ABSTRACT

Title of Thesis:	**EMBRACING DISRUPTION:** URBAN STREETS AND INFRASTRUCTURE OF THE 21ST CENTURY
	Gijoon Paris Sim, Master of Architecture, Master of Real Estate Development, 2020
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Mass production of affordable automobiles in the early 20th century have completely reshaped American landscape. Since then, every part of American cities and neighborhoods have been designed to move cars rather than people. On the brink of a broad adoption of autonomous vehicle (AV) technology, cities have an historic opportunity to reorient urban spaces and redesign its streets. Concurrent with the evolving public health challenges and shifting in urban demographics and consumer habits, how are these changes of the 21st century impact the design of urban streets and public realm of the future? This thesis aims to explore and propose an urban incubator dedicated to the advancements of all mobility and reimagine how urban living of the future look like as people reclaim the urban streets.

EMBRACING DISRUPTION:
URBAN STREETS AND INFRASTRUCTURE OF THE 21ST CENTURY

by

Gijoon Paris Sim

Thesis submitted to the Faculty of the Graduate School of the
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Advisory Committee:
Professor Matthew Bell FAIA, Chair
Professor Brian Kelly, AIA
Maria Day-Marshall, Clinical Associate Professor
Tanya Bansal, Clinical Assistant Professor

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List of Abbreviations

AIA	American Institute of Architects
AV	Autonomous Vehicle
CDC	Center for Disease Control and Prevention
CSPC	Center for the Study of the Presidency and Congress
EPA	Environmental Protection Agency
EV	Electric Vehicle
NHTSA	National Highway Traffic Safety Administration
NCSL	National Conference for State Legislatures
NACTO	National Association of City Transportation Officials
SAE	Society of Automotive Engineers
TNC	Transportation Networking Company
UAV	Unmanned Aerial Vehicle
WHO	World Health Organization

Chapter 1: Introduction

American cities and neighborhoods have been designed to move cars rather than people. Our built environments have developed over the last century to ensure our cars move faster, cheaper and safer, fundamentally framing how we design cities, communities and buildings. The invention of automobiles in the early 20th century and the introduction of "the universal car," made personal vehicles an ubiquitous piece of technology available to all Americans. The automotive industry rapidly grew into one of the largest sectors in the economy by exponentially increasing the growth of private vehicle production.[1] With the power of growing industry, the leaders soon heavily lobbied politicians to federally fund highway infrastructure projects that could accommodate the explosive number of new vehicles on roads.

Development of highways and construction of paved roadways then connected major cities and made easier to travel greater distances. As the pioneers of interstate-highway planning, the automotive industry leaders took great charge in the brand-new transportation network without a single urban planner at the time. While the profession was at its infancy, the "'planners' inability to foresee the impacts of private cars at the beginning of the twentieth century contributed to the proliferation of an engineering-dominated vision of urban highways that focused almost entirely

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[1] John Alfred Heithmann, *The Automobile and American Life* (Jefferson:Mcfarland & Co., 2009), 18-19.

on vehicle throughput.”[2] The expensive highway infrastructure network stretched thousands of miles across the continent linking cities but physically separating communities within.

Figure 1.1: *Life on Mulberry Street, NYC c.1900 before the introduction of automobiles. (Source: Detroit Publishing CO./Wikipedia Commons, 2008)*

While personal cars gave great freedom to individuals and stimulated national economic development, they also had immeasurable consequences. Suburban sprawl became the norm in the real estate and urban planning practices throughout the 20th century as the privileged fled city centers to open suburbs. Suburban neighborhoods required large tracts of untouched lands and costly infrastructure, while separating us

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[2] Erick Guerra, “Planning for Cars That Drive Themselves: Metropolitan Planning Organizations, Regional Transportation Plans, and Autonomous Vehicles,” *Journal of Planning Education and Research* 36, no.2 (November 2015): 210, https://doi.org/10.1177/0739456X15613591.

further from each other. With recent shifts in migration towards cities with the new generation, the intense urbanization over the last few decades have proven private vehicles in cities to be inefficient, dangerous and environmentally harmful. Today, our dependency on our cars continues to directly influence unsustainable urban planning and irresponsible policies.

Emergence of autonomous technology, micro-mobility and smart data are forcing us to rethink about how our cities operate and transport goods and people to achieve greater mobility. Autonomous vehicle (AV) technology is one of the major developments that the World Economic Forum leaders are calling the technology as a part of "the fourth industrial revolution."[3] The futuristic fantasy of driverless cars from the 1900s are becoming tomorrow's reality. Most large automobile manufacturers are already heavily investing in AV technology and municipalities across America are studying the impacts of adaptation. So, when will autonomous vehicle technology take over streets and cities? While the exact year cannot be ascertained, *figure 1.1* illustrates how fast adoption of new technologies in the 21st century has exponentially increased. The trend is likely to continue, especially among the younger generations, if not expedite, for the rise of driverless vehicles in urban street and our daily routines.

[3] Klaus Schwab, "The Fourth Industrial Revolution: what it means, how to respond," *World Economic Forum,* January 14, 2016, https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/.

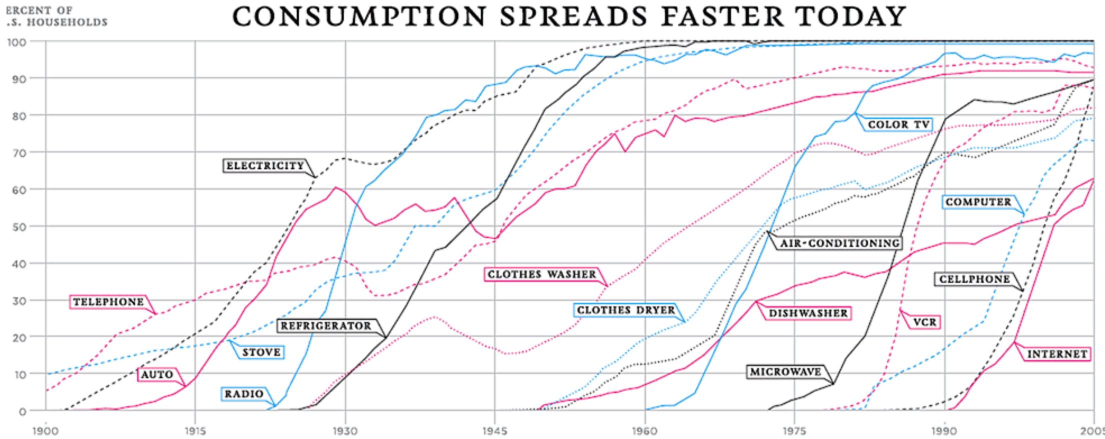

Figure 1.2: *Rate of consumer adoption of technology in the 20th century America. (Source: Nicholas Felton, New York Times, 2014)*

While the trend is to speculate on the technology as an engineering revolution, we must shift the conversation of this massive change in the transportation technology as an urban planning and community development issues. How do architects, planners, developers, and politicians inevitability adapt the AV technology and the new age of mobility and prepare our cities towards a people-centered future and avoid another engineering-dominant society of the past? We must build our vision, learn from the past and prioritize on pedestrian walking, biking, amplify transit, and orient people at the center of urban life and street design, while taking the advantages of technology to advance our mobility, reduce environmental impact, increase safety, and strive for social equity.[4] Further, evolving public health concerns in the light of the novel COVID-19 as well as shifting in urban demographics and escalating e-commerce activities, will be investigated as they will impact how the future of urban street and public realm will be designed.

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[4] National Association of City Transportation Officials, "Blueprint for Autonomous Urbanism: Second Edition." (September 2019), 6.

This thesis aims to explore paradigms of the urban living as it is impacted by those changes of the 21^{st} century. The proposed urban incubator will speculate on the community with minimum private vehicles and link AVs and micro-mobility into an existing transportation network to complete a *continuous mobility ecosystem*. A system of robust green infrastructure strategies will be implemented on streets to promote sustainability, healthier behavior and enhance public health. Further, at an architectural scale, impacts of a new multi-level mobility system, aerial, ground and underground mobility, on building system will be explored. Thus, the subject site will be a case study for the design of the future of urban living that accommodates advancement of all mobility as well as explore the impact of the changes on incremental changes to existing infrastructure.

Chapter 2: American Urbanism in 20th Century

"Our unity as a nation is sustained by free communication of thought and by easy transportation of people and goods."

– Dwight D. Eisenhower[5]

Introduction of Automobiles

The first invention of automobiles in 1885 by Karl Benz in his garage and the inception of mass production of affordable vehicles at the turn of the century drastically changed America's urban streetscape with petroleum fueled auto machines weaving through pedestrians. By 1913, Henry Ford's Ford Motor Company built a world's first moving assembly line factory and helped forge a manufacturing revolution.[6] The introduction of Model T as the "universal car" supplied millions of cars on the roads in the next few years. The horse carriage industry soon collapsed as people saw the new invention as the means of faster transportation, revolutionizing how people and goods travel. Private cars became a symbol of independence and personal freedom and, in some areas, as a status of class. While the assembly lines continued to supply cars on the roads, America needed to improve its old roadways designed for horse carriages. Inadequate infrastructure at the time could not keep up with the advancement of automobiles.[7]

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[5] Richard F. Weingroff, "Highway History," *U.S. Department of Transportation Federal Highway Administration*, June 27, 2017, https://www.fhwa.dot.gov/infrastructure/originalintent.cfm.
[6] Renee Montagne, "Model T: 'Universal Car' Sparked Gasoline Demand," *npr*, July7, 2008, https://www.npr.org/templates/story/story.php?storyId=92216092.
[7] Norman Bel Geddes, *Magic Motorways* (New York: Random House, 1940), 12-13.

When the motor cars simply inherited the winding roads of the carriage, undeveloped traffic regulations and signs caused massive traffic congestions and collisions. In search for the better auto-driven future, General Motors, in concert with Architect Albert Kahn and industrial designer Norman Bel Geddes, presented Futurama at the 1939 New York World's Fair, a "visual dramatization of a solution to the complex tangle of American roadways."[8]

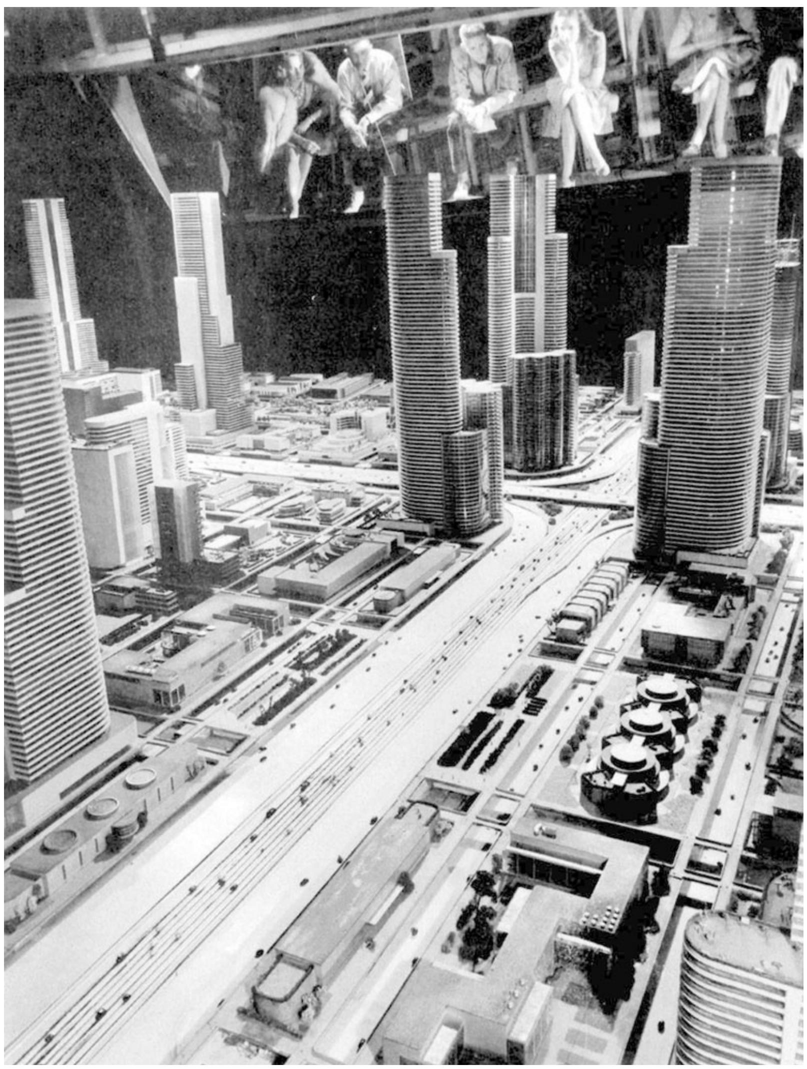

Figure 2.1: *New York World's Fair, Futurama: Highways & Horizons, 1939. (Source: General Motors)*

[8] Bel Geddes, *Magic Motorways*, 4.

The exhibit showcased to the world the American's new future built on safe, comfortable, speedy, and economical highways.

Highway Infrastructure

Futurama of the General Motors Highways and Horizons Exhibit featured a vision of new highways and fantasized about a utopian version of America on wheels. Though the highly imaginative model was popular among daydreamers, the plan was just as appealing to practical engineers.[9] President Dwight D. Eisenhower was also a great advocate for expressway construction and envisioned Futurama's plan as a great model and economic opportunity during the recession. The Federal-Aid Highway Act of 1956 was passed under the Eisenhower administration to increase interstate mobility and provide jobs for people out of work. The superhighways required large amounts of land, sometime requiring a direct route through existing neighborhoods. When the federal and state government struggling to racially segregate communities, they began routing highways directly through African American dominate neighbors to enforce the "urban renewal".[10] The federal program was used as a device to cleanse the slums in cities as targeted demolitions furnished pathways for the automobiles while forcing poor families with limited housing options. These segregated communities were left with deteriorating infrastructure and continued to experienced lack of investments for improvements, including public transportation. This dark side

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[9] Bel Geddes, *Magical Motorways*, 6.
[10] Richard Rothstein, *The Color of Law: A Forgotten History of How Our Government Segregated America*, (New York: Liveright Publishing Corporation, 2018), 127-31.

of history touched beyond the transportation revolution and established housing crisis in the United States. The impacts of automobile advancements and its policies are paramount to understanding the design of the upcoming changes in our cities to ensure the problems are not aggregated.

Figure 2.2: *I-35E in Oak Cliff, TX bisecting neighborhoods in 1961. (Source: Dallasnews Administrator/The Dallas Morning News, 2016)*

<u>*Birth of Suburbia*</u>

As automobiles developed and enabled us to travel further, our desire to move outside of crowded and chaotic city centers grew. Increased road connections and the progressive development of automobile technology and policies allowed for longer distance commutes possible and gave birth to American suburban life. Unrestricted growth of suburban sprawl become a norm to real estate industry practice that swallowed acres of untouched land outside of cities. Real estate developers and municipalities quickly enacted zoning ordinances to produce single family homes out in suburbs. Communities and neighborhoods then dedicated tremendous amounts of their surfaces to paved asphalt roads for vehicle as it was the only feasible method of transportation. Suburban living was fully realized on the foundation of individual mobility relying on individual cars.

