets and infrastructure in dire need of replacement. Per the ASCE, Ohio infrastructure average is at a C- with both roads and transit in need of investment. In 2018, the state of Ohio's per capita funding for transit was $0.57 per person or $6.5 million. Ranking 42nd in the United States, Ohio's investment in transit is 1000% less than the national average per capita ($58.69).[155] Between 2016 and 2020, more than 5,000 people lost their lives in traffic fatalities and more than 100 pedestrians were killed, a 12% increase in pedestrian deaths.[156] Regardless, NOACA and HTT have applied for a $5 million grant from the Federal Railway Administration for an environmental impact study to pursue the hyperloop-corridor project.[157]

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[154] Transportation Economic & Management Systems, Inc, *Great Lakes Hyperloop Feasibility* Study (Northeast Ohio Areawide Coordinating Agency: Hyperloop Transportation Technologies, December 2019), 153.

[155] American Society of Civil Engineers, "Infrastructure Report Card Brochure. 2021 Report Card GPA C–," *Ohio Infrastructure Report Card*, accessed March 23, 2022, https://infrastructurereportcard.org/wp-content/uploads/2016/10/ASCE_Brochure%E2%80%94OH2021.pdf.

[156] Governors Highway Safety Association, *Pedestrian Traffic Fatalities by State: 2020 Preliminary Data* (Spotlight on Highway Safety: GHSA, 2021), 7; Ohio State Highway Patrol, "Ohio Fatal Crash Summary Statistics," Ohio.gov, accessed March 23, 2022, https://www.statepatrol.ohio.gov/statistics/statspage3.asp.

[157]Steven Litt, "Cleveland-Chicago-Pittsburgh Hyperloop's Next Move Depends on Federal Government," *Cleveland.com*, December 17,2019, https://www.cleveland.com/news/2019/12/cleveland-chicago-pittsburgh-hyperloops-next-moves-depend-on-federal-government.html.

Form: The only hyperloop in testing and construction in the United States is being conducted by Hyperloop One. In 2016, it conducted its first public test using a custom-built sled that reached 115 mph in 1.1 seconds.[158] In 2019, the company raised more than $172 million with $90 million coming from a Dubai-based investor. This was a second round of investment after the company already raised $295 million. At the time, 35 miles outside of Las Vegas, Virgin Hyperloop One built a 1,640-foot-long, 11-foot high, full-scale test track. The empty pod traveling inside the test tube has reached speeds of 240 mph.[159] In November 2020, the company conducted its first trial with people reaching a traveling speed of 48 miles per second, about 107 miles per hour. The test carried four adult people.[160]

Analysis: The hyperloop is not an urban mobility system but an inter-urban one. The system's connection to the urban street is from the nature of the stations having to be in city centers to become viable access points. In alternative mobilities scenarios the hyperloop is often in the background, intended to conjure a level of technological sophistication. Most smartification elements of urban management are invisible, but with the hyperloop it becomes tangible, something that can be seen. A hyperloop is also a lot more exciting to market than trains or walking, and it is easier and more politically appealing to fund than management and maintenance of existing mobility infrastructure. In short, the hyperloop eliminates the urban street with proponents arguing that it is simply the space to enter and exit a tube. With the hyperloop the destination (and origin point) is

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[158] "Hyperloop One Tests Supersonic Transport Propulsion Systems," *The Guardian*, May 12, 2016, https://www.theguardian.com/technology/video/2016/may/12/hyperloop-one-tests-supersonic-transport-propulsion-system-video.
[159] Eric A. Taub, "A Real Tube Carrying Dreams of 600 MPH Transit," *New York Times*, February 18, 2019, https://www.nytimes.com/2019/02/18/technology/hyperloop-virgin-vacuum-tubes.html.
[160] Virgin Hyperloop, "World's First Hyperloop Passenger Test," accessed March 23, 2022, https://virginhyperloop.com/pegasus.

not the important thing, it is the speed of the journey that is most salient, an echo of the existing automobile regime. Because of that, it scores a total of minus –22 points (see Table 5.10).

Table 5.10 The Hyper (Loop) Lens Scorecard.

	Pedestrians		**Micromobility**		**Riders (Public Transit)**	
Lens of safety	Protection against traffic & collisions	Eliminating fear of traffic	Protection against traffic & collisions	Eliminating fear of traffic	Protection against traffic & collisions	Eliminating fear of traffic
	Protection against crime & violence	Lively public realm			Protection against crime & violence	Ability to safely wait for transit
	Overlapping functions	Protection from light, weather, pollution, dust, noise, & glare	Protection against crime & violence	Ability to safety store, & maintain micromobility devices	Protection from weather, pollution, dust, noise, & glare	
Lens of comfort	Opportunities to walk with no obstacles	Accessibility for everyone	Opportunities to roll with no obstacles	Accessibility for everyone	Opportunities to travel with no obstacles	Accessibility for everyone
	Interesting facades	Opportunities for standing & seating				
	Spaces for play & "talkscapes"	Lighting at night	Spaces for commute, leisure, & repair	Lighting at night	Opportunities for standing & seating	Lighting at night
Lens of delight	Buildings scale	Opportunities to enjoy positive climate	Lane size	Opportunities to enjoy positive climate	Positive sensory experience: materials, plants, water, attention to detail (human dimensions)	
	Positive sensory experience: materials, plants, water, attention to detail (human dimensions)		Positive sensory experience: materials, plants, water, attention to detail (human dimensions)			

See Table 4.4 (page 153) for comprehensive lens analysis overview. Green: sufficient. Yellow: passable Red: unsatisfactory. Total score –22 points.

The hyperloop, unlike other forms of high-speed transit, does not intend to provide intramodality access as it expands travel distance in shorter time to the public. It is designed for private travel not to be integrated into existing urban conditions, provide amenities, or improve health and safety conditions. The original concepts of a passive magnetic levitation system above ground have been replaces by underground tunnels accommodating single-lane private vehicle travel. Autonomous and electric vehicles are assumed to be the technology that will make the idea of hyperloop a more efficient tubed public transit system (trains or buses) while everyone is in their individual spaces (their cars). There is not design for any other forms of mobility, nor thought for any other users beyond those inhabiting private cars.

5.4.2 Tesla "Autopilot"

Tesla, founded in 2003, began business as a company specializing in electric powered sports cars and has become synonymous with Elon Musk, who has been connected to a number of high visibility ventures in the last two decades, including PayPal, the Boring Company and the hyperloop discussed earlier. *Time* named Musk its Person of the Year in 2021.[161] In a year filled with COVID-19 vaccinations and of global crises, Musk was showcased for his personal achievements. Under his leadership Tesla became the leading EV manufacturer on the market and has it expanded its focus from electric only to electric and autonomous. Autopilot is one of the Tesla's names from its autonomous capabilities' software. As an alternative mobility, Tesla (the company) and "Autopilot" (the software), are both objects, intended to be used on the urban street as it is.

Tesla has had numerous difficulties as it ventured away from electric technology and concentrated on the development of autonomous driving, which has led to several fatalities. In May 2016, Joshua Brown, a former Navy SEAL, died when his Tesla Model S collided with a truck while the car was engaged in Autopilot mode. Publicly, Tesla has argued that the Autopilot camera could not distinguish between the white truck and the

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[161] Alejandro de la Garza, "How Elon Musk Built His Fortune – And Became the Richest Private Citizen in the World," *Time*, December 13, 2021, https://time.com/6127754/elon-musk-net-worth-person-of-the-year/.

bright sky.[162] A 500-page report by the NTSB blamed the driver, finding that Brown kept his hands off the wheel for a long period of time even though an automated warning told him not to. The NTSB stated that Brown did not apply the brakes, and that he set his cruise control at 74-mph in a 65-mph speed limit highway. The truck driver, whose vehicle collided with Brown's car, was charged with a right-of-way traffic violation.[163] Tesla was allowed to continue to market its Autopilot software to provide autonomous capabilities.

Technology: Tesla's Autopilot feature, like most contemporary AV technology, relies on an array of cameras and radars that track the surrounding environment and the various elements in it, including infrastructure, people, and other vehicles. According to Tesla's Autopilot webpage the hardware for full self-driving vehicles is already installed in the vehicles, "your car will be continuously upgraded through over-the-air software updates."[164] Tesla's narrative of autonomous driving basically describes a technology that no company is currently close to achieving. For example, Tesla writes that "all you will need to do is get in and tell your car where to go. If you don't say anything, your car will look at your calendar and take you there as the assumed destination. Your Tesla will figure out the optimal route, navigating urban streets, complex intersections and freeways."[165] When arriving at a destination, no matter where, you "simply step out at the entrance and your car will enter park seek mode, automatically search for a spot and park itself. A tap on your phone summons it back to you." [166] All of these serves to highlight how

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[162] Cade Metz and Neal E. Boudette, "Inside Tesla as Elon Musk Pushed an Unflinching Vision for Self-Driving Cars," *New York Times*, December 6, 2021, https://www.nytimes.com/2021/12/06/technology/tesla-autopilot-elon-musk.html.
[163] David Shepardson, "Tesla Driver in Fatal 'Autopilot' Crash Got Numerous Warnings: United States Government," *Reuters*, June 19, 2017, https://www.reuters.com/article/us-tesla-crash/tesla-driver-in-fatal-autopilot-crash-got-numerous-warnings-u-s-government-idUSKBN19A2XC.
[164] Tesla, "Autopilot," accessed March 23, 2022, https://www.tesla.com/autopilot.
[165] Tesla, "Autopilot."
[166] Ibid.

inconsistently the Tesla autonomous software performs. Despite its name, the Autopilot program uses driver assistance, lane steering, and adaptative cruise to control speeding and breaking. Thus, while it appears as if the vehicle is autonomous, actually it is not.

Indeed, Tesla's use of the term "autopilot" has been criticized for misleading the public into believing the vehicle is able to do more than it can. In 2014, the Tesla Model S was only capable Level 2 autonomy, giving the impression of autonomy while still requiring the full attention of the driver. The car's owner's manual includes a collection of warnings to "not depend on Traffic-Aware Cruise Control to adequately and appropriately slow down Model S" and "Traffic-Aware Cruise Control may react to vehicles or objects that either do not exist or are not in the lane of travel, causing Model S to slow down unnecessarily or inappropriately." It goes on to detail conditions in which Autopilot is unlikely to operate as intended, on roads with sharp curves, bright lights, or a dirty sensor.[167] Still, Tesla continued to market the software as autonomous capable. In 2020, a Tesla commercial was banned in Germany for misleading advertising because it oversold the capabilities of the Autopilot feature. The case against Tesla was brought by the German *Wettbewerbszentrale*, a regulatory group tasked with policing anti-competitive practices, to German court. In the court's conclusion, Tesla was banned from including terms such as "full potential for autonomous driving" and "Autopilot inclusive" in its German advertising materials.[168] In the United States, the company is still allowed to use the term in its marketing.