Figure 2.3: *Aerial View of the vast spread of Levittown, New York developments in 1955. (Source: Hulton Archive/Getty Images)*

Our Dependency on Automobiles

Automobile ownership in America constantly grew since its inception in early 1900s, except for a short period of decline during economic recessions. According to 2018 Census figure, about 91.5 percent of households in America owned at least one vehicle[11] and 80 percent of them drove alone to work.[12] Even with the growing trend and options in shared mobility in cities, automobile industry continues to show strong contribution to the national economy.[13]

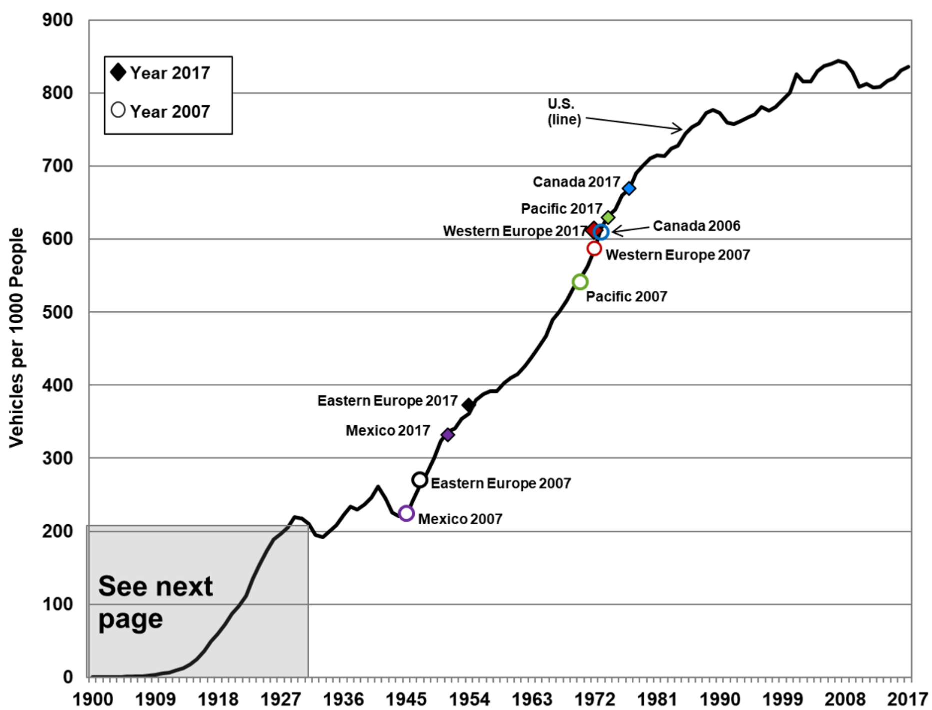

Figure 2.4: *Vehicles per Thousand People: U.S. (Source: Oak Ridge National Laboratory for the US Department of Energy, 2020)*

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[11] "Selected Housing Characteristics," U.S. Census Bureau 2018, accessed May 20, 2020, https://data.census.gov/cedsci/table?q=DP04%3A%20SELECTED%20HOUSING%20CHARACTERISTICS&hidePreview=true&tid=ACSDP1Y2018.DP04.

[12] "Means of Transportation to Work by Travel Time to Work," U.S. Census Bureau 2018, accessed May 20, 2020, https://data.census.gov/cedsci/table?q=Means%20of%20Transportation%20to%20Work%20by%20Travel%20Time%20to%20Work&tid=ACSST1Y2018.S0802&t=Transportation&vintage=2018.

[13] "Automotive Spotlight: The Automotive Industry in the United States." SelectUSA, accessed March 2020, https://www.selectusa.gov/automotive-industry-united-states.

As the new generation intensifies urbanization, they are disrupting the century old tradition of automobile industry. Data have shown among the millennials and generation Y that they prefer an urban life closer to their work with more public transit options.[14] Numerous Transportation Network Companies (TNC) such as Uber and Lyft are providing ridesharing services across America while micro-mobility such as electronic scooters and shared bikes are adding additional travel methods for young generation in cities.

Implications

At the beginning of industrialization of automobiles, there was many debates over whether the machine should be fueled by gasoline or electricity. The pioneers struggled to sound practicalities of electricity-powered cars as gas-powered proved to be a superior as refueling was easier and quicker to start.[15] Gasoline prevailed the ignition of the industry. That decision came without the slightest clue on its impact on the global environmental crisis decades later. Sole reliance on gas to move our cars proved to be fatal when the production of foreign oil-rich counties failed to provide the recourse. The 1970s energy crisis enlightened the world how on its dependence on petroleum fueled economy has the potential to crash the world market and demonstrated how fragile the automobile economy could be.

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[14] Erica Interrante, "The Next Generation of Travel: Research, Analysis and Scenario Development" *FHWA Office of Policy Transportation Studies*. November 7, 2014, https://www.fhwa.dot.gov/policy/otps/nextgen_finalreport.cfm.
[15] Renee Montagne, "Model T: 'Universal Car' Sparked Gasoline Demand."

Numerous articles and studies have proven the environmental consequences of petroleum fueled cars over many decades. Transportation alone contributed to more than a quarter of all U.S. greenhouse gas emissions and caused severe air quality issues in metropolitan areas[16]. New generation of environmentally sensitive people sparked a demand of alternative energy as evidence is becoming ever clear on single ownership of cars are detrimental to the environment. Momentum of electric vehicle (EV) technology development as well as hybrid cars are also on the rise as a possible alternative to gasoline cars. Global calls to actions are asking for prohibition of sales of new gasoline and diesel vehicles in the near future in hopes to reach zero emission clean cars in our cities.[17]

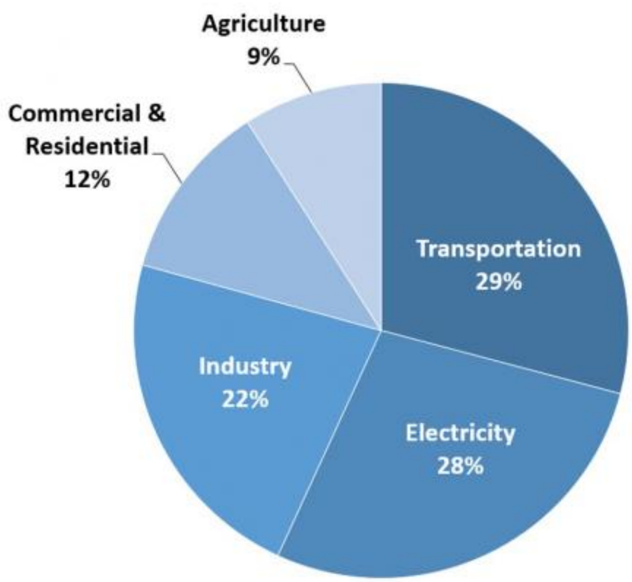

Figure: 2.5: *Total U.S. Greenhouse Gas Emissions by Economic Sectors.*
(Source: EPA, 2017)

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[16] "Progress Cleaning the Air and Improving People's Health," United States Environmental Protection Agency, accessed May 22, 2020, https://www.epa.gov/clean-air-act-overview/progress-cleaning-air-and-improving-peoples-health.
[17] Trevor Russell, "Global actions on hybrid and electric vehicle commitments." *Friends of the Mississippi River*, October 1, 2019, https://fmr.org/legislative-updates/global-action-hybrid-and-electric-vehicle-commitments.

According to the National Highway Traffic Safety Administration (NHTSA) about 94% of the accidents on U.S. roadways are due to human errors with more than 35,000 fatalities in 2015 alone.[18] With the growing concerns of driverless cars from the public, the United States seems to disregard risks associated with a 16-year-old operating the vehicle himself, 21-year-old driving home under the influence of alcohol and 95-year-old persisting to drive with a poor vision. The perception of human errors on fatalities has been completely blinded by American's inseparable relationship with cars. It's clear that our dependencies on private vehicles are rooted in all aspect of cultural, social and political structures.

Automobile technology is continuing to exponentially develop with new features striving for higher efficiently, safety and comfortability of our travel. Yet the progress seemed to focus on how we move our car rather than people. The same invention that enabled us to travel faster is the reason today our cities are suffering from congestions and segregated communities, ultimately slowing our progression for smarter, healthier and happier society.

As the set designer of the Futurama, Norman Bel Geddes, precisely captures our progression of automobile development, "we are satisfied with the mere possession of the automobiles and fail to make use of its full potentialities"[19] that holds to be true till this day.

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[18] Center for the Study of the Presidency and Congress, "The Autonomous Vehicle Revolution: Fostering Innovation With Smart Regulation," (March 2017), 3.
[19] Bel Geddes, *Magic Motorways*, 10-11.

Chapter 3: Changes in the 21st Century Urban Streets

"The world we are now seeing is a vision, an artistic conception, which may undergo many changes as it develops into the great realities of tomorrow."

– New York World's Fair, Futurama: Highway & Horizons.

Introduction

Autonomous technology in transportation presents an enormous opportunity to reform street design and urban living. Streets dominated by single occupancy vehicles could soon be replaced by ride-hailing and ride-sharing AVs that dramatically increase safety and mobility while decreasing private car ownerships in urban environments. Concurrent with the evolving public health issues as well as shifting in urban demographics and retail shopping experiences, the changes in the 21st century allow architects and planners to reidentify urban streets and public realm of the future.

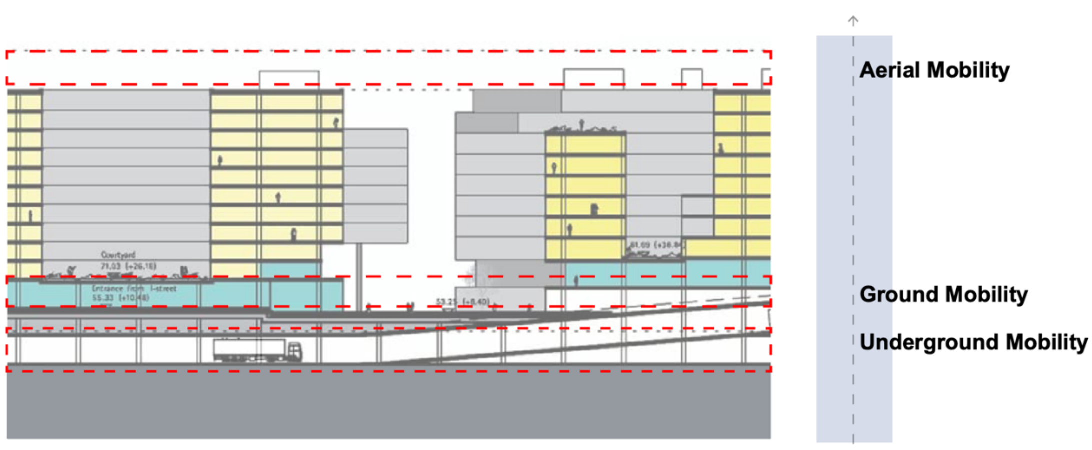

Figure 3.1: *Multi level mobility could be achieved by integrating autonomous technology at underground, street and roof level of a building. (Source: Author)*

Urban mobility at multiple levels will be reshaped as capability of autonomous technology expand beyond ground transportation. On the street level, AVs force us to fundamentally challenge the vehicular right of way as streets no longer require wide impervious roads for single occupancy car, buses and trucks. This will cause profound changes to the urban streetscape by giving back the opportunity to widen the pedestrian's right of way, once overtaken by the vehicular dominance. Streets will soon demand more pickup zones for AV services rather than parking spaces and loading zones. Unmanned Aerial Vehicles (UAV) and drones add another layer of autonomous mobility above grade level. While mainstream adoption of UAVs as a method of transporting people are further away, the technology will soon challenge architects, developers and politicians, how buildings can prepare and adopt to the future of aerial mobility. Finally, buildings no longer need to finance for costly multi-level underground parking structures and reimagine urban freight transportation and waste collection. Building services, wastes and deliveries on the street level can amalgamate underground with a coordinated autonomous technology to dramatically increase efficiencies of the last-mile logistics while reducing unnecessary truck traffics on streets.

Technologies continue to evolve at an unprecedented rate. Autonomous vehicles will become an ubiquitous piece of technology integrated into urban life and they, once again, have the potential to reshape American landscape and built environments of the 21st century. Understanding its technology, multi-level mobility potentials and policies of ownership can guide us to avoid another unforgiving urbanism in the 20th century America and towards more advanced urban mobility, pedestrian oriented, sustainable, resilient, and equitable communities.

Early Concepts of Autonomous Vehicles

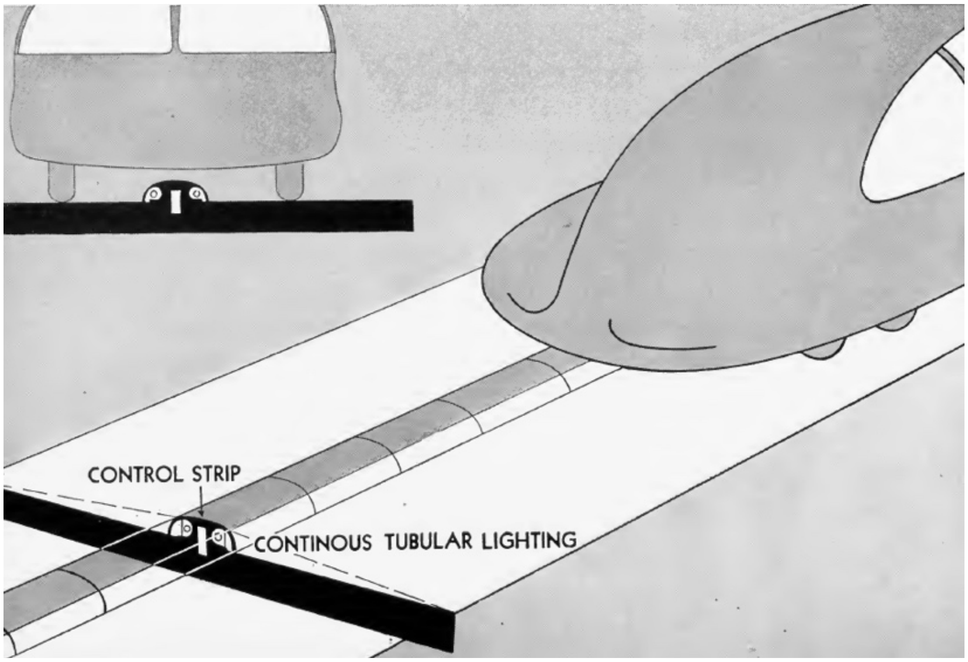

Figure 3.2*: Illustration of continuous uniform road surface illumination from center curb. (Source: Magic Motorways, Bel Geddes)*

The first concept of an automated technology dates back to 1478 when Leonardo Da Vinci conceptualized a self-propelled cart powered by large, coiled springs that has the capability of propelling over 130 feet in the air.[20] While the invention never came to life, engineers and designers continued to vision for an autonomous machine for the next centuries. It wasn't until the Futurama Exhibit in 1939, when Norman Del Geddes showed the concept of the first autonomous

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[20] Marc Weber, "Where To? A History of Autonomous Vehicles," *Computer History Museum*, May 8, 2014, https://computerhistory.org/blog/where-to-a-history-of-autonomous-vehicles/?key=where-to-a-history-of-autonomous-vehicles.

technology applied to automobiles, controlled by electromagnetics for regulating individual vehicle's speed and spacings along uninterrupted stretches of highway.[21] The designer of the exhibit was an early advocate for removing human from operating automobile, stating in 1940 that "human nature itself, unaided, does not make for efficient driving."[22]The smooth gliding automated electrical car at the exhibition catalyzed the fantasies of driverless cars on freeways that were uninterrupted, congestion-free and safe.

In 1956, *Americas Independent Electric Light and Power Companies* placed an ad in LIFE magazine aesthetically depicting a family of four riding comfortably in an autonomous automobile as if they were in a living room.[23] However, the advancement of autonomous technology did not progress amidst optimism as gasoline-fueled car production was proven to be more economically feasible for both the manufacturers and consumers. Thousands of miles of new highway and motorway constructions persuaded Americans to purchase private cars and soon it became an essential item of the daily routines. The idea of driverless cars on roads were largely left in science fictions and never progressed until the turn of 21st century. In just few years, a much-forgotten futuristic fantasy from the last century have become tomorrow's reality.

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[21] Bel Geddes, *Magic Motorway*, 100.
[22] Ibid. 48.
[23] Fabian Kroger, "Automated Driving in Its Social, Historical and Cultural Contexts," in *Autonomous Driving*, ed Markus Maurer, J. Christian Gerdes, Barbara Lenz, and Hermann Winner (Springer, Berlin, Heidelberg, 2016): 51-52, https://doi.org/10.1007/978-3-662-48847-8_3.

Figure 3.3: *Electricity May be the Driver! 1950s promotional advertisement for America's Electric Light and Power Companies depicting a family enjoying a board game while on electric powered autonomous vehicle speeding on an automated freeway. (Source: Paleofuture, 2019)*

<u>*Ground Mobility*</u>

According to the University of Michigan's Center for Sustainable System, a leading institution researching on the technology in partnership with car manufacturers and AV technology companies, AVs use layers of technology to partially or entirely replace the human driver in navigating a vehicle while avoiding road hazards and obeying to traffic regulations.[24] Generally, AVs create an internal map of their surroundings using a wide array of sensors[25]. Built-in software then processes millions of inputs, together with hard-coded traffic rules and algorithms help AVs make decision on their own on steering, acceleration and breaking.

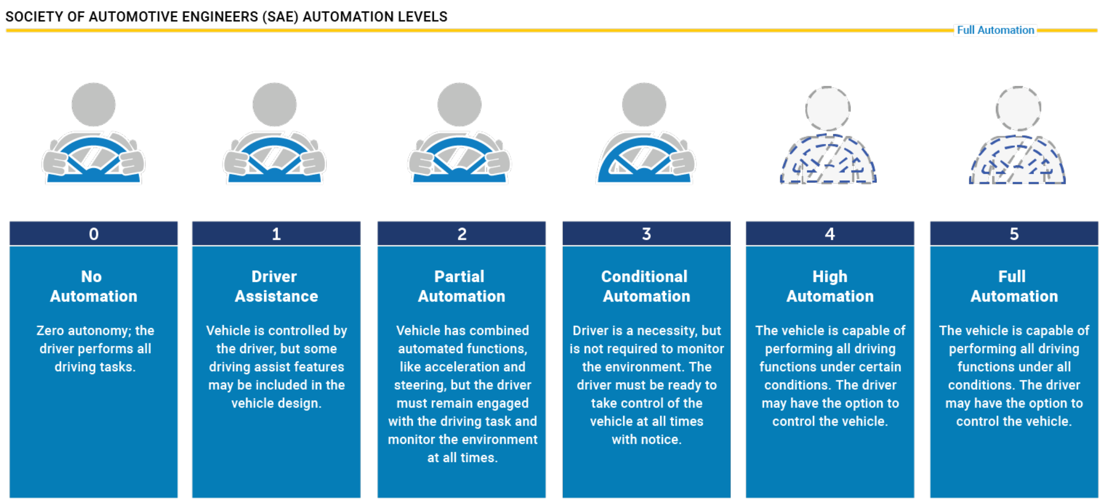

Figure 3.4: *Autonomation Levels. (Source: Society of Automotive Engineers)*

The Society of Automotive Engineers (SAE) has created an automation level chart measuring the progress of AV development which has been adopted by the National Highway Traffic Safety Administration. Level 2 of autonomation has already been integrated into our conventional vehicles. Most major manufacturers already market and sell high-end vehicles with level 2 automation features like cruise control, automated braking, self-parking, lane-departure warning, and rudimentary

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[24] Center for Sustainable Systems, University of Michigan. “Autonomous Vehicles Factsheet,” Pub. No. CSS16-18.

[25] Major sensors integrated into AVs include Global Positioning System (GPS) to locate the vehicle by using satellites information, Light Detection and Raging (LIDAR) to determine the distance of obstacles by using light beams, Dedicated Short-Range Communication (DSRC) system that communicates critical data, and Inertial Navigation Systems (INS) to improve its location accuracy.

sensors detecting close objects.[26] While achieving level 5 of full automation seems far in the future, leaders of AV technology companies such as Waymo, a subsidiary of Alphabet Inc., have already deployed fully self-driving cars (SAE automation level 4) in 2018 on streets of Phoenix, Arizona within ten years of its establishment.[27] Waymo's vehicle arrives at your pick up location without a driver inside and will take you to your destination with few touches on your smartphone application today.

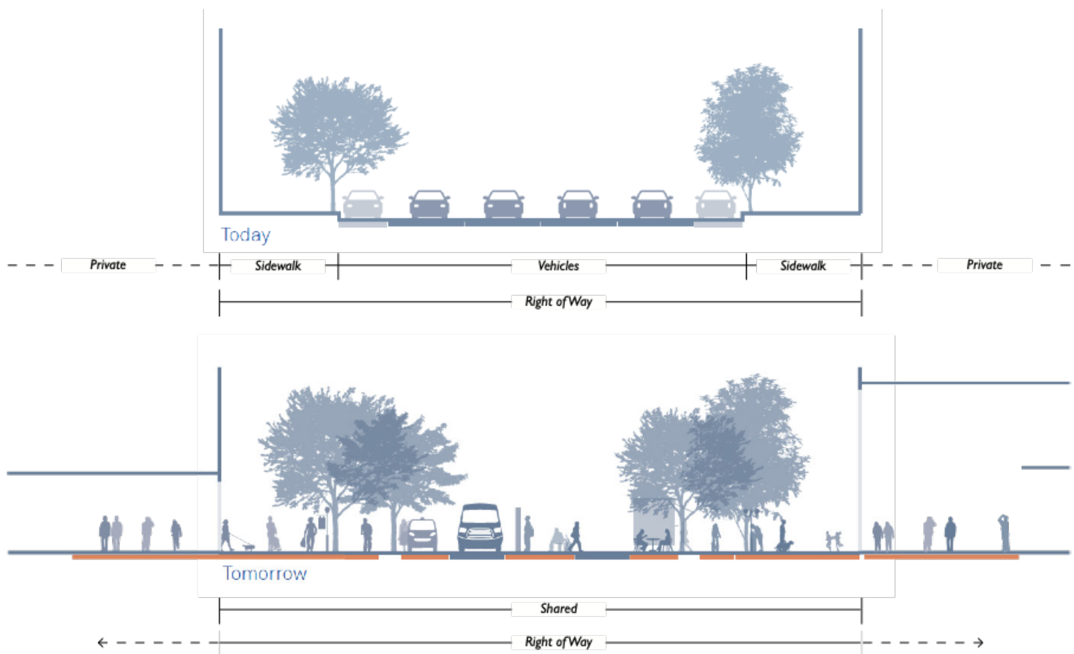

Figure 3.5*: Life on the street - New street design adopting to AV while pedestrian reclaim the majority of street space. (Source: Author)*

The ability for AVs to collect live stream data to map its surroundings and precisely calculate its position and speed allow less spaces for sophisticated maneuvers. It will also allow pedestrians to reclaim street spaces once dominated by private cars. Parallel parking spaces and loading zones will be replaced by

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[26] Erick Guerra, "Planning for Cars That Drive Themselves," 210.
[27] "Journey," Waymo, accessed April 24, 2020, https://waymo.com/journey/.

multifunctional smart curbs[28] and AV pickup zones to accommodate variety of new mobility services. Further, increases in sidewalk widths enhance pedestrian safety and experience, plant the seed for urban green infrastructure, and for ground level retail stores to enjoy from increased in foot traffic. Today's streets dominated by single occupancy vehicles with lack of ground level social and environmental life could transformed into a harmonious coexistence of pedestrians, children, cyclist, AVs, and scooters with more natural features and building programs spilling on the tomorrow's streets.

Ownership and Operation

New autonomous mobility combined with driverless cars may reshape the entire model for car ownership. Individual ownership of conventional automobiles could plummet as private AVs may become readily available and affordable. However, the new ownership and operation of AVs should be carefully discussed and studied as they will have significant impacts on urban landscapes. The mainstream adaptation could worsen the problems caused by automobiles that it promised to change if AVs are priced affordably and encourage solo driving.

If self-driving vehicles are individually owned and operated as a personal commodity, it may exponentially increase the number of vehicles on roads and worsen urban and suburban congestion. It could also cause "sprawl on steroids;" another mass sprawl development even far beyond the suburban areas as two-hour

[28] NACTO, "Blueprint for Autonomous Urbanism," 116.

commute become less onerous if travelers can do other activities within them. Possible scenarios based on private and public ownerships of AVs will be further explored in chapter 5 of this document.

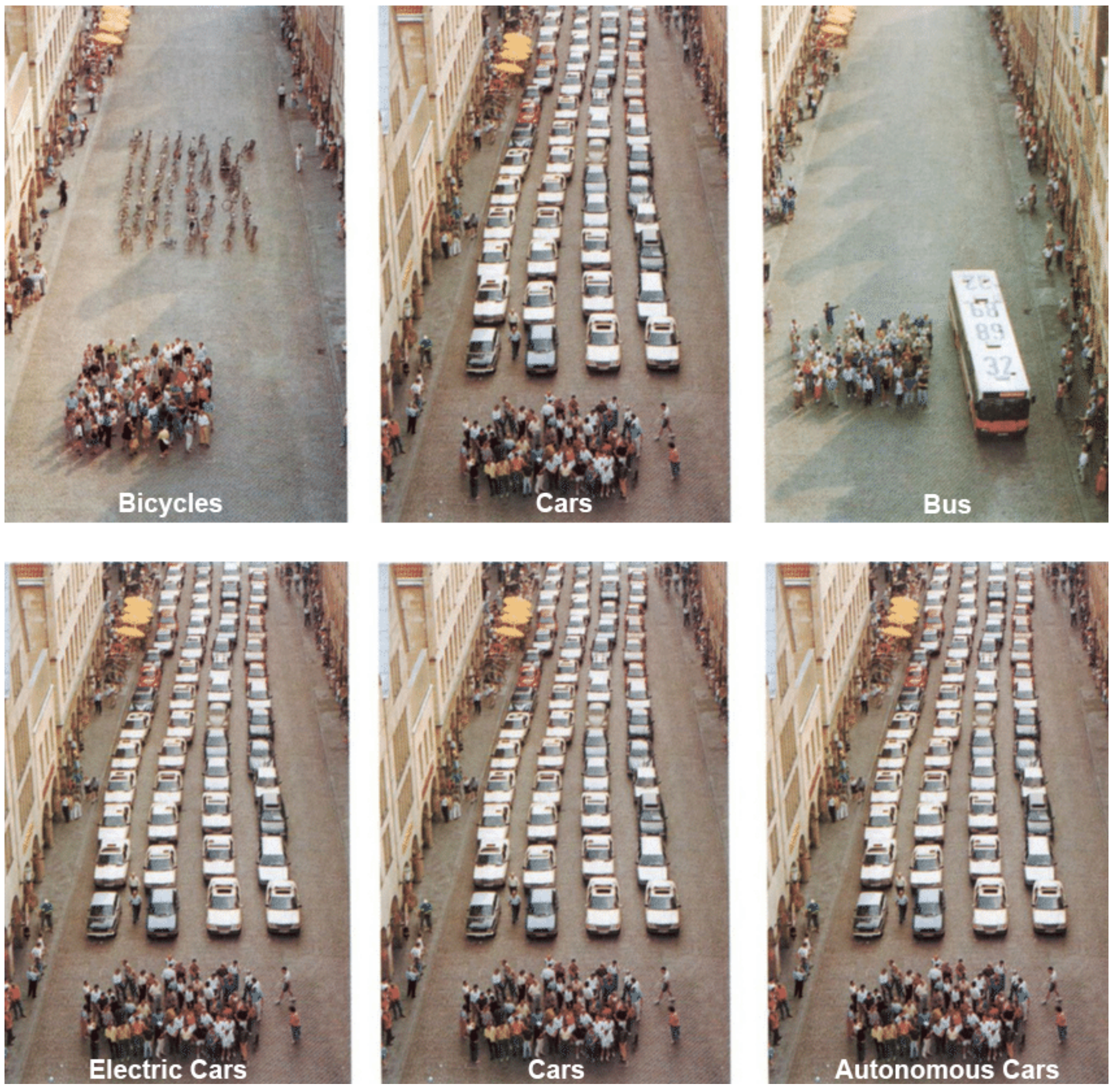

Figure 3.6: *Street spaces required for 60 people. If AVs or EVs are privately owned in cities without any regulations, it would have no effect on urban congestions and mobility or even exacerbate the problems. (Source: Author)*

Aerial Mobility

Advancement of automatous technology also promises the possibility of aerial mobility. Cities can look to the sky as an opportunity to provide a third dimension of urban mobility. Commercial uses of Unmanned Aerial Vehicles, or drones, in recent years have seen a spike in the U.S. as private industries discover the capabilities once reserved exclusively for military operations and developments. Investments and value of UAV applications have surged since 2010 and is projected to reach annual impact of $31 billion to $46 billion on the country's GDP by 2026[29]. E-commerce giant Amazon Inc. have launched beta tests in rural areas of Cambridge, England in 2016 and Transportation Networking Companies such as Uber have presented its progressive developments on autonomous air taxi services through compelling visualizations of new 'Skyport Mobility Hub' concepts in 2019.

The rapid increase in private companies' drone application activities question how urban communities and buildings should transform to accept new aerial mobility. While mainstream adoption of UAVs for transporting people and goods are farther away, they will play an increasingly critical mobility role in the built environments and urban mobility. Drone landing facilities at the top of buildings will add another layer to the autonomous mobility ecosystem. It will demand additional space planning and reorganizing of programs while rethinking vertical relationships and connectivity of buildings.

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[29] Pamela Cohn, Alastair Green, Meredith Langstaff, and Melanie Roller, "Commercial drones are here: The future of unmanned aerial systems," *McKinsey & Company*, December 2017, https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/commercial-drones-are-here-the-future-of-unmanned-aerial-systems.

Underground Mobility

The potentials of autonomous mobility also impact urban freight and building services. The last mile delivery and waste management can be redesigned to unify the complex network of segmented travels. The last mile logistics experienced a dramatic increase in intensity coincident with urbanization and population growth, changes in the new generation of consumer behavior, and continuous growth of e-commerce developments.[30] The fragmented last mile business-to-customer delivery service is often described as one of the most expensive parts of the supply chain, exacerbating urban congestions, greenhouse emissions, air pollution, and noise.[31] Similarly, collection of waste is one of the most important and costly aspects of waste management due to labor intensity of the work and fleet of trucks collecting from scattered destinations throughout neighborhoods.[32] Consolidating waste produced from the neighborhood into a single pickup destination will dramatically increase municipality's waste management efficiencies and reduce the complex network of trucks routes in communities for house-to-house collection.

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[30] John Olsson, Daniel Hellstrom and Henrik Palsson, "Framework of last mile logistics research: Systematic Review of the Literature," *Sustainability* 11, no. 24, (December 2019): 1, https://doi.org/10.3390/su11247131

[31] Ibid.

[32] Jeroen Belien, Liesje De Boeck and Jonas Van Ackere, "Municipal Solid Waste Collection and Management Problems: A Literature Review*,"* *Transportation Science* 48, no.1 (November 2012): 78, https://doi.org/10.1287/trsc.1120.0448.