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[167] Chris Ziegler, "Tesla's Own Autopilot Warnings Outlined Deadly Crash Scenario," *The Verge*, June 30, 2016, https://www.theverge.com/2016/6/30/12073240/tesla-autopilot-warnings-fatal-crash.
[168] Kristen Korosec, "Elon Musk Rails Against German Court Decision on Tesla Autopilot Terminology," *Tech Crunch*, July 14, 2020, https://techcrunch.com/2020/07/14/elon-musk-rails-against-german-court-decision-on-tesla-autopilot-terminology/.

Tesla owners and other drivers post dash-cam footage and recordings of Tesla vehicles operating on various autonomous software updates, navigating highways and urban environments, via social media (YouTube, Twitter, and TikTok). The videos reflect the tensions that exists in Tesla between engineering and technological innovation and childlike humor obsessed with speed and macho posturing. There are long videos showcasing/testing the various Tesla software autonomous technology updates and videos of the software and other Tesla features being used in pranks and dry humor. In one video, a parked Tesla in an empty cemetery sees a pedestrian appearing and disappearing on the vehicle internal screen.[169] In another video, a driver films a Tesla with no driver sitting at the wheel, only a dog, speeding down a highway seat of the car.[170] Another video shows dashcam footage of a Tesla Autopilot successfully avoiding a stranded vehicle in an empty highway with low visibility (nighttime).[171]

Then there are the more serious videos, testing the capabilities of the software in various conditions. One dashcam video shows a Tesla owner running his car on the Autopilot software at night and hitting a deer. The car's Autopilot software fails to stop, and the deer flies in the air. The car suffers only minor scratches and dents, but a broken front light ends up costing the driver more than $8,200.[172] There are more successful Autopilot runs, but almost all of them are only successful when traveling on highways with

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[169] Tesla Silicon Valley Club (@teslaownersSV), "Tesla Pure Vision can see dead people @elonmusk," Twitter, December 21, 2021, 12:14 AM. https://twitter.com/teslaownersSV/status/1473159817883643907.
[170] Milford Michael (@maththrills), "Can't verify: @MoodyHikmet?? #Tesla," Twitter, December 14, 2021, 5:38AM. https://twitter.com/maththrills/status/1470704481696321538.
[171] Crider Johnna (@JohnnaCrider1), "Tesla Autopilot just saved a life in Louisianan. This video was sent to be by Dan B. in the Louisiana Tesla FB group to share on Twitter. @elonmusk $tsla Thanks @Tesla for making life saving technology," Twitter, December 11, 2021, 1:39 PM, https://twitter.com/JohnnaCrider1/status/1469738602460557318.
[172] Race Wood, "Tesla Autopilot Vs Deer (Fail!!)", YouTube video, April 8, 2021, https://www.youtube.com/watch?v=7NbD4L-jkfw&ab_channel=RaceWood.

no turns or lane switches. One video shows a Tesla owner trip in Los Angeles (using the full self-driving (FSD) Beta software update 10.3) successfully navigates turns, stop signs, and traffic lights and maneuvers around other vehicles while the driver mostly does not touch the wheel. At a crosswalk intersection, the vehicle stops for pedestrians waiting to cross the street. Inside the car, a screen shows the driver what the software identified: other cars, traffic lights, and the pedestrians.[173] There are hundreds of videos, ranging in style and content testing and experimenting with the various Tesla autonomous (and electrical) features. There are failures and successes, as well as abuses of the technology for pranks and experimentation and attempting to see how far the technology can go. In many of these videos, the street is used as a stage for Tesla's vision of the future. It is a fully automobile-focused future where the current urban street form does not change.

Tesla Autopilot and FSD are two different services offering similar promises – a car that can drive itself with no human intervention. They are both part of Tesla software packages that include the various programs that allow changing the horn sound, GPS features, and even games like solitaire. But Musk's promises about the software capabilities have fallen short and some of the installed features completely ignore safety concerns. This dangerous combination has resulted in death as well as lawsuits by customers and their families suing the company over crashes and misinformation. There is no definite number, but at least ten people have been killed in eight crashes involving Tesla Autopilot since 2016. One death that is not included in that number is Jovani Maldonado, a 15-old who died when he was thrown from the front passenger seat of his father's Ford Explorer pickup, which was hit from behind by a Tesla Model 3 traveling at 60 mph on

[173] Vehicle Virgins, "Tesla Full Self Driving in Beverly Hills!" YouTube video, November 10, 2021, https://www.youtube.com/watch?v=Yy0GaUv8kGg&ab_channel=VehicleVirgins.

Autopilot. According to the police report, the blame for the crash was the driver traveling in unsafe speeds and not the company that manufactured the software doing the driving at the time.[174]

Systemic change: In 2020, Tesla announced that access to its self-driving software would become a pay-as-you-go subscription, Musk and Tesla CFO Zachary Kirkhorn emphasized the value of purchasing the feature instead of subscribing calling it "an investment in the future."[175] The self-driving package's current cost is $7,000, with the company making price adjustments as new features are made available.[176] Tesla prices range by models and added features. A Model 3 with the rear-drive standard Range Plus option (meaning a range of 267 miles) starts at $47,690. Included in the price is a $1,200 destination fee (the delivery fee for the vehicle). An option with a longer range of 353 miles starts at $53,690. A Model S Tesla with a range of 405 miles (on a full charge) starts at $100,690.[177] These are not inexpensive cars, but Tesla enthusiasts are a growing community of people who find common ground with their love of the company, its cars, and its CEO, who they credit as the reason for the company success.[178]

The Tesla Silicon Valley Club, for example, has been holding meetings, including one in January 2022 that had over 105 attendees.[179] The Tesla Owners Club of New York

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[174] Neal E. Boudetter, "Tesla Says Autopilot Makers Its Cars Safer. Crash Victims Say It Kills," *New York Times*, July 5, 2021, https://www.nytimes.com/2021/07/05/business/tesla-autopilot-lawsuits-safety.html.

[175] Fred Lambert, "Tesla Confirms Self-driving as a Subscription Service But Brace Yourself for the Price, " *Electrek*, April 30, 2020, https://electrek.co/2020/04/30/tesla-self-driving-subscription-service-price/.

[176] Lambert, "Tesla Confirms."

[177] Kelly Lin, "How Much Is a Tesla? Here's a Price Breakdown," *Motor Trend*, November 2021, https://www.motortrend.com/features/how-much-is-a-tesla/.

[178] In 2019, Tesla shareholders voted to award Musk $2.6 billion in Tesla share options, a clear example of the company's faith in Musk leadership.

[179] Tesla Silicon Valley Club (@teslaownersSV), "Over 105 attendees came to @Machouse_ and rode @arcimoto FUVs. We got to experience the thrill and torque of the FUVs and ride other #emobility devices. Thankful for each member and all those who helped put this even on January 15. @omg_tesla @elon musk @nardopolo," Twitter, January 24, 2022, 11:51 AM, https://twitter.com/teslaownersSV/status/1485656520163414016.

State, an official Tesla Owners Club, organizes meetings around the state, often around/near supercharger stations.[180] Events are not limited discussing new technologies or software updates. The New York Tesla club, for example, hosted a camping trip for owners under the theme Tesla Can Camp. It used the Tesla Dreamcase, an attachment for various Tesla models that transformed the back seat and trunk of the car into a mattress.[181] The camping weekend was sponsored by Dreamcase and hosted at the Crazy Acres Campground where there are about 20 electric hookups sites "so you can easily maintain Camper Mode throughout your stay."[182] Camper Mode is a Tesla software update that allows owners to use the car systems, lights, and climate control to power a camping setup, while not using too much battery. These communities, like other car-enthusiasts are similar to the biking community, although they may not ride together through the streets, they share a common bond through software updates and charging infrastructure challenges. Sharing their experience online and when meeting face-to-face around chargers, Tesla owners are living the vision of the future set out by Tesla and Musk. It is not a vision made through videos, competitions, or large-scale redevelopment plans (as Ford and Alphabet have): it is a vision made by vehicle sales and the videos of people using Tesla autonomous technology.

The vision of the urban street according to Tesla "Autopilot" is manufactured, in part, by Elon Musk. In 2016, Musk promised that by 2017 a Tesla will be able to drive itself from Los Angeles to New York without any human intervention. But Musk says a lot

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[180] Tesla Owners Club New York State, "Meetups," *Tesla Owners Club New York States*, accessed March 24, 2022, https://www.tocnys.org/meetups.
[181] Dreamcase, "Dreamcase," accessed March 24, 2022, https://dreamcase.eu/.
[182] Tesla Owners Club New York State, "Tesla New York Camping Trip," accessed March 24, 2022, https://www.tocnys.org/event-4354088.

of things. He is a very active Twitter user and feels comfortable sharing his thoughts via tweets and during media appearances. Between 2018 and 2021, he was involved in a number of social controversies including boosting cryptocurrencies through tweets and threatening union organizers within the company and manipulating Tesla stock through unpredictable behavior and statements.[183] That has not stopped his or Tesla's popularity: in 2021, he hosted *Saturday Night Live* while Tesla celebrated selling more then 352,471 cars in the United States alone, a reported 87% increase over 2020.[184] Tesla displays itself as a cutting-edge car-manufacturer with a focus on vehicular innovation. As a scenario of the future of the urban streets its efforts towards AVs have little to do with environmental concerns but rather about maintaining the automobility system status-quo.

Analysis: The AV urban street is not so different from the urban street for the combustion engine car. On the contrary, the autonomous urban street stipules an electric future which requires a transition to a new form of "filling up your tank". EVs require individual chargers. For private homes in an urban street, that means running cables on the sidewalks, unless chargers are provided at the curb. If chargers are provided at the curb, the sidewalk and curb, remain as they are today, spaces for vehicular storage. Car storage (long or short term parking) becomes the visual background of cities, not the buildings, trees, or people, but the cars lining up the curb. AVs require sensors on infrastructure, other vehicles, and maybe even people. This raises similar questions and concerns as those raised in Toronto, during Sidewalk Labs efforts to development the Quayside site.

[183] Emily Stewart, "Truly, What Is Up With Elon Musk," *Vox Recode*, May 1, 2020, https://www.vox.com/recode/2020/5/1/21244346/elon-musk-tesla-twitter-stock-price-coronavirus-grimes.
[184] Neal E. Boudette, "Tesla Reports 87% Increase in 2021 Deliveries," *New York Times*, January 2, 2022, ttps://www.nytimes.com/2022/01/02/business/tesla-sales.html.