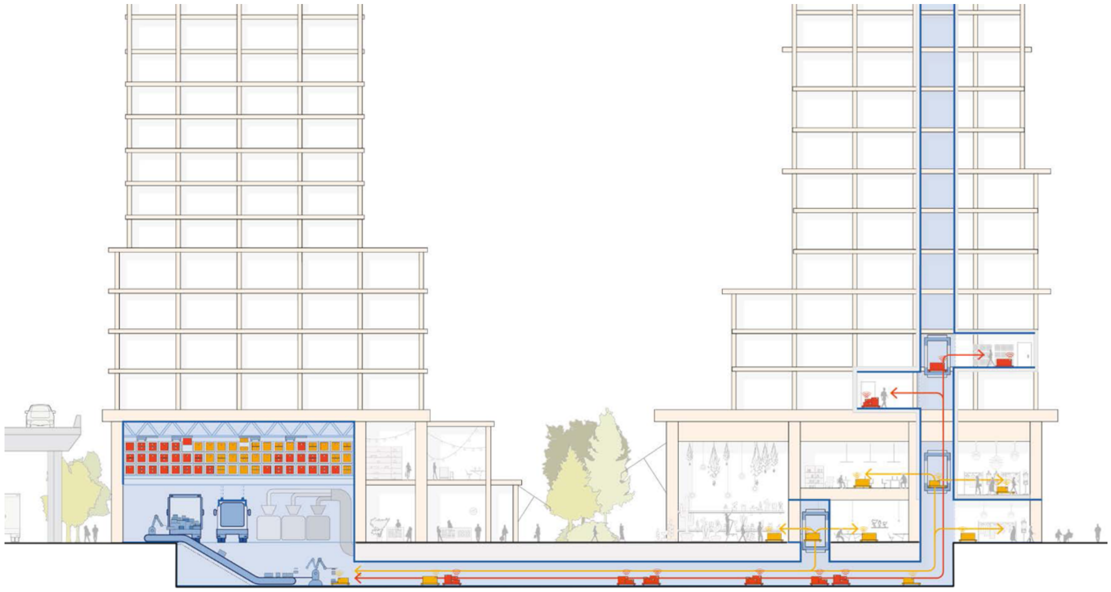

Figure 3.7: *Logistics Hub and underground connection concept. (Source: Sidewalk Labs, Toronto Tomorrow, 2019)*

Unification of segmented travels for both inbound and outbound of goods and waste can significantly reduce the necessary travels of delivery trucks and waste collections. A new 'Logistic Hub' in communities can provide a single destination for a community's imports and exports while reducing individual trucks entering urban streets.[33] Advancement of mobility will eliminate the need for multi-level undergtound parking structures and give opportunity to reimagine underground mobility and infrastructure between buildings. The logistic hub can operate a coordinated and connected underground autonomous logistics systems that could distribute and collect as a single destination for all individual dwellings and businesses.

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[33] Sidewalk Toronto, "Master Innovation and Development Plan: The Urban Innovations," 68-73, https://www.sidewalktoronto.ca/documents/.

E-commerce

The impressive growth of e-commerce (electronic commerce) activities around the world have placed significant challenges to the conventional brick and mortar stores in downtown areas. Since 2002, the U.S. economy has seen an intense increase of over 340 percent in virtual shopping[34]. As the world transitions from physicality to virtuality, a large reduction in the number of outings are being made for in-store purchases and force retail spaces to reshape or change entirely.[35] This effect of a more streamlined supply chain, often ending in residential or other convenient locations rather than concentrated commercial zones[36]. The decentralization of retail cores negatively impacts adjacent properties' value as their power to attract and retain physical shopping weakens.

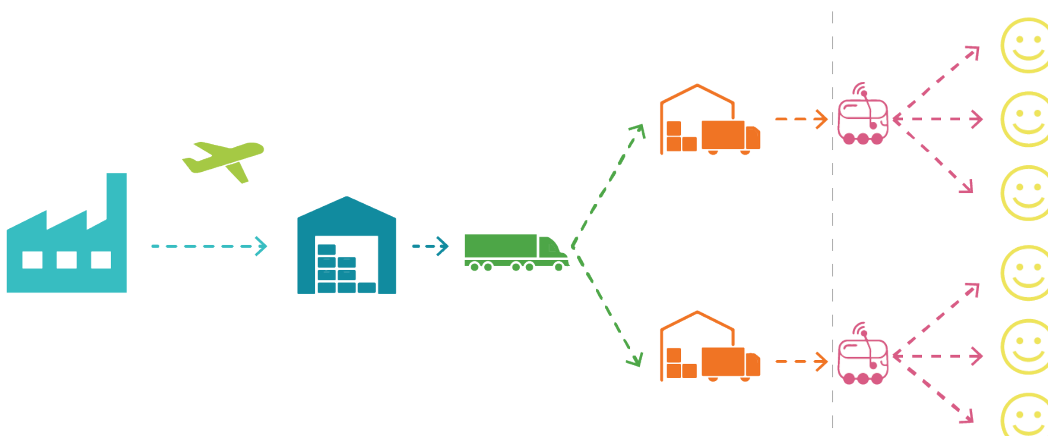

Figure 3.8: *The delivery logistics incorporating new technology to enhance efficiency and the overall delivery experiences. (Source: Author)*

[34] Kh Md Nahiduzzaman, Adel S. Aldosary, and Ishak Mohammed, "Framework Analysis of E-Commerce Induced Shift in the Spatial Structure of a City," *Journal of Urban Planning and Development* 145, no. 3 (September 2019): 3, https://doi.org/10.1061/(ASCE)UP.1943-5444.0000512.
[35] Ibid, 4-5.
[36] Ibid.

Further, despite the convenience of saving physical trips for customers, virtual shopping has also complicated the distribution of goods and generated increased intra- and intercity freight travel, adding to already existing transportation challenges and traffic congestions[37]. Lastly, with the evolving public health concerns, especially related to the novel COVID-19, physical retail stores are facing even greater challenges to reinstate its business. How can the design of the future of urban streets and rethinking of community's logistic system promote inviting, lasting and safe physical retail experiences?

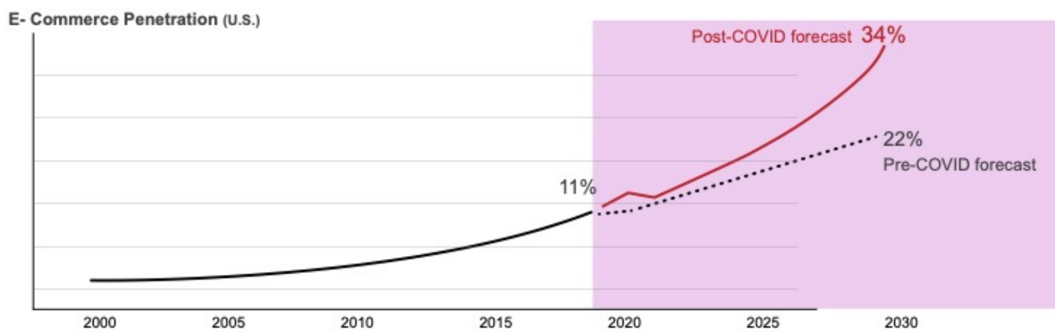

Figure 3.9: *E-commerce penetration in the U.S. expected to surge Post-COVID 19. (Source: Author)*

<u>*Public Policies*</u>

While major automobile companies and technology firms continue to heavily invest in the AV technology research and development, numerous municipalities across the nations are revising their planning policies to adopt the future advancement of mobility. Advancement of AVs will increase equity in mobility, reduce congestions, enhance road safety, and have a healthier impact on our environment. Growing skepticism around AV safety in recent years have discouraged public's

[37] Ibid, 1.

acceptance towards the new technology and decelerated policy reform on adaptation. However, governments at federal, state, and local levels are continuing to closely monitor AV development and formulating policies for near future adaptation. According to the National Conference of State Legislatures, Nevada was the first State to authorize the operation of autonomous vehicles in 2011 and Chandler, Arizona became one of the first U.S. cities to rewrite its zoning code to facilitate AV adaptation. Since then, 21 other states have passed legislations and 9 states issuing executive orders related to AVs.[38]

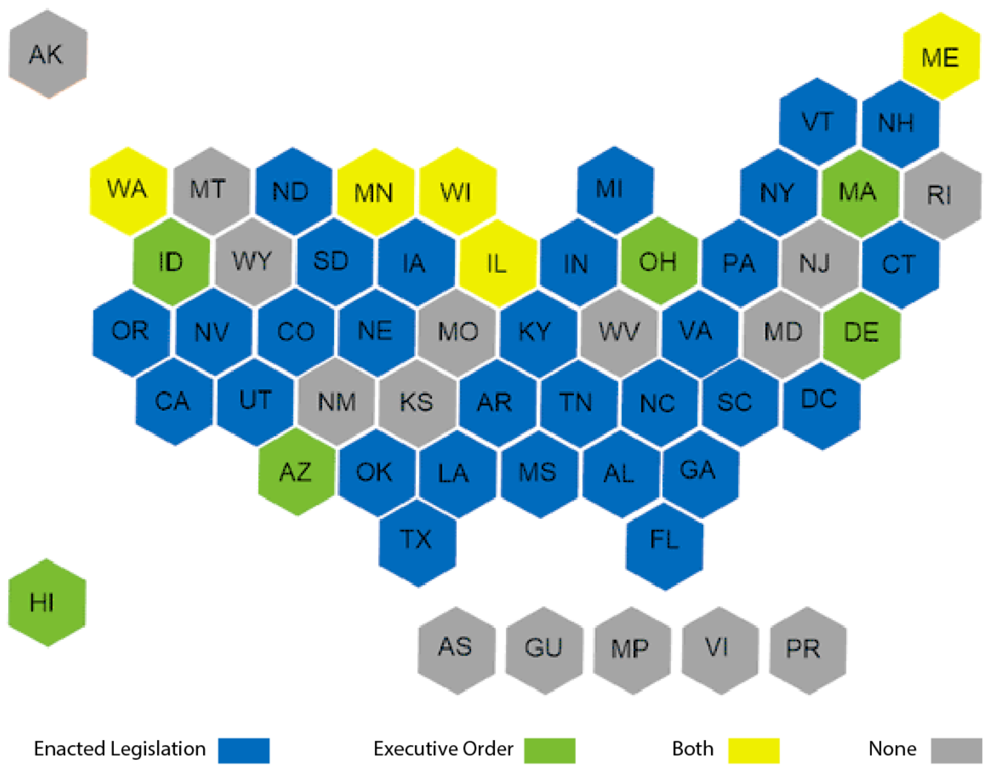

Figure 3.10: *State actions related to autonomous vehicles. (Source: National Conference of State Legislatures, 2020)*

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[38]"Autonomous Vehicles | Self-Driving Vehicles Enacted Legislations," National Conference of State Legislatures, accessed April 24, 2020, https://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx.

Moreover, City of Pittsburgh is enthusiastically engaging with local industries and institutions to expand upon AV technology advancements and brainstorming legislative implementation strategies. In 2018, the City of Pittsburgh Mayor William Peduto and Carnegie Mellon University students discussed AV policies[39] and in 2019, the City issued an Executive Order outlining City's objectives and expectations of AV development.[40] Finally, local jurisdictions could take advantage of devalued private vehicle parking spaces to leverage developers to produce denser development with a higher percentage of affordable dwelling units. Elimination of costs related to constructing expensive multi-level underground parking spaces will restructure financial pro forma for developers. Housing authorities could then incentivize bonus density for developers to remove parking spaces and encourages aforementioned connected mobility.

Public Health

According to the American Public Health Association, public health is defined as "promotes and protects the health of people and the communities where they live, learn, work and play,"[41] in which architecture and urban design can have significant roles in contributing to promoting and protecting public health. In the light of

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[39] Scott Barsotti,, "Heinz College Students Craft Autonomous Vehicle Policies for the City of Pittsburgh," *Carnegie Mellon University*, March 2018, https://www.heinz.cmu.edu/media/2018/June/consequences-weekend-autonomous-vehicles-updated-june.

[40]"Mayor William Peduto Issues Transformative Policies for Autonomous Vehicle Testing and Development," Pittsburgh Pennsylvania, March 4, 2019, https://pittsburghpa.gov/press-releases/press-releases.html?id=2724.

[41] "What is Public health?" American Public Health Association, accessed May 22, 2020, https://www.apha.org/what-is-public-health.

COVID-19, cities around the world are faced with unprecedented challenges to rethink about public health and how people interact on streets. Cities such as London, Paris and New York City are permanently closing their streets for private vehicles and adding miles of 'emergency bike lanes' to provide additional and safer spaces for bicyclist and pedestrians[42]. The World Health Organization (WHO) and Center for Disease Control and Prevention (CDC) are encouraging such transformation as nonpharmaceutical interventions (NPIs), actions apart from getting vaccinated and taking medicine, to help slow the spread of contagious viruses[43], proven to be an effective measurement in reducing transmission of a contagious pathogen[44].

***Figure 3.11**: Can urban streets become an intricate part of public health system in our cities and be prepared for future pandemics? (Source: Author)*

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[42] Carlton Reid, "Paris To Create 650 Kilometers OF Post-Lockdown Cycleways," *Forbes,* April 22, 2020, https://www.forbes.com/sites/carltonreid/2020/04/22/paris-to-create-650-kilometers-of-pop-up-corona-cycleways-for-post-lockdown-travel/#58ccabd254d4.
[43] "Nonpharmaceutical Interventions (NPIs)," Centers for Disease Control and Prevention, accessed May 22, 2020, https://www.cdc.gov/nonpharmaceutical-interventions/index.html.
[44] David M. Hartley and Eli N. Perencevich, "Public Health Interventions for COVID-19: Emerging Evidence and Implications for an Evolving Public Health Crisis," *JAMA* 323, no. 19 (April 2020), https://doi.org/10.1001/jama.2020.5910.

So, are streets an intrinsic component of public health system? And if so, are buildings on street a part of the larger public health infrastructure of a community? As the new transportation technology allows for a paradigm shift in the street design, this thesis further investigates in ways to implement green infrastructure, arrange physical spaces and reorient public realms to encourage healthy behaviors and improve overall quality of public health.

Chapter 4: The Future of The Public Realm

Introduction

For the first time in human history, more than half of the world's population live in cities. While the world's cities only occupy a mere 3 percent of land mass, they are projected to house 60 percent of the population by 2030.[45] As communities become denser, it is essential for cities to provide an advanced and enhanced urban mobility that is multimodal, seamless and connected, and reinforce public health and urban sustainability. The new streets and public realm that fails to cope with the population growth, deteriorating infrastructure and sustainability will be detrimental to economic and social vitality of growing cities.[46]

Today, most Americans use only one form of transportation for daily travels, whether by driving personal vehicles or relying on mass transits. However, the rise of shared mobility and micro-mobility are providing additional choices for people in urban transportation. Rather than relying on only one mode of transportation, the possibility of multi-modalism, integrated with robust digital infrastructure and platform, a complete mobility ecosystem can give abundance of options and synergistically transport people and goods.

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[45] World Bank Group, "Mobile Metropolises: Urban Transport Matters," An IEG Evaluation of the World Bank Group's Support for Urban Transport, 2017, 1.
[46] Ibid.