The AV/EV urban street does not protect pedestrians, micromobility users, or public transit riders from traffic or collision. The focus on vehicles as a solution toward a sustainable urban form present the same safety, spatial, and pollution challenges combustion engine vehicles do. As discussed in Chapter 3.2, EVs suffer from their own environmental limitations (batteries, wheels) while offering only a minimal improvement to comfort conditions, such as improved sound-and smell-scapes. The scenario total score is –11 (see Table 5.11).

Table 5.11 Tesla "Autopilot" Lens Score Card

	Pedestrians		**Micromobility**		**Riders (Public Transit)**	
Lens of safety	Protection against traffic & collisions	Eliminating fear of traffic	Protection against traffic & collisions	Eliminating fear of traffic	Protection against traffic & collisions	Eliminating fear of traffic
	Protection against crime & violence	Lively public realm			Protection against crime & violence	Ability to safely wait for transit
	Overlapping functions	Protection from light, weather, pollution, dust, noise, & glare	Protection against crime & violence	Ability to safety store, & maintain micromobility devices	Protection from weather, pollution, dust, noise, & glare	
Lens of comfort	Opportunities to walk with no obstacles	Accessibility for everyone	Opportunities to roll with no obstacles	Accessibility for everyone	Opportunities to travel with no obstacles	Accessibility for everyone
	Interesting facades	Opportunities for standing & seating				
	Spaces for play & "talkscapes"	Lighting at night	Spaces for commute, leisure, & repair	Lighting at night	Opportunities for standing & seating	Lighting at night
Lens of delight	Buildings scale	Opportunities to enjoy positive climate	Lane size	Opportunities to enjoy positive climate	Positive sensory experience: materials, plants, water, attention to detail (human dimensions)	
	Positive sensory experience: materials, plants, water, attention to detail (human dimensions)		Positive sensory experience: materials, plants, water, attention to detail (human dimensions)			

See Table 4.4 (page 153) for comprehensive lens analysis overview. Green: sufficient. Yellow: passable Red: unsatisfactory. Total score: –12 points.

The idea that changing the system of operation from away from fossil fuels will resolve all the issues related to the car and urban places in misguided. It does not consider the system of automobility and its century long history in molding urban streets for vehicular circulation and storage. While both micromobility users and public transits users were eliminated from the Tesla scenario scorecard it still preforms poorly. In part, it does so poorly because the company has come to perpetuate the system of automobility instead of offering an alternative.

5.4.3 Ford's Vision of Tomorrow

Ford's City of Tomorrow envisions the urban street as a digitalized thruway. The roots of this vision can be found in 2017, when Ford launched the City of Tomorrow, an annual one-day symposium that included a minute-long video vision for the future of urban streets. Ford later deleted this video, but it was subsequently uploaded to YouTube by an automotive news channel. Ford continued the ideas shown in the video by founding the City of Tomorrow Challenge, awarding funds for innovative mobility solutions, and then purchasing Detroit's Michigan Central Station to serve as its center for mobility development. I'll start off by talking about Ford's future plans utilizing its 2017 City of Tomorrow video.

The video begins with a view of a six-lane street filled with barely moving private cars. In the distance, a city center is visible: we know it is a center by the dense high-rises that have come to signify many downtowns. To the left of the frame, what seems to be a parking garage also acts as a public space around an office-like building (point 1). The scene quickly starts to shift as various elements of infrastructure start to sprout flora; the parking garage becomes a semi-open seating area in anticipation of a future train station (point 2). The roadway becomes a four-lane street with a central protected, two directional, bike lane (point 3 in Figure 4.3.3). In the distance, a crosswalk is visible (point 4). There are drop-off/loading shoulders for drivers in both directions. The video points to various technologies: a crowed-sourced dynamic-route shuttle service, e-bikes, and Level 4 AVs; the kind that are autonomous, but still require a person in the vehicle to take over. All of these are technologies in which Ford has invested in. As the video continues, the street has become an intersection facing a transit hub that Ford describes as a place for "convenient access to shared transportation modes."[185]

Figure 5.10 Ford the City of Tomorrow Screenshots.
Source: Ford City of Tomorrow. https://www.youtube.com/watch?v=FO824cwTYJY&ab_channel=Motor1

The entrance, has steps, making it accessible only for able-bodied individuals (point 9). A raised walkway to the right (point 7), with what seems to be a hyperloop above (point 6), sets the stage for local and regional transportation systems. Ford calls the system not a hyperloop but an "advanced high-speed mass transit."[186] There are no other transit systems

[185] Motor1, "Ford City of Tomorrow." *YouTube* video, January 9, 2017. Sec 00:39 https://www.youtube.com/watch?v=FO824cwTYJY&ab_channel=Motor1
[186] Motor1, "Ford City of Tomorrow."

operating within these elevated enclosed tubes. The walkway space below the high-speed mass transit system is the only place in Ford's vision where cyclists appear. On the ground level, the intersection is mostly road, but there is no congestion; the roadway is filled with vehicles smaller than contemporary private cars. Some seem to be two-seat or one-seat vehicles (points 11, 12, and 13). These vehicles all appear to be able to communicate with each other and the environment itself. There are no cyclists, people on scooters, cargo bikes, buses, or trucks of any sort; they are all various versions of private automobiles, and electric, of course. A large-scale wireless charging station is shown near a drop-off/pick-up area across the transit hub (point 13).

Form: The urban street roadway in Ford's vision is made from a digital surface with the road responding to countless vehicles crossing perpendicular to one another with flexible on-road marking. The company notes that most of the on-road vehicles are autonomous.[187] A dashed line appears and disappears on the road to direct traffic. There are no traffic lights or speed limits posted. There are also no crosswalks until a group of three pedestrians appears, the first in the video. The pedestrians choose to cross in a straight line at the intersection. The road surface changes to indicate the zebra lines of a traditional crosswalk (points 11 and 13). A green circle highlights the group of pedestrians, following with them as they cross the street into a slightly elevated sidewalk (point 8). This sidewalk seems to be made of hexagonal surfaces, similar to those in Sidewalk Labs' vision for the Quayside. Traffic, which is comprised mostly of AVs, is routed around the pedestrians and other vehicles which are always in motion and never standing still. Different kinds of flying drones are also part of Ford's vision, and to make sure the viewer does not assume they are

[187] Motor1, "Ford City of Tomorrow."

all commercial drones delivering packages, Ford makes it clear that at least one drone was summoned by a city resident via a wearable device to deliver emergency medicine. Ford's video includes tag lines appearing on the screen such as "less parking," "improved walkability," "more access to transportation," and "more green space." The video concludes with a list of opportunities for the City of Tomorrow: a city with no accidents, no emission, no congestion, and universal access to mobility.

Systemic change: Around the time that Ford held its City of Tomorrow symposium (2017), it formed Ford Smart Mobility LLC, a subsidiary now simply called Ford Mobility, dedicated to developing and investing in mobility services. Under this corporate arm, Ford expanded its alternative mobilities programs to include Spin, a scooter company, Ford bought in 2018, Chariot Shuttles, an app-based commuter service, Ford reportedly purchased for $65 million, but shut down in 2019 claiming it was economically unsustainable.[188] Ford also bought TransLoc, a software-interface company that provides real-time data about bus locations for riders and service providers. TransLoc DoubleMap is basically a bus-tracking system that riders can access through their phone; TransLoc Ride Systems helps service providers give customers real-time travel data. At the same time, Ford also invested in GoBike, the San Francisco bike-share managed by Motivate, which was bought by Lyft in 2018. (The system's name reverted to Bay Wheels in 2019, after the Lyft purchase). Ford also bought Argo AI, a Pittsburgh-based company focused on developing and testing self-driving vehicle technology. All of these technologies can be found in Ford 2017 vision for the future of the urban street.

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[188] When Ford closed the service, Chariot 25 vans in New York City were serving only an average of nine passengers a day. In San Francisco, Chariot rides at peak times cost $5 per ride, a significant price increase compared to the available public transit system in the region.

As part of its City of Tomorrow vision, Ford began providing grants through a City of Tomorrow Challenge. (Later re-branded as "City: One Challenge.")[189] Which launched in Pittsburgh in 2018 and for eight months, Ford accepted ideas from the community on mobility problems and solutions with the intention of investing about $250,000 in the city. The winning proposal was chosen by Ford, AT&T, Dell Technologies, Microsoft, and the Pittsburgh Downtown Partnership, all of whom contributed money for the award. From 125 submissions the Challenge Steering Committee selected 13 projects to refine their proposals in collaboration with a mentor and local accelerator. Three finalists were selected. Two of the three winning teams, Safe Shift and iomob, were given $50,000 to fund pilot programs. Safe Shift—a collaboration of representatives from local transportation and advocacy groups, students, and Moovit, an urban mobility, data, and analytics company—proposed a plan to provide safe and reliable transit for those who work during off-peak hours and travel with unpredictable commuting times (due to traffic). Iomob proposed an app that allows users to combine, book, and pay for various mobility services. Open sourced, it allows mobility providers to join the platform, which in turn enables users to find the best combination of mobility options for their needs. Basically, it works as a MaaS operating system. The third winning proposal, Intersection, requested no prize money as it was supported through its own revenue. Intersection's focus is bridging services through digital kiosks distributing a LinkPGH that provides public WiFi, device charging, wayfinding, and allows phone calls to be made anywhere in the United States.[190]

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[189] Pete Bigelow, "City of Tomorrow Challenge helps Ford learn," *Automotive News*, Mobility Report Newsletter, March 7, 2019, https://www.autonews.com/mobility-report-newsletter/city-tomorrow-challenge-helps-ford-learn.

[190] Ford Media Center, "Pittsburgh Announces the Winners of the City of Tomorrow Challenge," *Ford Motor Company*, November 28, 2018, https://media.ford.com/content/fordmedia/fna/us/en/news/2018/11/28/pittsburgh-announces-winners-city-of-tomorrow-challenge.html.

Ford subsequently ran its City: One Challenge (the rebranded City of Tomorrow Challenge) in Austin, Detroit, and Indianapolis. In Austin, a five-phase, nine-month process resulted in 150 pilot ideas and 12 finalists.[191] Two winners, Tappy Guide and Good Apple, were awarded $75,000 each to fund their proposed pilots. Good Apple's pilot included assessment of East Austin barriers to access food and the Tappy Guide is a mobile app that uses live video feeds and GPS data to allow people with disabilities to place calls and have a live advisor support their navigation.[192] In Indianapolis, 120 pilot ideas were submitted and 12 pilots were selected to receive a stipend of $1,200 to support the development of their final proposal.[193] The two winners were the Learning Tree and

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[191] (1) The Tappy guide, a mobile app that provides first and last mile solution using real-time data and location. (2) Equidad Express, a non-profit working on mobile services that offer health resources to disrupt generational poverty. (3) GoKart Kids, a transportation provider that also overs scholarships. (4) Good Apple, a produce delivery service. (5) GoKid; a venture-backed carpooling software. (6) Briometrix. Creates maps to determine the best routes for wheelchair users and proposed mapping 60-120 miles of sidewalks with concentration on key linkages between transit and pedestrian destinations. (7) HealNow, an onboarding and payment platform for pharmacies proposed using smart technology to reduce barriers to prescription access. (8) Advatech Healthcare, an India based health logistics company proposed a pilot providing individual transportation to aged people, persons with disabilities, and differently abled persons. (9) Ride Connect, a software and technology company for ridesharing and last/first mile companies, proposed a pilot that included a platform to coordinate between the various systems of transportation. (10) Skoop provides companies with hardware and software needed to sell digital advertising on vehicles. It proposed launching six micromobility vehicles running on a fixed route, as well as twenty-four digital screens in high traffic areas. (11) Send a Ride, a company that provides rides, including carpooling, for people with non-emergency needs, proposed the development of an app or a 1-800 number to allow hospitals, case workers, charities, and individuals to order rides based on need. (12) State of Place, an AI-driven building environment database that is meant to be used by city officials to make better decisions, proposed a single-use public space with a variety of health service concentration for easier residential access.

[192] Ford Mobility, *Austin City: One Challenge Final Report* (Austin: Ford Motor Company, 2021), 19-22, 24.

[193] (1) AbleLink Smart Living Technologies is a wayfinding app designed for travelers with cognitive disabilities providing step-by-step travel instructions using pictures, audio, and text. For its pilot it proposed using its Wayfinder app to enable individuals to transition away from expensive services. (2) Briometrix, an organization that was also a finalist in Austin, uses the experience of local wheelchair users to create a map of best routes for local destination. For the proposed pilot Briometrix wanted to map 125 miles of Indianapolis. (3) Bukkaroo, Ultimate Kids Kab Service offers premium transportation for children ages 4-15. For its pilot the company wanted to launch service with charter and private school only. (4) GoKid, another organization that was a finalist in Austin, is a venture-backed carpooling software company. For the pilot the company proposed implementing a shared carpool system in 20 Indianapolis schools during the 2020/21 school year. (5) Kboose wanted to launch a pilot that helps community members who are struggling to find mobility services. (6) Lazarillo, an app that helps people with limited or no vision to

AbleLink Smart Living Technologies. The Learning Tree received $50,000 to hire residents to organize community groups to discuss how/where to distribute awareness materials to influence knowledge and behavior of residents. AbleLink Smart Living Technology received $75,000 to launch a cloud-based SMART Routes Library of existing fixed routes. Partnering with a local agency that provides intellectual disability services, Easterseals Crossroads, the pilot identified users of the IndyGo's Open Door Para-transit services that may be able to transition to a fixed route service using the AbleLink Wayfinder, an app that provides users with personalized visual and audio that helps with independent use of public transportation.[194]

Technology: Ford funded mostly digital solutions and not pilots that changed urban form or how we use it. Overall, there were not many proposals that even attempted to change urban form conditions. Most proposals focused on access to information or a specific service of value to the community. At the time (between 2016 and 2019), Ford planned on doubling its presence in Silicon Valley. It invested $75 million in Velodyne, a developer of sensors and LiDAR manufacturer for AVs.[195] It also created the FordPass, an app for vehicle owners to monitor and control their cars. At one point, the app also allowed

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navigate urban spaces, wanted to integrate with the IndyGo bus system in Indianapolis. (7) LookingBus, a connected vehicle technology software company that alerts drivers when riders with disabilities are waiting to get on/off the bus, proposed the installation of the software on all Bus Rapid Transit and associated bus stops. (8) MLK Center, a neighborhood-based community center wanted to launch a Mid-Town-Get-Around pilot project, a ride share program using families' mini vans. (9) Supervision, an app that performs visual recognition of transit signs, proposed creating an app for the local IndyGo bus stop signs. (10) Sociali is a ridesharing platform for communities to share last mile options. A proposed pilot looked to help match local supply and demand. (11) Tappy Guide, a finalist, and one of the winners of the One Austin Challenge, is a mobile app that provides first/last mile solutions in real-time for people with disabilities. The proposed pilot was about collecting data to make the guides specific for the Indianapolis. (12) The Learning Tree, an association of neighbors who proposed to hire residents to convene community groups and conduct discussions on how to improve quality of life of people.

[194] Ford Mobility, *Indianapolis City: One Challenge* (Indianapolis Ford Motor Company, 2021),16-19, 23.

[195] Brent Snavely, "Ford to Double Silicon Valley Presence; Invests 75$M," *Detroit Free Press*, August 16, 2016, https://www.freep.com/story/money/cars/ford/2016/08/16/ford-silicon-valley-velodyne-self-driving-cars/88810184/.

those in San Francisco to access Ford GoBike. Unlike other vehicles, FordPass does not yet allow drivers to remotely move their vehicle, rather it allows people to lock/unlock their car from a distance as well as to remote start the car. The company made its Safety Insight tool publicly available. This is a web-based big-data tool that includes crash data, hard-braking events, and traffic data. Users can use Safety Insight to identify crash hotspots and risky streets (Ford calls them roads) and then to simulate solutions, including predicted costs and benefits. During the 2018 North American International Auto Show in Detroit, Ford announced a host of new initiatives and partnerships: creating a Transportation Mobility Cloud, a connected car open-source platform; work with Qualcomm on V2X communications for cities, cyclists, and cars; and collaboration with Postmates, Lyft, and Dominos for various autonomous, ride-hailing, on-demand deliveries, and smart cities programs.[196] In short, Ford appears to be investing in every transportation system available and any software or technology that has to do with mobility systems to make its 2017 vision a reality.

Many of the types of projects Ford has invested in have become the standards for most (if not all) car manufacturers, or as they now call themselves mobility providers: investing in various micromobility vehicles and systems, electric vehicles, autonomous technologies, delivery drones, advanced transportation-operating systems, and advanced technologies for traffic management. But Ford, due to its history and famous founder, has taken extra steps to invest in competitions, symposiums, and collaborations with cities and

[196] Andrew J. Hawkings, "Ford Wants to Be the Self-Driving OS of the Future of Transportation," *The Verge*, January 9, 2018, https://www.theverge.com/2018/1/9/16868814/ford-self-driving-autonomous-vehicle-ces-2018.

private organizations. Another thing that separates Ford from other car manufactures is its plan to invest more than $1.2 billion in building a headquarters in Detroit.

Form: When Ford ran its City: One Challenge in Detroit, it focused on Michigan Central Station (known as MCS). The station, located in a neighborhood known as Corktown, south of Downtown Detroit, was built in 1914. MCS was a passenger-rail station until 1988; sitting abandoned up to 2018 when it was purchased by Ford for an undisclosed amount.[197]. Ford renamed the MCS, Michigan Central, making it the anchor of its 30-acre walkable innovation hub.[198] Investing more than $740 million to create a mobility innovation district around MCS, Ford used the City: One Challenge to answer the City of Detroit Community Benefits Agreement to engage the community around the project's impact area.[199] Ford hosted five-community working sessions. and collaborated with local facilitators, 400 Forward,[200] to ensure local context was maintained throughout the design process. Events were hosted in local businesses and institutes, the Sainte Anne

[197] Built in the Beaux-Arts style, the building was designed by Warren & Wetmore and Reed and Stem architectural firms, known for the design of New York City's Grand Central Terminal. The MCS price tag at the time of its construction was $2.5 million ($55 million today). The main waiting room, with 54 ½ -foot ceilings and marble floors, was modeled after Roman baths and stretches the length of the building. Divided by coffered arched and coved in tile vaults, the waiting room had bronze chandeliers, Corinthian columns, and three arched covered 21x40 foot windows. The station had a restaurant, bathing facilities, and more than 500 offices occupied by railroad departments. To say that it was an impressive station would be an understatement. While the building was put on the National Register of Historic Places in 1975, during the 1990s it was left wide open for trespassers and vandalism. In 1995, when it was bought by the Controlled Terminal Inc. of Detroit, owned by billionaire Manuel Moroun, the city building inspector recommended it be demolished. Instead, Moroun fenced off the structure. Through the years, multiple entities, including the city of Detroit, and Moroun himself, proposed various renovations, but the high cost kept the building standing as is. Even demolishing the structure was deemed too expensive with demolition experts estimating it would cost almost $10 million.

[198] Ford News, "Ford Reveals Plans for Inclusive, Vibrant, Walkable Mobility Innovation District Around Michigan Central Station," Ford Motor Company, November 17, 2020, https://media.ford.com/content/fordmedia/fna/us/en/news/2020/11/17/ford-plans-mobility-innovation-district.html.

[199] Ford Mobility, *Michigan Central Station City: One Challenge Final Report* (Ford Motor Company: Ford Mobility, 2021), 5.

[200] 400 Forward is an initiative that aims to support the next 400 licensed women architects through exposure, financial assistance, and mentorship.

de Detroit Catholic Church, the Factory at Corktown, and even in Nancy Whisky Pub.[201] But overall, only 152 people participated in the community workshops,[202] which was reflected in the 164 proposals that were submitted to the City: Michigan Central One Challenge. Only 15% came from applicants located in the MCS impact area.[203] Like in Austin and Indianapolis, Ford Mobility chose 12 finalists.[204] Instead of funds or mentorship sessions, finalists were taken on a tour of the MCS Information Center and were given up-to-date information on Ford development plans.