Ride-Hailing and Ridesharing

The rise of *shared mobility*, such as ride-hailing and ride-sharing services, have significantly disrupted existing urban transportation business models. In 2009, Uber introduced its ride-hailing services[47] by attracting individual vehicle owners as the service providers through a smartphone application. In the subsequent years, similar TNC, such as Lyft and Via, have entered the new market, instantly increasing the number of users among younger generations. In 2018, about 30 percent of adults have used shared mobility services[48] and *Rodier* found that the services are affecting private vehicle ownerships in major U.S. cities at about 10 percent of respondents to the survey gave up a vehicle after subscribing to ridesharing.[49]

The rise of ride-hailing and ride-sharing services have been largely controversial in many major U.S. cities due to the reduction in mass-transit ridership.[50] However, other factors such as income growth combined with cheaper gas price, increase in car ownership, and reliability issues with deferred maintenance and service cuts, also have contributed to the decline in net transit ridership.[51] While disagreements on TNC's impact on public transit exists, TNC services can increase

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[47] Regina R. Clewlow and Gouri S. Mishra, "Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States," *Institute of Transportation Studies, University of California, Davis*, Research Report UCD-ITS-RR-17-07 (December 2017): 17, https://escholarship.org/uc/item/82w2z91j.

[48] Ibid, 17.

[49] Caroline Rodier, "The Effects of Ride Hailing Services on Travel and Associated Greenhous Gas Emissions," *UC Davis: National Center for Sustainable Transportation, (April 2018): iii,* https://escholarship.org/uc/item/2rv570tt.

[50] Clewlow, "Disruptive Transportation," 2.

[51] Michael Graehler, Jr., Richard Alexander Mucci and Gregory D. Erhardt, "Understanding the Recent Transit Ridership Decline in Major US Cities: Service Cuts or Emerging Modes?" *98th Annual Meeting for The Transportation Research Board* (November 2018), 5, https://usa.streetsblog.org/wp-content/uploads/sites/5/2019/01/19-04931-Transit-Trends.pdf.

transit ridership by providing first- and last-mile connectivity, decrease private ownerships[52] and reduce energy use and greenhouse gas emission.[53] Further, with the integration of autonomous technology, public-private-partnership between municipalities and AV technology firms can seamlessly offer multimodal transportation and bridge the gap where public transit network is sparse.[54]

Micro-mobility

From stationed-based bike share to e-scooters, shared micro-mobility solutions are reshaping the future of urban transportation in conjunction with shared mobility. In 2018, the total trips made in the U.S. doubled within a year as people saw great convince to fill the gap of the first- and last-mile connectivity to mass transit.[55] Micro-mobility fills an important gap in urban mobility and has a great potential to make city life more equitable and inclusive.

***Figure 4.1**: Shared Micro-mobility. (Source: NACTO, Shared Micromobility in the U.S.,2018)*

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[52] Ibid, 6.
[53] Susan Shaheen, "Shared mobility: The Potential of Ride Hailing and Pooling," *UC Berkeley: Transportation Sustainability Research Center,* (March 2018), 1, https://escholarship.org/uc/item/46p6n2sk.
[54] Ibid, 10.
[55] "Shared Micromobility in the U.S.: 2018," *National Association of Transport Officials*, accessed April 23, 2020, https://nacto.org/shared-micromobility-2018/.

Despite the excitement and convenience surrounding micro-mobility, there are lack of concerns over infrastructure quality and the safety of roads. Micro-mobility often conflicts with one another on limited and narrow city bike lanes and invades pedestrian walkways posing a threat of collision. Just as the automobiles simply inherited roads designed for horse carriages 100 years ago, these compact vehicles cannot simply enter existing roads without the redesign of urban streets.

Mobility Evolution to Revolution

As cities across the world are reorienting their transportation priorities towards people over cars and with the recent change in trends among the new generation's preferences on more sustainable travel, the era of automobile dominance seems to have peaked. While replacing cars with people in cities can reduce congestions, enhance road safety and be more sustainable[56], the complete elimination of cars significantly diminishes the full potential of urban mobility.

The evolution of automobiles towards autonomous vehicles, combined with ubiquitous micro-mobility, have the potential to revolutionize urban mobility by filling the first- and last-mile connectivity gap with existing mass transit. Continuous network of transportation in collaboration with robust digital infrastructures can generate a complete mobility ecosystem that seamlessly transport people and goods. Collective data from a fleet of AVs, micro-mobility and mass transit can feed real-time data on congestions, weather, travel time, and cost of commute through a touch

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[56] CSPC, "The Autonomous Vehicle Revolution," 3-7.

of a smart phone application.[57] The challenge for planners and architects is how the physical environment can support the easy and continuous flow of movements and be an intrinsic component of the ecosystem.

The integration of various modes of transportation in cities also significantly enhances accessibility to those limited by the cost of car-ownership, licensing difficulties, disability, or age.[58] Ongoing research from Harvard University suggests that urban mobility and commuting times significantly impact social mobility more so than crime and education.[59] For them, accessibility to transportation means physical freedom and a greater socioeconomic mobility.

Physical Infrastructure

The necessity of physical infrastructures to accommodate the multi-modal transportations include subtle interventions on the curbs of urban streets, transit hubs and public spaces. Curb-less streets stretching from building to building will allow the entire street to grow and shrink quickly and easily as needed. Street curbs once reserved for parallel parking spaces and loading zones transform into flexible 'smart curbs' or 'flex zones' by adapting to different uses at different times of the day.[60] The

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[57] Scott Corwin, Nick Jameson, Derek M. Pankratz, and Philp Willigmann, "The future of mobility: what's next?" *Deloitte Insigts*, September 14, 2016, https://www2.deloitte.com/us/en/insights/focus/future-of-mobility/roadmap-for-future-of-urban-mobility.html.
[58] CSPC, "The Autonomous Vehicle Revolution," 5.
[59] Raj Chetty and Nathaniel Hendren, "The Impacts of Neighborhoods on Intergenerational Mobility: Childhood Exposure Effects and County-Level Estimates," *Harvard University* (April 2015), https://doi.org/10.1093/qje/qjy007.
[60] NACTO, "Blueprint for Autonomous Urbanism," 116-121.

people-first streets will serve as a foundation for social interaction, economic vitality[61] and multimodal mobility.

Figure 4.2: *New Road in Brighton & Hove, England providing safe shared street with great flexibility. (Source: Gehlpeople.com)*

<u>*Green Infrastructure*</u>

Many definitions exist for Green infrastructure. Depending on the context in which it is used today, different people may describe its meanings and functions differently. In the context of urban or built environment, green infrastructure is best defined by *Mark A. Benedict* as "an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human population."[62] Green infrastructure is a cost-effective and resilient strategy for

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[61] Sidewalk Toronto, "Master Innovation and Development Plan: The Urban Innovations," 136-37.

[62] Mark A. Benedict and Edward T. McMahon, "Green Infrastructure: Smart Conservation for the 21st Century" *Renewable Resources Journal* 20, no. 3 (Autumn 2002): 12, https://www.merseyforest.org.uk/files/documents/1365/2002+Green+Infrastructure+Smart+Conservation+for+the+21st+Century..pdf.

cities to manage wet weather impacts. While traditionally, planning approach was to reinforce single-purpose gray stormwater infrastructure to move larger volume of water away from built environment, green infrastructure reduces and treats stormwater at its source by implementing rain gardens, planter boxes, bioswales permeable pavements and other systems.[63]

Implementation of green infrastructure in the built environment have number of benefits. Environmentally those benefits include storm-water management, water capture and conservation, air quality, reduce ambient temperate and urban heat island (UHI) effects, increase carbon storage, expanding wildlife habitat, and recreational spaces.[64] In additional to the environmental benefits, EPA have also identified green infrastructure as a contributor to improving public health, lowering energy demand, reducing capital cost savings, and even increasing land-values by up to 30 percent.[65] When streets become increasingly narrower for automobiles, cities can strategically implement green infrastructure elements to reestablish the status quo of urban streets and public realm. Incorporated into the evolving urban mobility, green infrastructure can simultaneously provide biological, social and economic benefits, as well as aesthetics of the future urban streetscape.

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63 "What is Green Infrastructure?" United States Environmental Protection Agency, accessed May 22, 2020, https://www.epa.gov/green-infrastructure/what-green-infrastructure.
64 Josh Foster, Ashley Lowe and Steve Winkelman "The Value of Green Infrastructure for Urban Climate Adaptation," *The Center for Clean Air Policy* (February 2011): 4, http://ccap.org/assets/The-Value-of-Green-Infrastructure-for-Urban-Climate-Adaptation_CCAP-Feb-2011.pdf.
65 Ibid.

New Identity for Urban "Streets"

So how will all the ingredients of the changes 21st century in autonomous technology, micro-mobility, public health issues in the light novel COVID-19, shifting in urban demographics, e-commerce's influence on physical retail spaces, impact the design of streets and urban living? The millennia-old definition and typical functions of urban streets that channeled horse carriages, vehicles, pedestrians and utilities may evolve into a new interpretation of a non-linear network of public realm.

Figure 4.3: *La Ramblas in Barcelona. (Source: Getty Images)*

A great example of an urban street that have seen a dramatic transformation in the past include *Las Ramblas* in Barcelona. The tree-canopy-covered avenue once a leftover space between two medieval towns, filled with sewage and drained the town's rainwater[66], transformed into perhaps one of the most popular public promenades in the world. The large and central pedestrian island, flanked by narrow lanes of vehicular right-of-way, weaves through about a mile of the old town Barcelona, creating a "*linear forum*" of the city more so than a typical urban street. A high volume of pedestrian traffic combined with various mixed-use programs along the street generates a powerful retail economy as well as a safe, joyful and convivial public space.

Throughout the history, streets have connected people and reinvented civilization; from the veins of roads leading to Rome, introduction of public utilities by Georges-Eugene Haussamann's massive renovation plan of Paris, and to the streets of New York inundated by the invention of automobiles were the basis of how civilization evolved. As the changes of the 21st century bring new challenges to architects and planners, they also give a historical opportunity to reimagine the future of urban streets to accommodate advanced mobility, improve the quality of public health and enhance the natural environment of urban areas.

[66] Juan Jose Ospina-Tascon, "Las Ramblas In the urban growth of Barcelona," *Architecture and Urbanism* 35, no. 1, (Spring 2014), http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1815-58982014000100003#n3.

Chapter 5: Autonomous Urbanism

Introduction

Over a century ago as automobiles swept cities across the nation, city planners responded by removing all obstacles on roads, including pedestrians, to make a way for the new vehicles. With the close reality of autonomous vehicle technology, city planners are faced with an historic opportunity for an extensive transformation to reclaim urban space and correct the mistakes of the 20th century auto-reign of congestion, pollution and suburban sprawl. With the arrival of the new technology, this thesis further investigates how design is impacted and how design impacts the incoming technologies as they relate to a variety of issues like mobility, streetscape, public realm, public health, and social equity. The design of the community of 21st century will attempt to address these issues holistically and make a transition from auto-oriented to a pedestrian-oriented society.

Autonomous Urbanism Scenarios

How our cities adapt and transform largely depend on public policies and affordability and ownership of the new technology. It is imperative to envision the new built environment at different scenarios and objectively critique the possible outcomes. Many questions will rise with no easy answers. But shifting the conversation on how the new technologies will impact and transform urban streets, public realms, building typologies, public health, and ultimately our lives, will be the foundation for the design of the communities of the 21st century America.

"The Good"

The utopian version of the new built environment places human at the core of the change rather than vehicles. The vision of "*transitopia*," a harmonious coexistence of pedestrians, bicyclists, variety of transportation modes and vegetation, as they incrementally reclaim urban street spaces to create a continuous mobility ecosystem while improving public health and street life.

Figure 5.1*: Pedestrian centered multi-modal transit hub in Pittsburgh, PA. (Source: Author)*

Here, the ownership and operation of the driverless cars largely relies on public-private partnership entities and discourage private ownerships in urban environments. Autonomous ride-hailing and hide-sharing services dominate vehicles on urban streets, which requires significantly less space, and syncs seamlessly to public transits. Buildings will devalue parking spaces and densify urban living to alleviate housing affordability in the most desired locations. Streets will too transform to allow new spaces for pedestrian activities, robust green infrastructure system and new interactions with the ground floor building programs.

New York City is already working with architects and designers to rethink its urban streets for the future. In 2017, the city launched a design competition to ensure that the city takes full advantage of the benefits of autonomous transportation and to avoid letting the new technology unfold haphazardly with no accommodations and restriction.[67] The winning proposal by an architecture firm in New York, FXcollaborative, a plug-and-play system of interlocking unitized squares was visualized that provide new infrastructural platform for a wide variety of surface module programs.[68]

"The Bad"

The second possible scenario on the mainstream adaptation of autonomous vehicles in the built environment is the possibility of new era of massive suburban sprawl or "*sprawl on steroid*." Affordability of AVs, similar to the introduction of automobiles in the early 20th century, and individual ownerships encourage and allow greater travel distances. Once driverless cars become an ubiquitous piece of technology, people will choose to live further away from city centers and seed for a second generation of suburban sprawl developments.

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[67] "Driverless Future," Blank Space. accessed May 22, 2020, http://driverlessfuture.blankspaceproject.com/?utm_medium=website&utm_source=archdaily.com.
[68] "Public Square," FXcollaborative. accessed May 22, 2020, http://www.fxcollaborative.com/projects/186/public-square/.

Figure 5.2: *Physical model of Broadacre City by Frank Lloyd Wright. (Source: Frank Lloyd Wright Foundation, 2018)*

In 1932, Frank Lloyd Wright visualized this new type of American suburbanism based on the decentralization of cities by creating an environment in which an individual would flourish. As a vocal critic of centralized urban concentration, Wright believed that large cities with limited spaces, congestions, and "economic artificiality" promoted dehumanizing values, stole individuality, and jeopardized democratic lifestyle.[69] Broadacre City would vision an utopian urbanism in which every person would be granted an acre of land for self-sufficiency and

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[69] Arthur C. Nelson, "The Planning of Exurban America: Lessons from Frank Lloyd Wright's Broadacre City," *Journal of Architectural and Planning Research* 12, no. 4 (Winter, 1995): 338-339, https://www.jstor.org/stable/43029176.

individualism. The main form of mobility in the City would have been the newly invented automobiles throughout the scattered dwellings over the 2,560 acres of land.

This utopian vision of a democratic and auto-centric suburbia seemed to ignore an array of consequences amidst the benefits it claims to have. The need for the massive expansion of infrastructure cost will be unbearable to accommodate the more remote developments. Public spending will focus on the creation of exhaustive road networks for AVs and neglect invigorating public and civic life. While people become closer to nature, society become physically more distant than ever, destroying the value of social interactions. The closest realization of Wright's plan was the development of Levittown in New York aforementioned in the previous chapters and it quickly vanished as an activist Jane Jacob's *The Death and Life of Great American Cities* in 1961 heavily criticized those visions of those Wright's like-minded.

"The Ugly"

The last scenario of the future of an autonomous urbanism is rather grim; "*death of street*". Once envisioned by a preeminent figure in architecture and urban design in the 20th century, or perhaps in the history, was *Le Corbusier*'s scheme for *Ville Radieuse* in 1930, a functionalist plan that exemplified the energy and efficiency of the Machine Age.[70] Often compared to Broadacre City by Wright, the highly centralized masterplan sought to reorganize urban fabric by new streets that classified different types of traffics by speed in cities. In hopes to eliminate existing

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[70] Le Corbusier, "The Contemporary City: from The City of Tomorrow and Its Planning 1929," accessed May 20, 2020, http://courses.washington.edu/gmforum/Readings/LeCorbusier.pdf.

congestions, the plan divided each traffic types into three kinds of roads and superimposed them in layers, creating a triple-level deck system of every needs of motor traffics.[71] The high-speed major artery system occupied the majority of urban space and leaving scarce space for pedestrians, claiming "a city made for speed is made for success."[72]

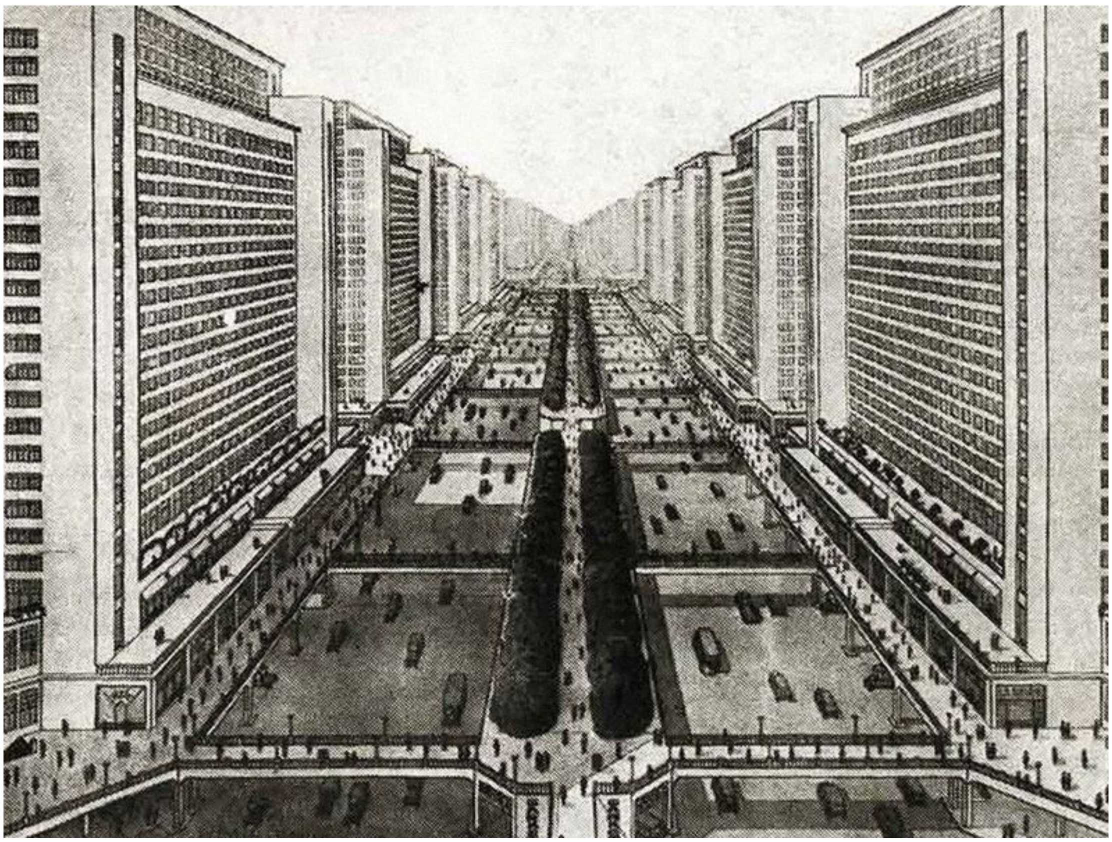

Figure 5.3: *Major arterial road system separated from the streetscape of the city. (Source: Ville Radieuse by Le Corbusier, 1930)*

Injected with autonomous vehicles and private ownerships, the problems realized in the auto-centric planning intensifies with the magnitude of mainstream adaptation. Prioritizing driverless cars and widening roads only worsens traffic and

[71] Le Corbusier, "The Contemporary City: from The City of Tomorrow and Its Planning 1929."
[72] Ibid. 343.

congestions, much in the same way the current highways. Further, investment in public transportation will inevitably continue to deteriorate and eventually disappear to only to serve the poorest of the poor in inner cities and herald the arrival of dystopia and death of streets. Pruitt-Igoe housing project in 1956 demonstrated the sheer failure of such urban planning with homogenous vertical architectures and wide-open spaces in-between, rapidly raided by poverty and crime as an eyesore to the City of St. Louis until its destruction in 1972.

Polycentric Developments

A transition towards an autonomous urbanism as communities anticipate the arrival of driverless cars and reorient urban design and spaces for the future of "streets", cities can begin to populate areas of focused developments around an existing mass transit facility center. This incremental interventions and scattered developments throughout the metropolitan, follow a similar set of urban planning principles by Sir Ebenezer Howard's Garden City Movement.

First introduced in his book *To-morrow: a Peaceful Path to Real Reform* in 1898 and reissued in 1902 as *Garden Cities of To-morrow,* Howard envisioned a cluster of several self-contained communities surrounded by 'greenbelts' as satellites of a central city, linked by major arteries and railroads. With the growing concern over uncontrolled growth since the Industrial Revolution at the time, Howard sought for new social reforms and ways to improve the quality of life by combining the benefits of both the rural and urban environments[73]. The circular form of the garden city, centers around a public garden space with six magnificent boulevards traverse the city from center to circumference.

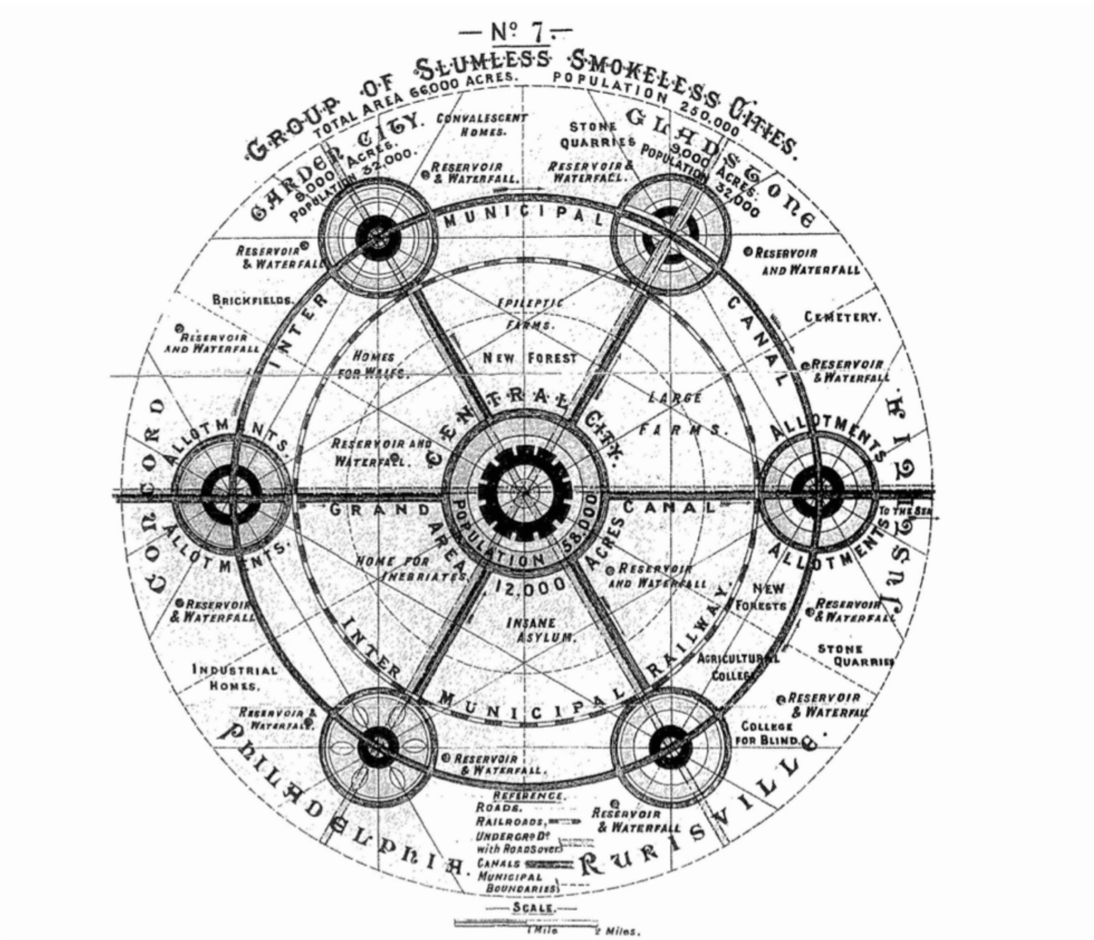

Figure 5.4*: A diagram of Garden City Movement. (Source: Garden Cities of To-morrow by Ebenezer Howard, 1902)*

Howard's garden city movement principles can be applied the today's mass transportation networks, framing the boundary of the new urban interventions and create a broader connection regionally. A fleet of autonomous vehicles and micro-

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[73] Ebenezer Howard, *Garden Cities of To-Morrow* (London: Swan Sonnenschein & CO., Ltd., 1092), 20-24, Project Gutenberg.

mobility deployed within the periphery can sync with transit, dramatically enhancing the first- and last-mile connectivity. Further, robust green infrastructure on the new urban "streets" acts as an urban linear forestry, weaves through the community, providing an equitable contribution of nature to the urban residents and can ultimately enhancing the overall health.

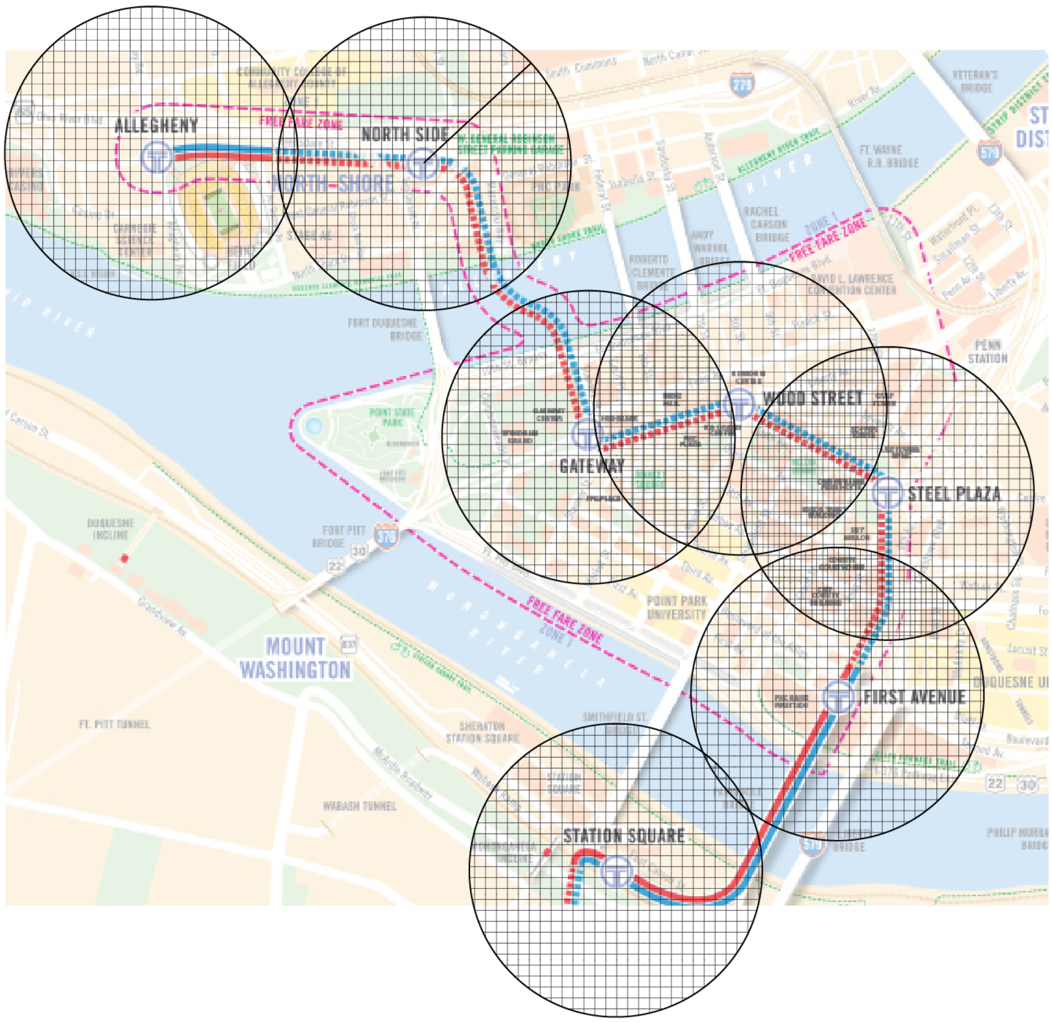

Figure 5.5: *Boundaries overlaid to an existing mass transit network in the City of Pittsburgh, replicating the Garden City Movement. (Source: Author)*

Chapter 6: North Shore District in Pittsburgh, PA

Site Selection Criteria

The site selection criteria focused on three major categories: mobility, adaptability, and adjacencies. Mobility included the quality of existing transportation network, pedestrian experiences and street typologies. The site also needed a high potentially of adaptability from its ability to implement, transform and adopt the new changes in the 21st century as mentioned previously. Further, the potential site needed to have a considerable amount of space for new developments as well as an existing context for exploring the incremental changes in the current infrastructure. Lastly, the site's adjacencies such as its connectivity to surrounding areas, public amenities and natural environments were considered.

	Site Selection Criteria	College Park, MD	Pittsburgh, PA	Crystal City, VA
Mobility	Transportation Network *Existing public transportation and infrastructure quality*	9	8	8
Mobility	Pedestrian Experience *Current sidewalk condition, walkability and comfortability*	5	8	6
Mobility	Airport Accessibility *Mobility beyond region via air travel*	9	5	10
Mobility	Street Typology *Variations in street typology around the site*	6	8	9
Adaptability	Transformative Potential *Potential to transform with the technology and new mobility*	9	10	6
Adaptability	Municipal Policy *Progressive policy towards implementing the technology*	6	10	6
Adaptability	Historical Significance *Variations in street typology around the site*	5	9	6
Adjacency	Site Connectivity *Access to site and connectivity to surrounding urban fabric*	8	8	9
Adjacency	Public Amenities *Public institution, facilities and community centers*	6	9	7
Adjacency	Natural Environments *Water proximity, parks and recreational spaces*	7	9	8
		70 / 100	**84** / 100	**75** / 100

Figure 6.1: *Site selection criteria matrix. (Source: Author)*

The selection process began with six potential sites from Washington D.C. metropolitan areas to Detroit, Phoenix, and Pittsburgh. All sites were near mass transit facilities of its respective cities and three sites showed the highest opportunities based on the criteria. Of the three final site candidates, Pittsburgh, Pennsylvania, more specifically North Shore, showed the greatest adaptability and ability to utilize and enhance its existing transportation network and transform the area into the community of 21st century. Although the proximity of the site to the downtown seems highly accessible with highways and metro station, the area an isolated urban island and disconnected from the rest of the city.

***Figure 6.2**: Pittsburgh, PA is an important link between major East Coast cities such as New York City and Washington D.C. and Mid-west cities like Chicago. (Source: Author)*

The City of Pittsburgh itself also provides great connectivity within and around the city boundary. The Pittsburgh Light-rail connects Southern parts of Pittsburgh Metropolitan Area in conjunction with the abundance amount of local and regional bus routes, providing a great accessibility beyond personal vehicles.