Three pilots received seed funding: Mercy Education Project received $95,000; AbleLink SmartLiving Technologies, also a winner in the Indianapolis challenge, received $80,000; and the DDP received $75,000.[205] Two of the three pilots, unlike previous challenges, were for physical interventions to urban street space. The Mercy Education pilot, a project conceived by local high school students, proposed creating Rock City Mobility Stations (RCMS), mobility and information hubs that will include a kiosk with a

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[201] Ford Mobility, *Michigan Central Station*, 8.
[202] Ford Mobility, *Michigan Central Station*, 9.
[203] Ford Mobility, *Michigan Central Station*, 14.
[204] (1) AbleLink Smart Living Technologies. (2) Bedestrian, a mobility technology company, proposed to use its sidewalk micro-autonomous vehicle system for daily delivery. (3) Corktown Business Association (CBA), a group of 150 local business owners, proposed the creation of a shuttle service with refabricated electric golf cars. (4) DAVIS (Detroit Ain't Violent It's Safe) proposed a framework of local talent and skills and producing a 3D model rendering of future greenway paths in the neighborhood. The final framework was to provide a summary of skills and talents in the community for the realization of the project. (5) Downtown Detroit Partnerships. (6) FEV Group wanted to develop a modular design concept the eChariot. A demand-based 3-wheel power-assist vehicle. (7) Greenspot proposed to build e-Mobility hubs offering electric vehicle charging stations, electric-shared mobility services for micromobility, electric shuttles, and electric vehicle rentals. (8) Liftango, a technology platform for shared mobility systems, proposed for its platform to be used in the Michigan Central Station Commuter co-op. (9) Mercy Education Project. (10) Rally, a software platform for the creation of bus rideshares. Rally platform aggregates similar trips through dynamic routing and pop-up bus stops. It proposed launching its platform to solve the middle mile challenge for Corktown residents. (11) Southwest Detroit Business Association proposed to design and install multilingual wayfinding signage throughout the district celebrating the local history and heritage of the Mexicantowns and Southwest Detroit. (12) Wayne State TranpoTower, a student team from the university, proposed the creation of an interactive multilingual touch board that will show all DDOT bus stops and allow users to selected destinations and find routes.
[205] Ford Mobility, *Michigan Central Station*, 16-19, 21.

direct line to the Detroit Police Department, a phone charging tower, and an interactive map showing distance to various neighborhood and city destination. Beyond the kiosks, micromobility-sharing systems would be available.[206] The final version of the project included a digital monitor with local transit options, businesses, and community services. Painted with murals created by local artists, the small hub provided shade, lighting, WiFi, charging points, and picnic tables nearby.[207] The Downtown Detroit Partnership launched its "Bridging Histories, Building Futures" project to create a large-scale art intervention on Michigan Avenue under the Lodge Freeway.[208] Intended to make the space feel safer and be more walkable, Detroit-born artists Freddy Diaz and Donald Calloway produced a brightly colored sidewalk and wall mural, which was completed in October 2021.[209] These interventions, while physical, had very little to do with changing the urban form.

Analysis: While Ford's City of Tomorrow is not a physical vision, Michigan Central is. It offers a contrast to the company's deep financial investment in technology and software in the last several years. It is a physical, tangible investment in structures and physical space. Anchored around MCS, Ford's 30-acre innovative mobility campus is being designed as a 20-minute walkable community that encourages "spontaneous connections that build community, create partnerships and drive innovation."[210] The campus architects, Practice for Architecture and Urbanism (PAU) in collaboration with Mikeyoung Kim Design as the campus landscape architect, created a master plan

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[206] Ford Mobility, *Michigan Central Station*, 22.
[207] CBS Detroit, "Detroit Teen Girls Create 'Mobility Hub' in Corktown, as a Way to Connect Detroiters" CBS Detroit, June 11, 2021, https://detroit.cbslocal.com/2021/06/11/detroit-teen-girls-create-mobility-hub-in-corktown-as-a-way-to-connect-detroiters/.
[208] Ford Mobility, *Michigan Central Station*, 23.
[209] Downtown Detroit Partnership, "Bridging Histories, Building Futures in Detroit," accessed March 24, 2022, https://downtowndetroit.org/experience-downtown/bridging-histories-building-futures/.
[210] Ford News, "Ford Reveals Plans."

organizing the multiple structure on the site and Ford collection of requirements beyond making it a walkable campus. Requirements such as upgrades to existing public infrastructure, space to display and test emerging technology, and parking were all met, as stipulated by Detroit's zoning. PAU plan repurposes the existing MCS tracks into testing platforms for Ford's various mobility experiments.[211] More than 5,000 employees are expected to work in the new campus's four key buildings. Ford's vision for Michigan Central as a new mobility-innovation district does not offer much of anything new. Its 30-acre walkable hub also includes at least multi-story parking garages. There are several streets that are retained as part of the campus while keeping residents at a distance from park space that does not seem to offer any impressive amenities. There are no playgrounds, playscapes, or water features. There are neither micromobility-shared stations introduced to the neighborhood nor proposals to reimagine the streets within the campus. Crosswalks are only at intersections, and sidewalks are kept as they always have been—traditionally smaller than the space dedicated for car travel.

Ford's vision for the future of the urban street is of a techno-autopia. A street where traffic lights are obsolete because vehicles speak to one another. There are no crosswalks because the few people that do cross the street are also connected to the network. An autonomous network that can protect pedestrians from traffic and collision while maintaining continuous travel to all vehicles. It is a vision where the comfortable and delightful streets for people are segregated from those streets delighted by vehicle drivers. Ford's vision of the future of the urban street, The City of Tomorrow 2017 video design interventions show a collection of streets unchanged from the automobile regime. Delight

[211] PAU, "Michigan Central Station," accessed March 24, 2022, https://pau.studio/what/michigan-central-station/.

and comfort are saved for park spaces only. The scenario total score then is –7 (see Table 5.12).

Table 5.12 Ford Vision of Tomorrow Lens Score card.

<table>
<tr><th></th><th colspan="2">Pedestrians</th><th colspan="2">Micromobility</th><th colspan="2">Riders (Public Transit)</th></tr>
<tr><td rowspan="3">Lens of safety</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td><td rowspan="2">Protection against traffic & collisions</td><td rowspan="2">Eliminating fear of traffic</td><td>Protection against traffic & collisions</td><td>Eliminating fear of traffic</td></tr>
<tr><td>Protection against crime & violence</td><td>Lively public realm</td><td>Protection against crime & violence</td><td>Ability to safely wait for transit</td></tr>
<tr><td>Overlapping functions</td><td>Protection from light, weather, pollution, dust, noise, & glare</td><td>Protection against crime & violence</td><td>Ability to safety store, & maintain micromobility devices</td><td colspan="2">Protection from weather, pollution, dust, noise, & glare</td></tr>
<tr><td rowspan="3">Lens of comfort</td><td>Opportunities to walk with no obstacles</td><td>Accessibility for everyone</td><td rowspan="2">Opportunities to roll with no obstacles</td><td rowspan="2">Accessibility for everyone</td><td rowspan="2">Opportunities to travel with no obstacles</td><td rowspan="2">Accessibility for everyone</td></tr>
<tr><td>Interesting facades</td><td>Opportunities for standing & seating</td></tr>
<tr><td>Spaces for play & “talkscapes”</td><td>Lighting at night</td><td>Spaces for commute, leisure, & repair</td><td>Lighting at night</td><td>Opportunities for standing & seating</td><td>Lighting at night</td></tr>
<tr><td rowspan="2">Lens of delight</td><td>Buildings scale</td><td>Opportunities to enjoy positive climate</td><td>Lane size</td><td>Opportunities to enjoy positive climate</td><td colspan="2" rowspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
<tr><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
</table>

See Table 4.4 (page 153) for comprehensive lens analysis overview. Green: sufficient. Yellow: passable Red: unsatisfactory. Total score: –7 points.

Ford’s efforts toward vision of tomorrow are mostly in the name of maintaining the existing conditions of automobile dominance of the urban street while greenwashing technological mobility innovation. Safety is not a product of a lively public realm of overlapping activities but a result of autonomous networked environment. Comfort is superficial, only provided in specific and isolated cases. Everything relays on technological solutions and existing infrastructure with no significant formal changes. On the contrary, streets are kept as they have been in the last several decades, spaces for car travel and storage. Overall, the scenario does poorly across all three users at the lens of delight. This reflects the type of investment Ford interested in, not the creation of urban space but the advancement of technologies that will facilitate a future like the one it crafted in 2017. An automobile future that because sustainable by advanced technologies (autonomous and electric networks) that will absolve the automobility system of all its adversity.

5.4.4 SOM City of Tomorrow for *National Geographic*

Skidmore, Ownings & Merrill (SOM) is an architecture firm with headquarters in Chicago and offices in New York, San Francisco, and Los Angeles. Known for glass and steel facades and skyscrapers it is one of the most significant American architecture firms of the twentieth century.[212] The website legacy section of the website states that "since our founding in 1936, SOM has been designing the future,"[213] a future in the image of the company's design values and standards. This is why, as an alternative mobility, SOM's vision of the future is placed on the spectrum as an object. It offers a vision that is less about the future of the urban street and more about the visionary's skills of SOM staff and leadership.

[212] Kenneth Frampton, "Introduction" in *SOM: Architecture of Skidmore, Owings & Merrill 1997-2008* (The Monacelli Press, 2009), 13-14.
[213] SOM, "About," SOM website, accessed March 24, 2022, https://www.som.com/about/.

SOM is an architectural firm known for buildings such as the Burj Khalifa in downtown Dubai, One World Trade Center in New York City, the John Hancock Center in Chicago, and the Beacon in San Francisco. SOM is staffed with architects, urban planners, and engineers, providing services beyond tall-building design, including sustainable design, urban design, and urban planning. The lead for the City of Tomorrow project is the current Director of SOM's City Design Practice for western North America, Peter J. Kindel.[214] The design team included about five SOM employees,[215] with input from the staff of *National Geographic*. Choosing to focus on the year 2050, the design team went through a process of "now & then," taking current urban design concepts and reimaging them for the future.[216]

In April 2019, *National Geographic* dedicated a special issue to cities and ideas "for a brighter future." Susan Goldberg, the magazine's editor, poses the questions they wanted to answer with the issue, "should we live in dense urban areas with public transit and walkable amenities? Is sprawling suburbs created by our infatuation with the car?" To answer these questions, at least in part, *National Geographic* partnered with SOM to create a "detailed representation of the city of the future."[217]

Form: The future as it was envisioned by the SOM design team offers a decentralized city of what seems to be small neighborhoods of glass high-rises and mid-rises with green roofs. Bands of roadways weave between the neighborhoods, and the entire

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[214] Kindel is also a member of the Urban Land Institute's Public Development and Infrastructure Council.
[215] The core design team included Michael Powell, James Kirkpatrick, Zi Yi Chen and Tanli Lu of SOM's Hong Kong office, and Saki Mizuguchi and Nadia Conceicao in SOM's San Francisco office and Jason Treat of *National Geographic*.
[216] SOM News, "SOM Collaborates with National Geographic to Envision Cities of the Future," *SOM*, March 14, 2019, https://www.som.com/news/som_collaborates_with_national_geographic_to_envision_cities_of_the_future
[217] SOM, *Cities of the Future* (*National Geographic*, Special Issue on Cities: Ideas for a Brighter Future: April 2019), 20.

city is surrounded by trees and rivers/marshes. This aerial perspective of the future of urban hubs (see Figure 5.11) details a collection of design interventions not clearly identifiable in the built environment within but described in the text accompanying the image. Mixed-use districts providing services within walking distance from homes and workspaces. Hydroponic urban farms, remote-sensing, and information technologies for smart water use and rainwater collection, and automated recycling all supposedly exist within the high-rise communities. No images are provided to visualize the spatial distribution or urban accessibility of any of these amenities. In the magazine spread of the vision notations about AVs (electric of course, see point 5) and green streets are included, “water filtration, environmental monitoring, and native landscaping”[218] as part of the streetscape (point 6).