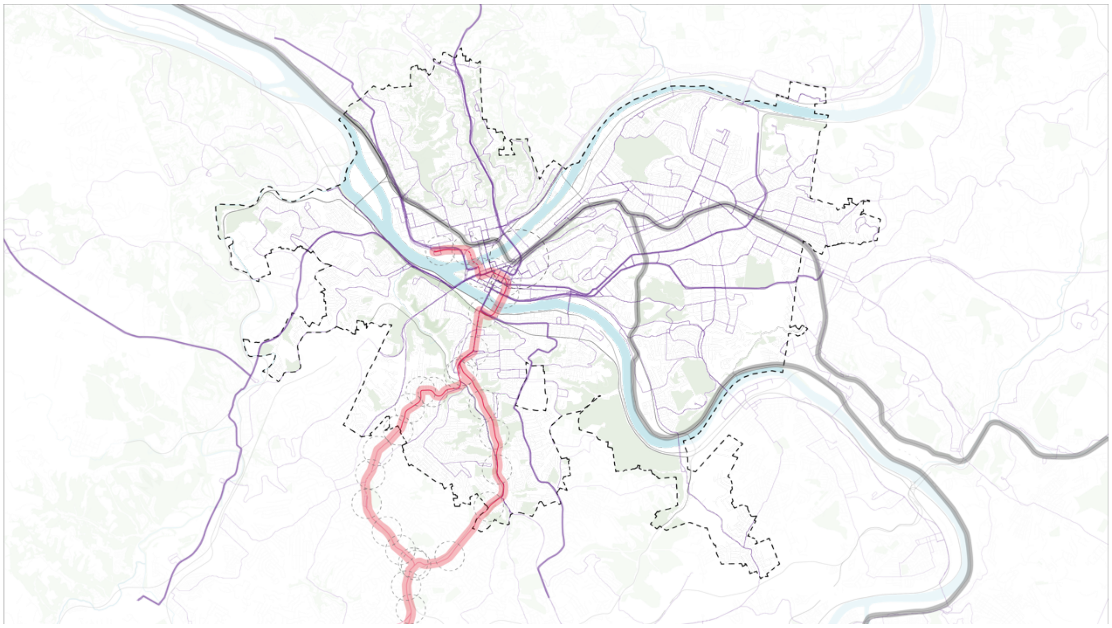

***Figure 6.3**: Red shows Pittsburgh's light-rail route, purple highlights city bus routes, and black indicates Amtrak rails all providing great transportation. (Source: Author)*

The North Shore District, as only few undeveloped areas adjacent light-rail station in the City of Pittsburgh, will be the site for the test case of what the future of urban street and public realm look like with the impact of autonomous technology, evolving public health concerns, e-commerce consumer habits, and shifting in demographics.

<u>*Rust Belt to Smart Belt*</u>

With the stabilization of decreasing population in the last two decades and the recent resurgence of population fueled by an emergence of new technology and robotics industries, Pittsburgh is in the midst of transforming its notorious icon as a Rust Belt city into a forward-thinking, highly advanced Smart Belt of the future. The Gross Domestic Product of the city has also been growing exponentially compared to the national average and the state of Pennsylvania since the Recession. The growing new economy, supported by a strong foundation of institutions and health care services, is attracting highly skilled and educated individuals into the city from all over the country and internationally. This trend is expected to continue to grow, making the city as an excellent candidate for the case study of urban streets and infrastructure of the 21st century.

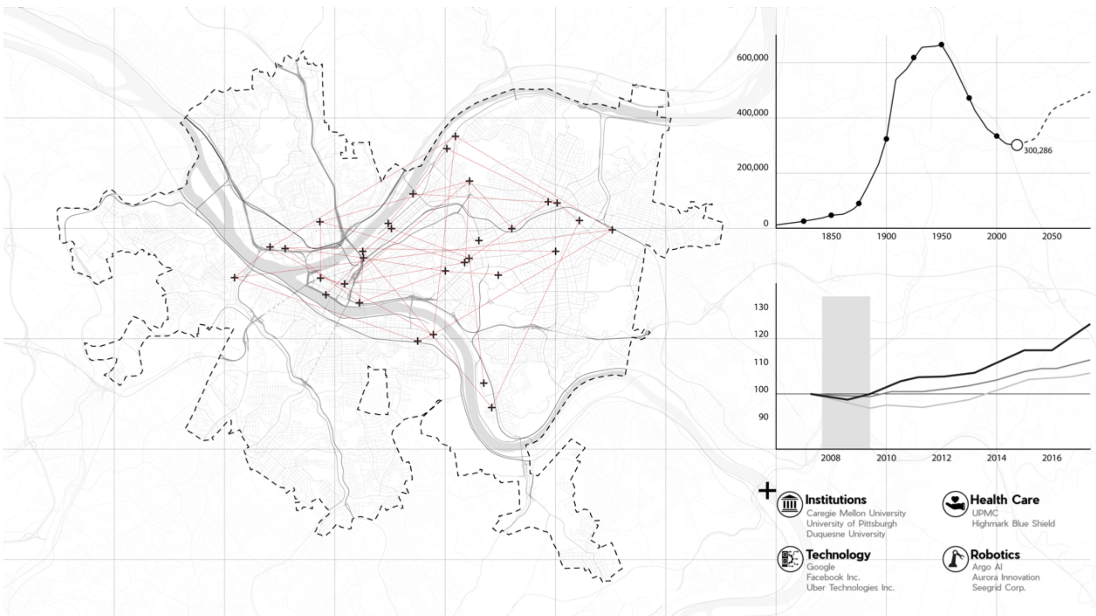

Figure 6.4*: Pittsburgh transforming its city from the icon of Rust Belt into Smart Belt with the new emerging technology and robotics industry. (Source: Author)*

<u>2070 Mobility Vision Plan</u>

As the City prepares for the additional population with robust economy, its reimagining its infrastructure and mobility in the near future. The 2070 Mobility Vision Plan proposed by the Pittsburgh Department of Mobility and Infrastructure visions how a growing mid-sized city like Pittsburgh can take the opportunity for “bold and proactive thinking about the future…” and “identify the connections and policies needed to ensure that all residents will have the physical mobility they need to reach the economic mobility they seek."[74]

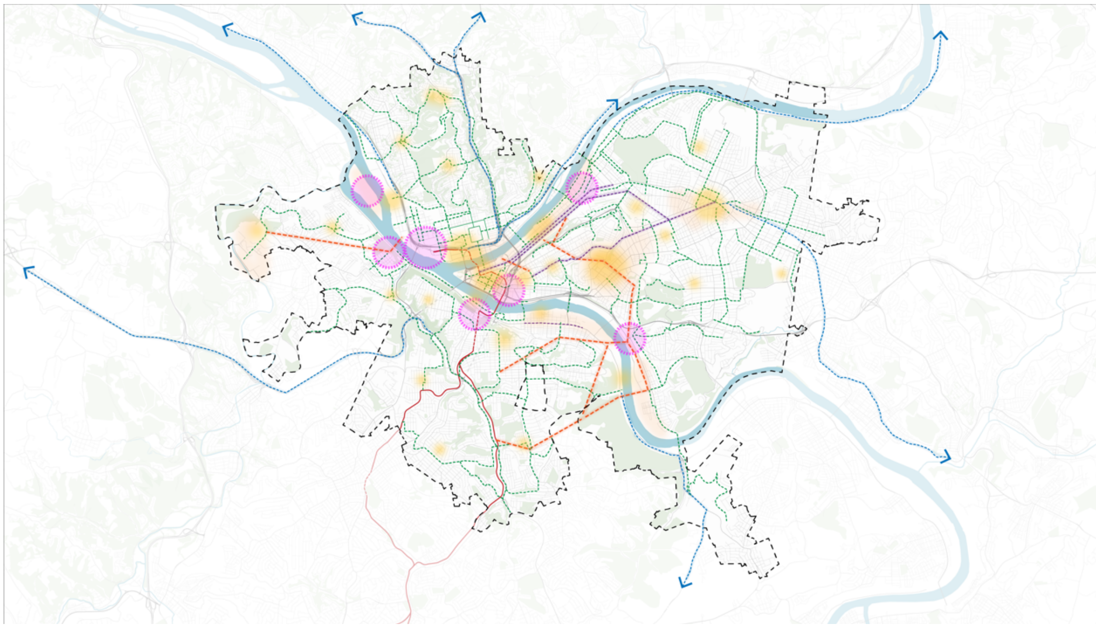

Figure 6.5*: Pittsburgh's 2070 Mobility Vision Plan identifying intermodal hubs and proposing new and additional transit options throughout the city. (Source: Author)*

The Vision identifies potential intermodal hubs that can provide city, regional, national, and international connection in the future. One of the locations the City has identifies is on North Shore District, suggesting the sites huge potential to revitalize as a future of multi-modal urban living space. It also proposed new aerial rapid and at-grade rapid transit system to provide greater accessibility. Bike lands reach every neighborhood in the city with more street or transit improvements. The plan clearly visualizes its city with little personal vehicles in its urban areas and promotes greater reliance on public transportation.

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[74] "2070 Mobility Vision Plan," Pittsburgh Department of Mobility and Infrastructure, accessed Dec. 20,2020, https://pittsburghpa.gov/domi/transport-vision-plan

North Shore, Pittsburgh

The lower North Shore of Pittsburgh is best known for its entertainment district along the Ohio and Alleghany Riverfronts. Historically, the area was first developed with the creation of Reserve Tract of lands for Revolutionary War veterans in 1783 and remained largely undeveloped across the thriving Pittsburgh[75]. The easily navigable waters with the discovery of rich natural resources such as coal, iron and limestone, caused the economy to grow exponentially and by the end of 19th century, became known as the American's industrial hub for coal mining and steel production[76]. Population exploded concurrently and reached more than half a million and in 1890, North Shore constructed the city's first sporting venue stadium and continued to evolve as home to its professional sports organizations. Since the collapse of the steel industry following the end of World War II, the City of Pittsburgh has rebounded with the growth of health care industry and today, as an emerging technology scene with prestigious educational institutions.

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[75] Dan Rooney and Carol Peterson, *Allegheny City: A History of Pittsburgh's North Side,* (Pittsburgh: University of Pittsburgh Press, 2013) 1-8.
[76] "Introduction to Pittsburgh," Visit Pittsburgh, accessed May 22, 2020, https://www.visitpittsburgh.com/things-to-do/arts-culture/history/

Urban Context

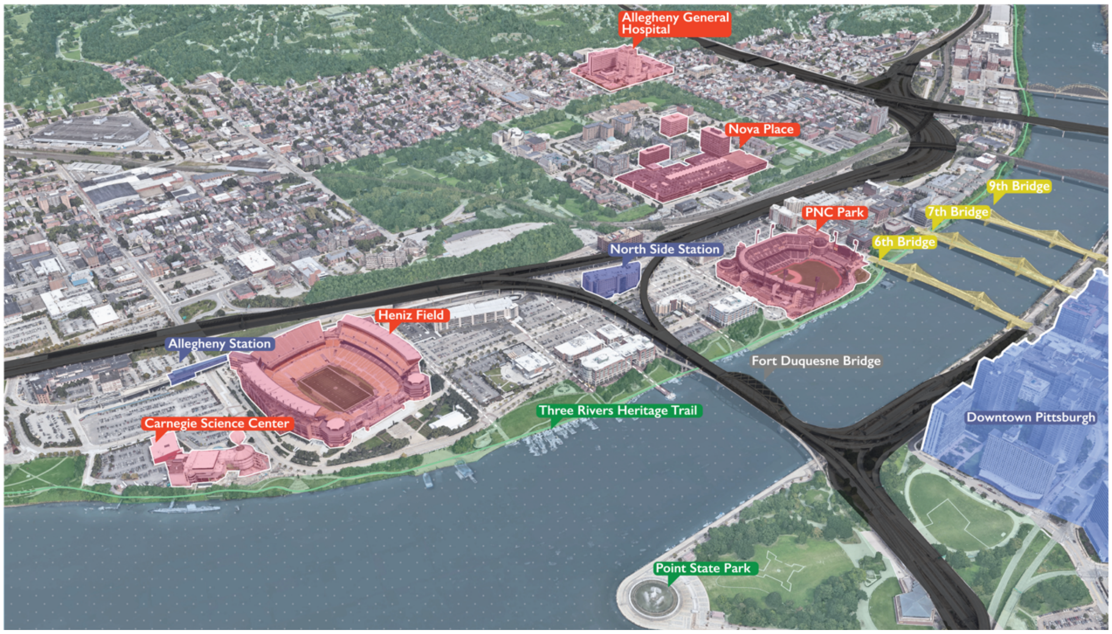

Figure 6.6: *North Shore District as an entertainment district of the city, housing two major stadiums and other major urban amenities. (Source: Author)*

The two stadiums on site surrounded by a sea of parking surface pose a fundamental question of what happens to the parking lots and garages near stadiums across America, once they become obsolete in the near future. The close proximity to downtown and access to mass transit brings tremendous opportunities and value to revitalize the areas into desirable locations for new developments.

The proposed site for master plan is clearly defined by its boundaries. To the North, construction of raised highways separates the site to the rest of Allegheny community and to the south, Allegheny River creates a natural riverfront boundary. To the East and West, PNC Park and Heinz Field stadiums anchors the site. As a destination for the City, the vicinity of the entertainment district also includes a casino, art museums and other cultural centers. Two metro stations serve the site: The

North Side Station and Allegheny Station as the northern terminus of the Pittsburgh Light Rail system.

Transformative Potentials

The proposed site shows great potentials to transform the large portion of the undeveloped surface parking spaces as the case study of how the future of urban realm could look like with new developments. By the riverfront, newly developed buildings present another opportunity for testing how the currently existing streetscape and infrastructure can adapt the changes and incrementally transform to accommodate the advancement of mobility, new technology and improving public health of the community.

S.W.O.T. Analysis

Strengths

The site's close proximity to downtown Pittsburgh, walking distances to both North Side and Allegheny light rail stations, and ample highway access, have great strength to introduce the next age of transportation technology to seamlessly connect with the Greater Pittsburgh Region. The City's robust advanced technology economy, prosperous health care sector and thriving educational institutions continues to fuel innovation and entrepreneurship. The largely undeveloped land is an ideal site for an urban incubator dedicated to transforming urban streets and reimaging the future of urban living. The North Shore continue to gain attractions for new developments and investments as the area unlocks is value.

Weaknesses

While two stadiums draw people for sporting event venues, lack of program diversity on the site is disadvantageous for new developments. Recent developments have added new programs such as restaurants, offices and live music venues, yet the site remains largely depended upon sport venues for attraction Further, despite the overall increase in job growth and economy, population continues to decline and could jeopardize economic vitality.

Opportunities

The lands beneath the raised highways have incredible amount real estate value with the connectivity and accessibility, if those highways were removed. Considering the deteriorating infrastructure with the emergence of more autonomous vehicle technology, the City can reimagine its urban highway network and unlock the value of urban land close to the downtown area and adjacent to the stadiums.

Physical and visible connections to the river and well-established riverfront trail system with the implementation of new green infrastructure on site presents great opportunities to redevelop the impervious site into sustainable and eco-friendly neighborhood. Development of mix-use program could revitalize the area from overly dominated by single purpose program and create year-around destination for where people can live, work and play.

Threats

Site accessibility and large influx of traffic, both vehicles and pedestrians, during sport events could present urban design challenges. Today, those undeveloped surface parking lots are used for football tailgates, which is an important culture of the fans. The proposed urban design and streets must be able to accommodate and continue the tradition of the game. Additionally, an immediate threat from flooding is low as FEMA identifies the majority of the site as 0.2 percent change of flood; 500-year flood plain.

Chapter 7: Vision

Reimagining the Urban Highway Network

The current highway system in the urban areas of Pittsburgh physically isolates the downtown area. The average daily volume of traffic in the core city center are notably smaller than those running North and South and entering the city from the East. With the average daily traffic of between 20,000 to 28,000[77], the core highways carries less than some prominent urban boulevards in the country. Most notably, Massachusetts Avenue, NW in Washington D.C. carries about 45,300 vehicles[78], which also includes streetscape and programs that generates an economy of its own.