Environmental monitoring usually refers to instruments collecting data and monitoring air, noise, or other conditions. The section drawn by SOM does not seem to show any street landscaping beyond trees at the areas adjacent to the buildings. There are no cars in the section, but in the aerial view of the vision, highway-like streets (point 2) seem to be the only connection. There do not appear to be any infrastructure for buses, people on bikes, or scooters represented graphically anywhere in the vision. A “commuter community” note (point 10) indicates an underground subway connection between cities. Two main concepts led the team’s design decisions: biomorphic urbanism, in which ecological systems and human-centered design are the most important influences on the city forms; and Ebenezer Howard’s Garden City.[219] As discussed in Chapter 3, Howard’s

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[218] SOM, *Cities of the Future*.
[219] Peter J. Kindel, “What Should Cities Be Like in 2050?” *SOM Medium*, March 26, 2019, https://som.medium.com/what-should-cities-be-like-in-2050-e9c3043447b0

vision came with no specific design guidelines, but rather a conceptual frame for a utopian future.

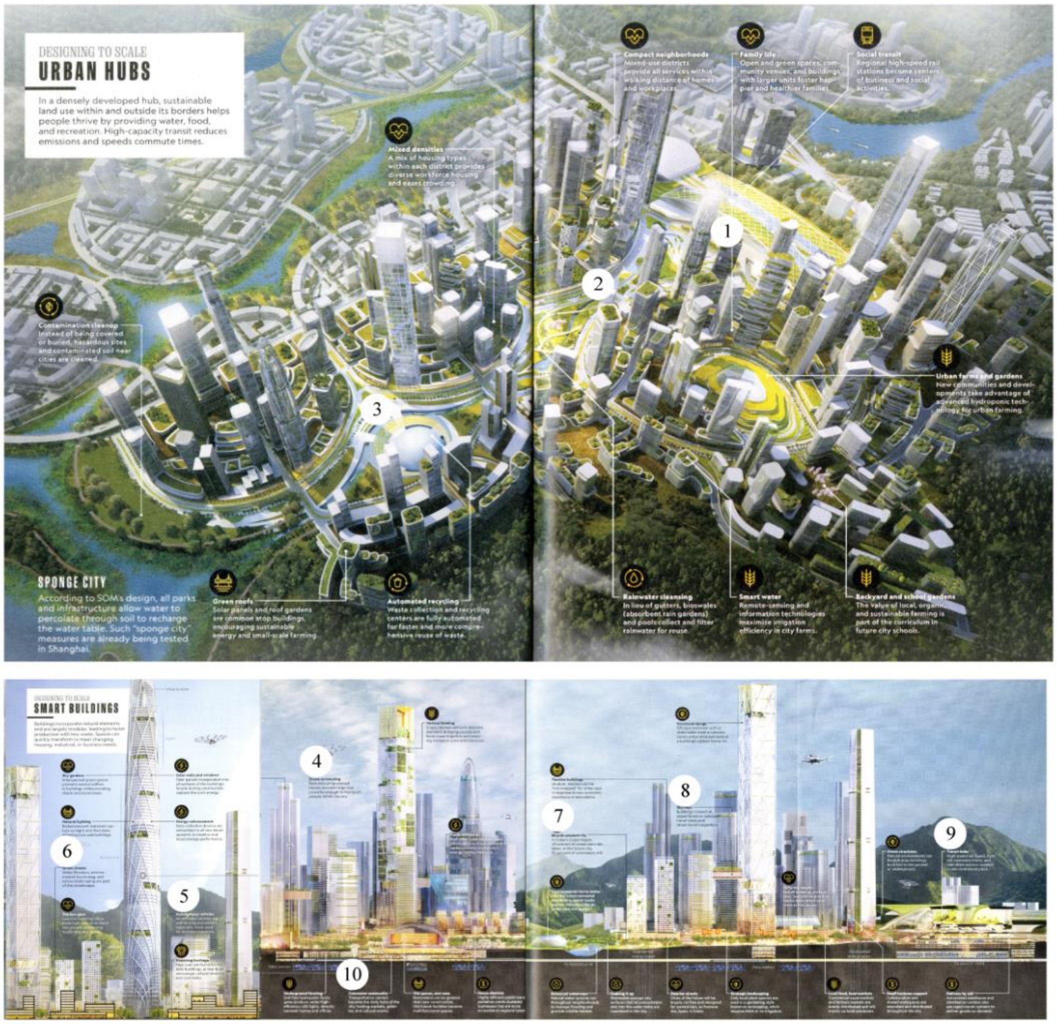

Figure 5.11 Skidmore, Owning & Merrill (SOM) for *National Geographic*. Top image: aerial view of SOM City of Tomorrow. Image below, sectional view.
Source: National Geographic, Special Issue on Cities: Ideas for a Brighter Future.

Many features of the SOM design remain not visualized and are only remarked on through a short notation. A "social transit" regional high-speed rail station (points 1 and 9) is supposed to be a center of business and social activities, but it is located far from the four residential hubs. Bridgeways (point 8) connect buildings to "reduce travel times and street-level congestion,"[220] which is an admission of a design strategy that intended to avoid the street level. If there are no people in the street, who is the street for? In SOM's vision, it is still a place for cars. While roadways for cars are visible in the aerial perspective of the vision, none of the bicycle connections that SOM mentioned briefly in point 7 appear in any of the drawings. A feature that is visible in the images are flying drones (point 4), intended to transport people autonomously, meaning without a pilot. This is yet another design method that removes people from the street by using future technologies—technologies that are known to not be ready for densely populated areas—to address urgent problems in the present.

Systemic change: Derek Moore, a SOM design principal and airports-practice lead, acknowledges the role of the firm in the creation of urban spaces, he writes:[221] "SOM has long been engaged in the planning, design, and engineering of the structure that surround, contain, overarch, or undergird the means of conveyance – airports, rail and bus stations, ferry terminals, bridges – along with the urban realm that they share with people."[222] These words are part of the forward to *SOM Thinkers*, a series of books that "originated from a desire to start a public conversation about the built environment" outside "professional" language.[223] Thus, the books provide the subtext of the buildings and masterplans made by the company. Moore, finishes his forward with a statement about the firm and mobility: "Mobility, in all its manifestations, is a ubiquitous force in shaping urban form and

[220] SOM, *Cities of the Future.*
[221] In the acknowledgments of *The Future of Transportation* (SOM Thinkers), a statement is added that the articles "are prepared by individual authors in their capacity" and that "the opinions expressed are the authors' own and do not necessarily reflect the view of Skidmore, Ownings & Merrill," 123.
[222] Derek Moore, "Forward," in *The Future of Transportation: SOM Thinker Series* (New York: Metropolis Books, 2019), 5.
[223] SOM, "SOM Thinkers: The Future of Transportation," November 5, 2019, https://www.som.com/publication/som-thinkers-the-future-of-transportation/.

transportation buildings. We at SOM see it as a force to be humanized through thoughtful design."[224] But the vision of SOM for *National Geographic* does little to reflect that thoughtfulness. SOM's City of the Tomorrow has no specific geographical place in the world and is designed as if constructed from scratch. According to SOM City of Tomorrow lead, Kindel, existing cities could adapt the ideas presented in the vision to "begin rethinking infrastructure, development patterns, and transportation systems...restoring ecosystems, achieving resiliency against natural hazards, and creating social mobility and economic equity for their citizens."[225] The proposal itself does not reflect any of that.

Analysis: As an idea, SOM's future urban street is safe, comfortable, and delightful. But Figure 5.11 depicts urban streets surrounded by glass towers. Streets seem to still function for vehicular traffic while all other spaces are rendered as a park. The delight and comfort are then within the buildings and in the designated leisure places and not intended for the urban street. SOM's scenario total score is –3 (see Table 5.13).

SOM scenario for *National Geographic* replicates superficial sustainability practices as if it is limited by exiting political conditions. While it alludes to having open space and opportunities to travel without obstruction, the design of the city reflects contemporary architectural strategies used in business enclaves, not of sustainable communities. Large glass skyscrapers present multiple sustainable development challenges including carbon intense construction material, energy consumption, and dangerous to avian species. The very scale of buildings and their facades is the proposal most poorly preforming cells.

Table 5.13 SOM for *National Geographic* Lens Scorecard

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[224] Derek Moore, "Forward," in *The Future of Transportation: SOM Thinker Series* (New York: Metropolis Books, 2019), 9.
[225] Kindel, "What Should Cities Be Like in 2050?".

<table>
<tr><th></th><th colspan="2">Pedestrians</th><th colspan="2">Micromobility</th><th colspan="2">Riders (Public Transit)</th></tr>
<tr><td rowspan="3">Lens of safety</td><td>~~Protection against traffic & collisions~~</td><td>Eliminating fear of traffic</td><td rowspan="2">~~Protection against traffic & collisions~~</td><td rowspan="2">Eliminating fear of traffic</td><td>~~Protection against traffic & collisions~~</td><td>Eliminating fear of traffic</td></tr>
<tr><td>Protection against crime & violence</td><td>Lively public realm</td><td>~~Protection against crime & violence~~</td><td>Ability to safely wait for transit</td></tr>
<tr><td>Overlapping functions</td><td>Protection from light, weather, pollution, dust, noise, & glare</td><td>Protection against crime & violence</td><td>Ability to safety store, & maintain micromobility devices</td><td colspan="2">Protection from weather, pollution, dust, noise, & glare</td></tr>
<tr><td rowspan="3">Lens of comfort</td><td>Opportunities to walk with no obstacles</td><td>Accessibility for everyone</td><td rowspan="2">Opportunities to roll with no obstacles</td><td rowspan="2">Accessibility for everyone</td><td rowspan="2">Opportunities to travel with no obstacles</td><td rowspan="2">Accessibility for everyone</td></tr>
<tr><td>Interesting facades</td><td>Opportunities for standing & seating</td></tr>
<tr><td>Spaces for play & “talkscapes”</td><td>Lighting at night</td><td>Spaces for commute, leisure, & repair</td><td>Lighting at night</td><td>Opportunities for standing & seating</td><td>Lighting at night</td></tr>
<tr><td rowspan="2">Lens of delight</td><td>Buildings scale</td><td>Opportunities to enjoy positive climate</td><td>Lane size</td><td>Opportunities to enjoy positive climate</td><td rowspan="2" colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
<tr><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td><td colspan="2">Positive sensory experience: materials, plants, water, attention to detail (human dimensions)</td></tr>
</table>

See Table 4.4 (page 153) for comprehensive lens analysis overview. Green: sufficient. Yellow: passable Red: unsatisfactory. Total score: –3 points.

5.5 Summary

The twelve visions discussed in this chapter offer a review of the spectrum of urban street futures in the United States, showing that there are various visions of the future of the American urban street. Beyond the technical differences, a temporary event or pilots, or a policy, these visions reflect sociocultural and technological preferences that continue to default to the automobile as a point of departure. At a time of climate crisis, the continued automobile-focused framing of urban street development has left the United States far behind with regards to sustainable development measures.

Table 5.14 Alternative Mobilities Lens Scorecard Totals.

Scenarios of Alternative Mobilities	Scorecard results	Total
Sidewalk Labs: Quayside Project	Safety: Ped 2/6, Micromobility –1/4, Riders 2/6. Comfort: Ped 3/5, Micromobility 2/4, Riders 2/4. Delight: Ped 3/3, Micromobility 0/3, Riders 0/1.	13 points.
NACTO Blueprint for Autonomous Urbanism	Safety: Ped 1/6, Micromobility 1/4, Riders 3/6. Comfort: Ped 2/5, Micromobility 2/4, Riders 3/4. Delight: Ped 1/2, Micromobility –1/3, Riders 0/1.	12 points
AIANY Future Street	Safety: Ped 2/6, Micromobility –1/4, Riders n/a. Comfort: Ped 3/3, Micromobility –1/3, Riders n/a. Delight: Ped 2/2, Micromobility 0/3, Riders n/a.	6 points
Public Square	Safety: Ped 0/6, Micromobility –1/4, Riders 0/6. Comfort: Ped 2/3, Micromobility 0/3, Riders 0/4. Delight: Ped 1/3, Micromobility –1/3, Riders 0/1.	1 point
Complete Streets Lens Scorecard	Safety: Ped 0/6, Micromobility 1/4, Riders 0/6. Comfort: Ped –2/4, Micromobility 1/3, Riders 1/4. Delight: Ped –1/2, Micromobility –2/3, Riders 0/1.	–2 points
SOM for *National Geographic*	Safety: Ped 0/5, Micromobility 0/3, Riders 0/3 Comfort: Ped –1/6, Micromobility 0/4, Riders 0/4 Delight: Ped –1/3, Micromobility –1/3, Riders 0/1.	–3 points.
Vision Zero	Safety: Ped 0/6, Micromobility 2/4, Riders 1/6. Comfort: Ped –1/5, Micromobility 0/3, Riders 0/4. Delight: Ped –2/2, Micromobility –3/3, Riders –1/1.	–4 points.
Ford Vision of Tomorrow	Safety: Ped 0/6, Micromobility 0/4, Riders –1/6. Comfort: Ped 09/6, Micromobility 0/3, Riders 0/4. Delight: Ped –2/3, Micromobility –3/3, Riders –1/1.	–7 points
Tesla “Autopilot”	Safety: Ped –5/6, Micromobility n/a, Riders n/a. Comfort: Ped –5/5, Micromobility n/a, Riders n/a. Delight: Ped –2/2, Micromobility n/a, Riders n/a.	–12 points.
Waymo	Safety: Ped –4/6, Micromobility –4/4, Riders n/a. Comfort: Ped –4/4, Micromobility –3/4, Riders n/a. Delight: Ped –2/2, Micromobility –3/3, Riders n/a.	–18 points
Smart Columbus	Safety: Ped –3/6, Micromobility –1/4, Riders –2/6. Comfort: Ped –4/5, Micromobility –3/3, Riders –2/4. Delight: Ped –2/2, Micromobility –3/3, Riders –1/1.	–21 points
The Hyper (Loop)	Safety: Ped –6/6, Micromobility –4/4, Riders n/a. Comfort: Ped –3/3, Micromobility –3/3, Riders n/a. Delight: Ped –2/2, Micromobility –3/3, Riders n/a.	–22 points

In Table 5.14 I organize the scenarios according to their scores. The results show a field of visions that has continuously failed to create safe, comfortable, or delightful urban street. More than that, some of the scenarios contribute to the perpetuation of the contemporary version of the urban street as a mostly vehicular travel and storage space, a thruway not a public space. Only four scenarios scored above zero, Sidewalk Labs Quayside project (Subsection 5.1.2), NACTO Blueprint for Autonomous Urbanism (Subsection 5.1.1), AIANY Future Street (Subsection 5.2.1) and *Public Square* (Subsection 5.1.3). All four, have strong urban formal interventions but varying degrees of dependence on mobility-related-technologies.

Only two scenarios scored above ten, Sidewalk Labs Quayside project (13 points) and NACTO Blueprint for Autonomous Urbanism (12 point). Both are visions of a complex urban street with formal variations incorporating a mix of technological drivers, systems of service, and urban interventions (discussed in Chapter 3). These two options present a range of design tactics for the transition to a low-carbon urban roadway in the United States that merit additional investigation and testing.

Four scenarios scored between zero to -10, Complete Streets (Subsection 5.2.2), SOM vision for *National Geographic* (Section 5.4.4), Vision Zero (Subsection 5.3.1) and Ford vision of tomorrow (Subsection 5.4.3). These scenarios present an interesting collection of vision types with a mix of object focused alternative mobilities (SOM and Ford), services (Vision Zero), and events (Complete Streets). The overall scores of these scenarios, between -2 to -7 points, suggests an internal on-going push-and-pull between sustainable innovations that stipulates changes from the status-quo of the urban street to ones that maintain it as it is. The most poorly preforming scenarios, Tesla "Autopilot" (Subsection 5.4.2), Waymo services (Subsection 5.3.3.), Smart Columbus (Subsection 5.2.2.), and the Hyperloop (Subsection 5.4.1) are split between objects and services alternative mobilities. All scenarios largely fail because the proposal they have put forth can only function within the automobility system. Neither one of the visions ignores the urban form as a space for the pubic and instead focused on automobile focused technologies that have yet to prove in any meaningful way their environmental benefits.

EVs are cars. They take the same amount of space as combustion engine and produce the same amount of spatial pollution. They only offer a perceived environmentally gentle vehicle. In reality, the infrastructure requirements, and the cars spatial requirement and emissions, maintain the urban environment as it is. In alternative mobilities, EVs often take a secondary or tertiary role, serving as the background of "progress" and "innovation" while presenting an image of a futuristic and sophisticated urban street. By naming a vehicle electric, creators assume it becomes something different than the traditional privately-owned combustion engine, but it does not. More than that, many visions ignore the additional infrastructural requirements of EVs, like charging facilities. Charging stations and parking for EVs are assumed to be fitted into existing automobile infrastructures, resulting in an unchanged urban street.

The same issue repeats with AVs. AVs are marketed to the public as objects that will lead to a car-less future through a shared-mobility system. But in terms of research and development, the AV is a personally owned/used software installed on the existing hardware of the private car projecting billions of dollars in gains for the first company to commercialize the technology and market it as a large-scale transit system for sale. Still, companies promote the technology to the public as a shared autonomous future, while the technological development is focused on the single occupancy privately-owned vehicle model. Urban context is unexpected, diverse, and vast. AV systems need to be able to analyze real-time variables, such as several pedestrians crossing a road from different directions and knowing whether to stop or continue driving. Extreme weather (rain, snow) presents another barrier and making the relationship between the built environment and the people using it even more complex for the AV system to comprehend and act accordingly. All of these limitations are added faults to the fact that AVs are cars, which result in a collection of adverse effect on the built form and environment (air, noise, and spatial pollution).

Micromobility, as objects or as a system of shared objects, gets a similar treatment to how EVs are used and conceptualized: it is always assumed to be part of the future of the urban street yet not always designed for use on it. Few visions embrace fully the idea of micromobility as the future of the urban street, and when they do, it is often muddled by over reliance on technology or by falling short of breaking away from an automobile vision. The same is often true for pedestrianization (walkability). Almost taken for granted, it is an element that is always the supporting character but rarely the focus.

In the United States, the most sustainable urban street development comes in the form of urban interventions that are tested in events, which makes these temporary interventions offer the least automobile-dominated vision for the urban street, while visions drawn through the lens of service and objects perpetuate the automobile system under the guise of being not-a-car. In the transition field, niches have been called "weapons."[226] They are the mechanism of regime resistances with a David and Goliath quality.[227] What Geels stipulates requires the study of how to weaken "Goliath" in order to enhance the chances of green "David's."[228] This study adds to the growing literature on niches (sustainable

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[226] James C. Scott, *Weapons of the Weak: Everyday Forms of Peasant Resistance*(New Haven: Yale University Press), 1985.
[227] David J. Hess, "The Politics of Niche-Regime Conflicts: Distributed Solar Energy in the United States:" *Environmental Innovation and Societal Transitions* 19 (2016): 43.
[228] Frank W. Geels, "Regime Resistance Against Low-Carbon Transitions: Introducing Politics and Power into the Multi-Level Perspective," *Theory, Culture & Society* 31, no 5 (2014): 37

mobility) been co-opted by the dominate regime (automobile system). This study re-affirms the conclusion of a growing body of literature pointing to the regime resistance of the automobile system in the United States.[229]

[229] Tim Schwanen, "Rethinking Resilience as Capacity to Endure: Automobility and the City," *City* 20, no. 1 (January 2, 2016): 152-153.

CHAPTER 6

CONCLUSION

This dissertation has been concerned with the future of the American urban street. I focused my study on visions of the future produced between 2017 and 2021, drawing on from future studies, architectural design practice, and urban planning ,identify scenarios, and alternative narratives, that speculated on the future of the street. To develop my research design, I took an auto(mobility) perspective, using what the late sociologist John Urry defined as the system of automobility to determine the physical manifestation of the system and its social influences on the urban street. The notion of the automobility system stipulates a systems perspective[1] where interlocking features of the system reinforce and correct each other.[2] It also specifies a mobility preceptive. I also draw on mobility transitions research, in which mobility is conceptualized as an individual freedom and a collective good.[3]

Finally, I adopted utopia, as a method, which sustainability becomes a tool to achieve human flourishing, the ability to exercise one's potential by having access to basic resources.[4] Utopia is often understood as a place, or an attempt to represent a place that forecasts a distinct future.[5] Using utopia as an analytical method, I look for utopian clues

[1] John Urry, The 'System' of Automobility, Theory, Culture, and Society, 21(4), 2004.
[2] Böhm, Steffen, Campbell Jones, Chris Land, and Mat Paterson, *Against Automobility* (Blackwell Publishing/Sociological Review, 2006), 5.
[3] Anna Nikolaeva, et al., "Commoning Mobility: Toward a New Politics of Mobility Transitions," *Transactions of the Institute of British Geographers* 44, no. 2 (2019): 348-349.
[4] Erik Olin Wright, *Envisioning Real Utopias* (Verso, 2010), 13.
[5] Fredric Jameson, "Utopia as Method" in *Utopia/Dystopia: Conditions of Historical Possibility*, eds. Michael D. Gordin, Helen Tilley, and Gyan Parkash (Princeton: Princeton University Press, 2010), 21-22.

and traces in the landscape of reality, or in this dissertation case, in visions of the future of the urban street.[6] In a world facing a climate crisis, I argue that a utopian place can be measured based on its sustainable features, or lack thereof (Section 1.2).

Beyond researching visions of the future of American urban streets, I also set out to identify its current conditions (form and use). In Chapter 2, I discussed the role of the street as a place of social circulation and an expression of power. I showed how in urban streets are dominated by roads through design policies United States. The street is a collection of networked infrastructure in the service of different users and systems. To enable a carful analysis of the urban street in the United States I documented the spatial distribution of programs on the street's infrastructure systems as part of my review (Figure 2.1).

The American urban street is often a stroad (street + road) dominated by a multi-lane vehicle thruway. The system of automobility (discussed in Chapter 1) has leaked into the very rules and standards guiding the development of streets. Streets in the United States have incomplete infrastructure for pedestrians and micromobility users if they have it at all. The *Manual on Uniform Traffic Control Devices* (*MUTCD*), one of the federal guidebooks dictating street-design rules, prioritizes car-traffic to an extreme degree, perpetuating the system of automobility (Chapter 2). The decades-long focus on car infrastructure has culminated in an automobile culture that does not consider the urban street as a public space, but rather as a thruway for vehicular circulation. This in turn has supported the rise of multiple crises manifesting on the urban street including a consistent

[6] Fredric Jameson, "Utopia as Method," 26.

increase in injuries and deaths of nonmotorized users.[7] Cyclists and pedestrians occupying the urban street are also adversely exposed to air and noise pollution that has furthermore been shown to greatly contribute to the climate crisis.[8]

In Chapter 3, I described the current conditions on the American urban street by isolating four components. First, I highlight how actors are taking advantage of this moment of transition by accumulating power on the urban street through technology, service systems, and vehicles (Section 3.1). Second, the chapter describes how technological drivers, electric vehicles (EVs) and autonomous vehicles (AVs) have drawn large amounts of financial investment from private companies and local, state, and federal sources (Section 3.2). Third, I discuss systems of service that have become available on the American urban street in the last decade and specifically focus on micromobility, microtransit, and mobility as a service (MaaS). Micromobility includes companies, shared systems, and a multitude of 2-wheel/1-wheel vehicles including, bicycles and scooters (both manual and electrical) (Subsection 3.3.1). Microtransit also refers to companies, services, and objects (Subsection 3.3.2).

MaaS is a framework for delivering growing multimodality of urban mobility service that has been frequently muddled with the conception of ride-hailing, which has also been confused with ridesharing. In Subsection 3.3.3, I reviewed how transportation-network companies (TNCs) arrived on American urban streets and how they have shifted the narrative around MaaS. Finally, I described four urban interventions that have dominated urban space transitions in the United States in the last two decades:

[7] Elizabeth Petraglia and Kara Macek, "Pedestrian Traffic Fatalities by State: 2021 Preliminary Data," *Governors Highway Safety Association*, May 2022.
[8] Global Alliance on Health and Pollution, *Pollution and Health Metrics: Global Regional, and Country Analysis* (GAHP online: Global Alliance on Health and Pollution, December 2019), 24, 49.

pedestrianization, bicycification, red bus lanes, and curb management (Section 3.4). Pedestrianization is the act of making a place fit for the use of people on foot rather than inside cars. First, pedestrianization is often used in reference to projects that have gradually transitioned away from an automobile space to walking space. Second, I use the term bicycification in the same manner and specifically to describe the process of transforming a space fit for the use of cyclists (and other micromobility users). Similar to pedestrianization, bicycification is intended to include both policies and pragmatic changes necessary for a complete and safe network. Third, the red bus lane is the American version of the bus-rapid systems introduced in numerous other countries. Alongside the introduction of the bicycle system, it represents two of the recent interventions focused on the curb of the urban street. Finally, in Subsection 3.4.4, I discuss other physical interventions relevant to the curb including parklets and sidewalk drones.

It is my conclusion that the contemporary American urban street remains a space dominated by the rules of the automobile, even as planners, policy makers try to provide other users with the same privileges. This has been a complicated experiment, one marked by rising deaths and injuries of people walking and riding micromobility vehicles and intensified by the impact continued reliance on the automobile in the face of the climate crisis. Because the crisis necessitates a transition away from the private car to achieve sustainable development goals. I use this as an evaluation criterion, evident in organization of the dissertation's methodology discussed in Chapter 4.

This is a qualitative study concerned with scenarios of the future of the American urban street. Scenario analysis includes a process to uncover the embodied perspectives of a creator's intentions.[9] I use a broad definition of scenarios based on three theoretical frameworks. First, I rely on Tim Creswell's description a constellation of mobility, including physical movement, meanings, and lived experience. Second, my conception considers Simon Marvin and Steven Graham's conceptualization of urban systems as networked infrastructure made of objects and actors. Consequently, throughout the dissertation, a scenario can be a rule, an occurrence, an item, a pilot, or an image. Finally, I deploy the multi-level perspective (MLP). Using its construction of a sociotechnical system perspective, and levels, to analyze the existing conditions of the urban street, and the proposed streets in alternative mobility scenarios.

I began with colleting scenarios and documenting who was involved in their creation, including who financed the project and what kind of design was proposed. I focused on three parts in each scenario: technology, systemic change, and form. Finding commonalities among 233 alternative mobilities that I produced from the period 2017–2020, I focused on common themes which I organized into five categories: 1) urban interventions that include visions of urban streets and cities, paper-based formulations, and constructed projects, 2) events like competitions and trade shows, 3) organizations from the automobile industry, design labs, and advocacy organizations, 4) services including AV shuttle pilots, bicycle-sharing initiatives, and private programs, 5) technologies comprising both hardware and software (see Table 4.1). Further analysis of these categories showed that scenarios of the future of the American urban street can be classified as four types—urban interventions, events, services, and objects (see Section 4.2). I selected twelve scenarios that represented these four conditions to address the different themes. In

[9] Gilberto Gallopin, Al Hammond, Paul Raskin, and Rob Swart, *Branch Points: Global Scenarios and Human Choice* (Stockholm Environment Institute, 1997), 11.

Figure 5.1, I organized the selected scenarios on a spectrum of alternative mobilities types to better articulate the relationship of the four types of alternative mobilities, types that are distinct but mingle into one another on the urban street.

Next, I conducted a narrative and visual analysis of each selected scenario, focusing on the role of sustainability and the assumed level of sustainable development in the vision. I relied on Jan Gehl's work on quality spatial conditions through three lenses: a lens of safety, a lens of comfort, and a lens of delight (Table 4.3) which I overlay with my own previous work involving the criteria for determining the livability of urban streets (Table 4.4). Together, these tables provide a rubric to measure the experience of pedestrians, micromobility users, and public transit passengers against each scenario (Table 4.5). Overall, I found that the sustainable development transition of urban streets in the United States is occurring at such a slow rate that it may as well be happening backward. Visions of the future of the American urban street are mostly pedestrian dystopias, or, as they are referred to by car manufacturers and technology companies, technological utopias. While these technological utopias are presented as solutions to urban problems—from traffic, health, and the climate crisis—each vision maintains the existing conditions of the street with minimal changes geared toward creating a false image of sustainable mobility.

The future of the American urban street has leaned away from sustainable mobility (post-automobility) solutions toward an automobile-dominated narrative. As I discussed throughout Chapter 5, the dominant features of visions for a supposedly sustainable urban street are automobiles (EV and AV). The street is continuously represented as accommodating all users equally with a notable refusal to acknowledge that a sustainable future will require changes in habits. As discussed in Chapter 4, one of the measures of sustainable travel has to do with the quality of the journey, not its speed. In the visions studied in this dissertation, vehicular speed, unlimited access, and the right to the urban street, for the most part all remain largely unchanged.

Since 2008, some researchers began to identify evidence of a peak-car phenomenon in the United States and Europe.[10] There seemed to be a trend that more people were deciding not get driver licenses.[11] Car ownership was on a downward trend and cities were investing in bicycle-infrastructure systems and celebrating car-free days.[12] By 2012, bicycle infrastructure was gaining momentum followed by the introduction of micromobility (scooters) to the toolkit of non-automobile vehicles available for urban travel. This study adds to the literature on the ongoing transition of American urban streets, providing, first, a snapshot of the niche actors and their relationship to the automobile regime in the United States between 2017 to 2020, and second, an example of how the automobile regime has successfully absorbed the sustainable mobility discourse. Consistent with key research on sustainability transitions, existing regime actors have managed to "capture" transformational processes.[13]

In other words, the automobile system has injected itself into the very fabric of sustainable mobility development in the United States. That is cause for grave concern, especially as injuries and deaths of pedestrians and cyclists continue to rise and climate-related events increase in frequency. Shaping the urban street presents a tremendous

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[10] Esther Zipori, and Maurie J. Cohen. "Anticipating Post-Automobility: Design Policies for Fostering Urban Mobility Transitions," *International Journal of Urban Sustainable Development* 7, no. 2 (July 2015): 147.

[11]Alexa Delbosc and Graham Currie, "Causes of Youth Licensing Decline: A Synthesis of Evidence." *Transport Reviews* 33, no 3 (2013): 273.

[12] Phil Goodwin and Kurt Van Dender, "'Peak Car'—Themes and Issues," *Transport Reviews* 33, no 3 (2013): 243-244.

[13] Bonno Pel, "Trojan Horses in Transitions: A Dialectical Perspective on Innovation 'Capture,'" *Journal of Environmental Policy & Planning* 18 no. 5 (2016): 273-274.

opportunity for meaningful change. From the day-to-day life of individuals and urban infrastructure as a whole. We have the opportunity to initiate a fundamental shift from urban street as thruway (automobility system) to urban street as public space (post-automobility)—and this is necessary to achieve sustainable lifestyles. The extent of the role of the car in American society must be fully acknowledged for the system of automobility to be truly disassembled.

Future researchers interested in the future of the urban street and related issues may want to focus on the cultural and individual relationships that exist between people and the automobile system. Specifically, there are opportunities to expand understanding of the actors in the technology and design industries who create future narratives as well as the training that they receive during formative stages of their careers (engineering, architectural and urban planning education). Further research on the system of automobility, its expression in formal conditions, may offer ways to break away from the traditions of street design around the personal vehicle. It is worth noting that in cities around the world much progress has been made toward reforming urban streets under livability standards (safer, comfortable, and delightful streets) including the Barcelona Superblocks program[14] and the Oslo Car-Free Livability Programme.[15] There may be future beyond the car in the United States, but it requires political recognition of the automobile system as unsustainable and in need of a drastic transformation.

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[14] "Barcelona Superblock," *Ajuntament de Barcelona,* accessed December 8, 2022, https://www.barcelona.cat/pla-superilla-barcelona/en.

[15] "The Car-Free Livability Programme 2019," *Oslo Kommune,* accessed December 8, 2022, shorturl.at/bzJV9.

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