The proposal calls for the reimagination of those raised highways bisecting North Shore District and barricading its connection to North Side. With the deteriorating current highway structures that are reaching its typical lifespan of 70 years, could the city reinvest in its infrastructure with a new vision?

[77] "Traffic Volume Maps," Pennsylvania Department of Transportation, accessed Dc. 20, 2020, https://www.penndot.gov/ProjectAndPrograms/Planning/Maps/Pages/Traffic-Volume.aspx
[78] "Traffic Volume Map 2018," District Department of Transportation, accessed Dec. 20, 2020, https://ddot.dc.gov/publication/traffic-volume-map-2018

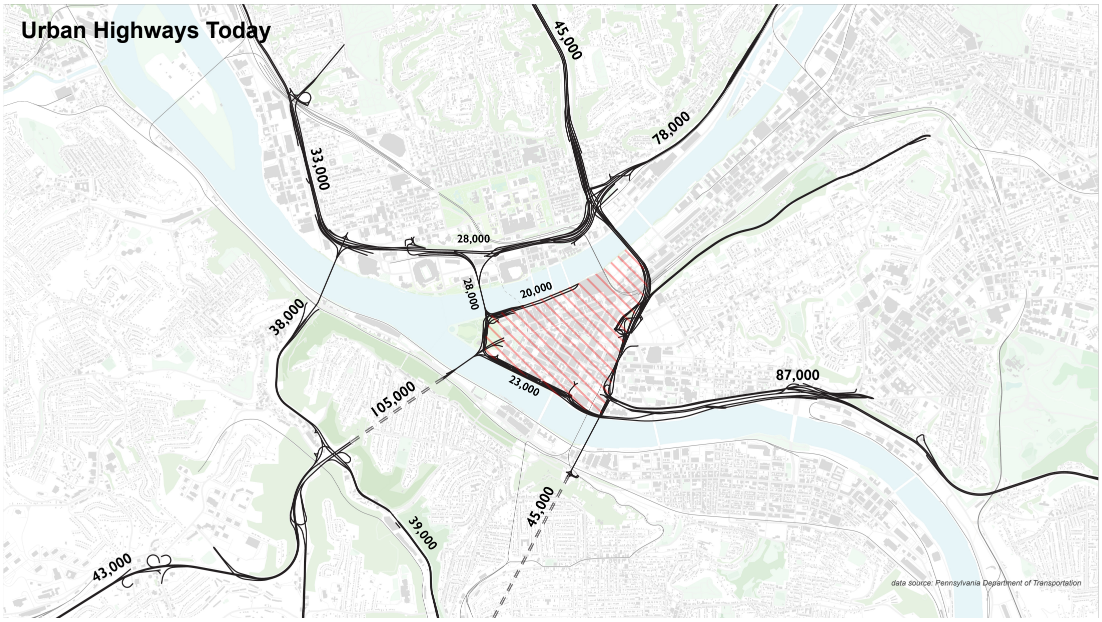

Figure 7.1: *Assessment of Pittsburgh urban highway network today. (Source: Author)*

The city has an incredible opportunity to reimagine the raised highways in the core urban areas to unlock valuable real estate for future development. The incremental transformation of the highways will allow for additional developments on North Shore to fully capitalize on its location and surrounding amenities.

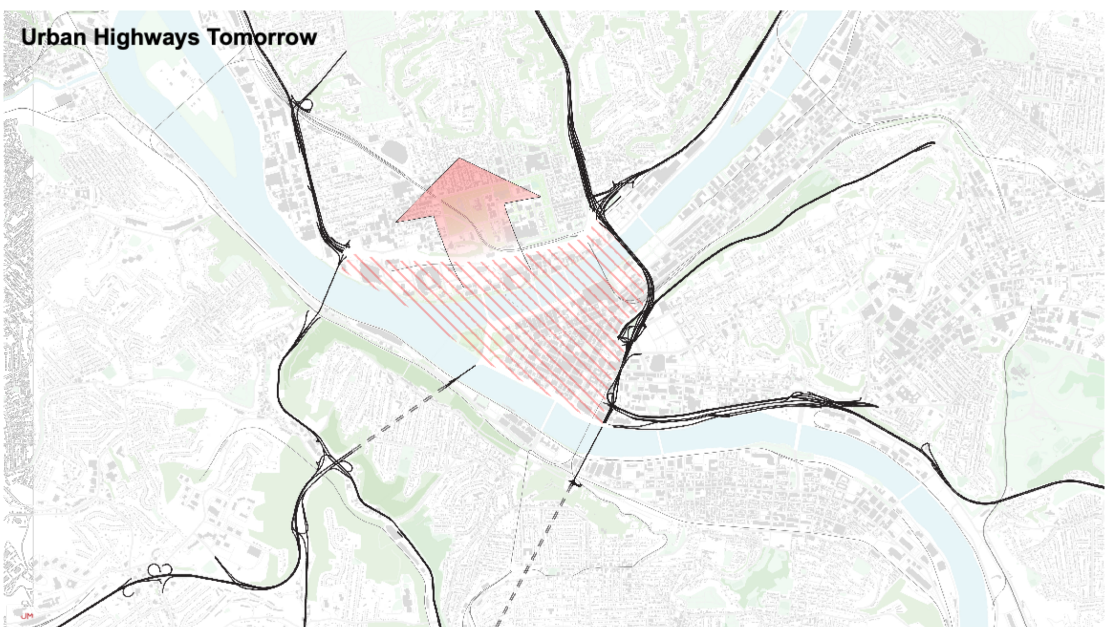

Figure 7.2: *Vision of Pittsburgh's urban highway network and expansion of the downtown area over the Allegheny river to allow for future growth of the city. (Source: Author)*

Figure 7.3: *Infrastructure strategy broken into three phases. (Source: Author)*

The Phase I of the incremental transformation of the infrastructure will focus on minimal physical interventions and reducing urban vehicle density, especially on the top deck of the raised highways. It proposes to systemize traffic flow on the top deck to include bike lanes and wider pedestrian passage. In the Phase II, the Fort Duquesne Bridge transforms to meet the ground at North Shore, acting similarly to the 6^{th},7^{th} and 9^{th} bridges to the East of the site that directly connects to the downtown district. Through these massive infrastructural projects, the city gains about 7.65 acres of new and improved lands for future development that can generate tax revenues to offset the cost of the projects. The new Fort Duquesne Bridge will provide another important connection over the Allegheny River to emphasize the city's intention to reconnect neighborhoods stronger in the future that was once lost in the past with the construction of the highways. The last phase will than transform the wall of raised highways to the north into an on-surface urban boulevard that reconnects with the city grid. The new urban boulevard will provide streetscapes and programs to create a streetscape with programs that generate an economy similar to Massachusetts Avue in Washington D.C. The entire transformation estimates to yield 20 acres for future development and offers an incredible opportunity to reimagine the site plagued by unsustainable, undesirable and unavailing properties into a fully sustainable, desirable and availing mixed-use district of the future.

Urban Principles on The New North Shore District

The current assessment of North Shore District lacks in many areas of good urban planning. While the site provides excellent connection via light rail station and walkable distance to the core of the city, it lacks in mobility, sustainability, diverse programs, and streets that could accommodate the future changes.

Figure 7.4: *Assessment of North Shore District today. (Source: Author)*

With the changes of the 21st century, the proposed urban principles of the new North Shore fully capitalize on the mass transit on site and prepares for the future of mobility including autonomous vehicles and micro-mobility. Streets will be designed with reconfigurable pavement systems that incorporate flexibility and smart technology to allow a seamless connection and communication with the digital infrastructure to navigate driverless vehicles and transform to adopt new programs. A robust green infrastructure will be incorporated into the urban design and provide clear access to the riverfront. Further, the two stadiums will be the core of urban amenities and programs that will be proposed to ensure that the site becomes lively and vibrant district year around.

Figure 7.5: *Proposed urban principles of North Shore District tomorrow. (Source: Author)*

Figure 7.6: *Current aerial view of the proposed site. (Source: Author)*

__Figure__ 7.7: Full vision of proposed masterplan on North Shore District. (Source: Author)

The full vision of North Shore District embraces the changes of the 21st century. With the transit hub as the core of the site, the main spine strongly links the two stadiums and connects to the surroundings.

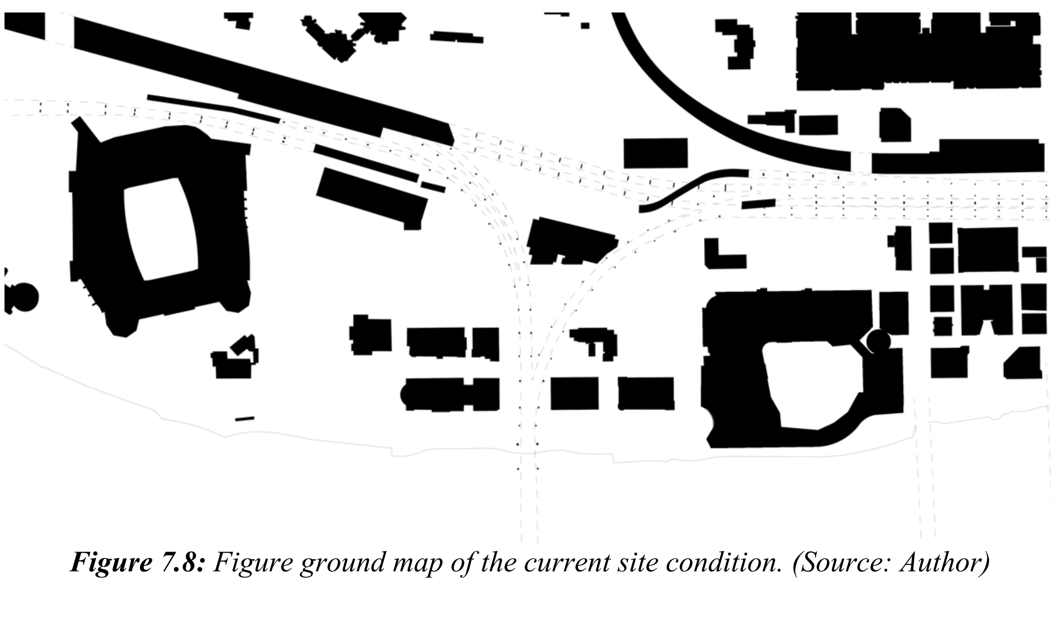

***Figure 7.8:** Figure ground map of the current site condition. (Source: Author)*

Figure 7.9: *Figure ground map of the proposed urban design. (Source: Author)*

<u>*Development Strategy*</u>

The full vision will be realized with a strategic development strategy that carefully crafts how transformation of the infrastructure and developments can occur concurrently. The phase I of the development focus on creating a place on North Shore at the corner of PNC Park with the first demolition of ramps that connects eastern portion of the highways. In Phase II, the development focuses on creating a strong core in the North Shore with the new transit hub that meets the light rail station and the new bridge landing. Phase III will begin to expend the development to the edges and connect to the surroundings. At the Heinz Field, the new plaza opens up directly to the water, while the Allegheny Gate changes the main axis of urban design to connect to North Side. The last phase focuses on the development of the urban boulevard and the streetscape. It also completes the reconnection of the city grid that was once lost.

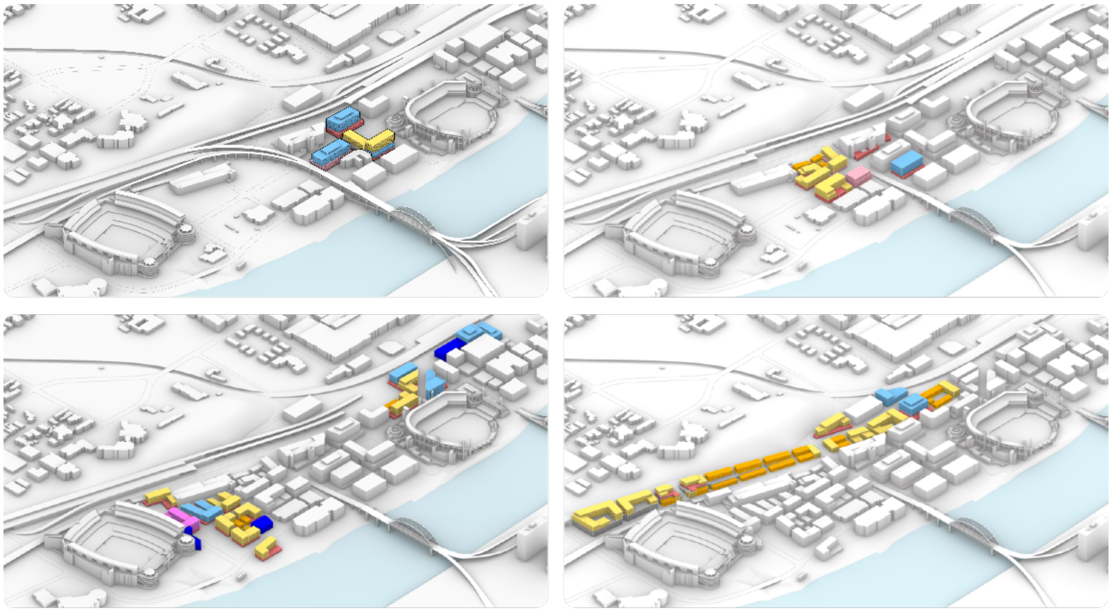

Figure 7.10: *Proposed development phasing strategy. From top left corner- phase I development to bottom right corner- phase VI. (Source: Author)*

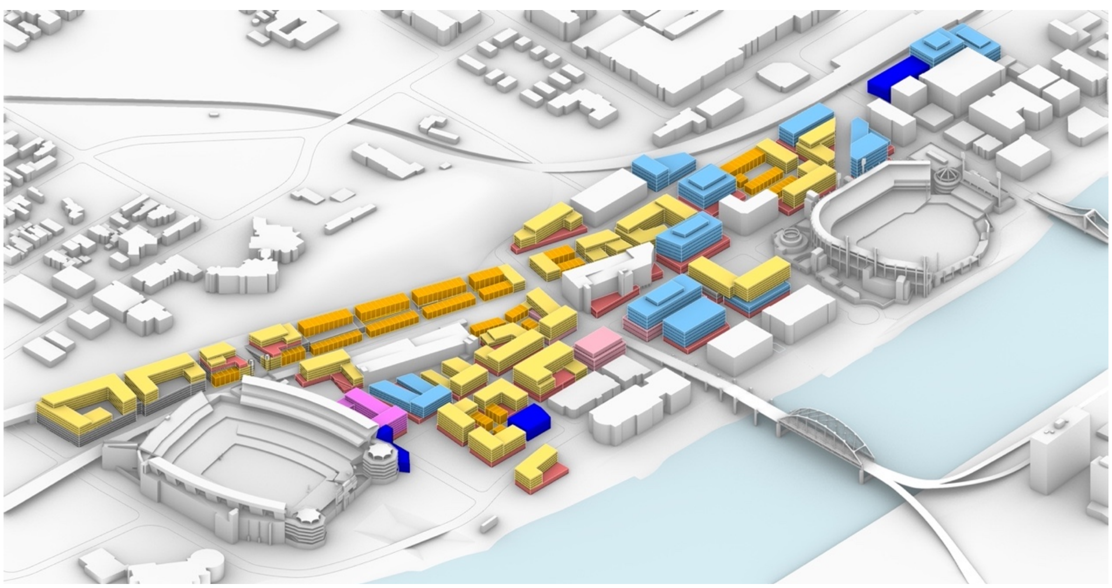

Figure 7.11: *Fully developed North Shore with preliminary programs proposed. (Source: Author)*

Urban Concepts

The North Shore will act as the *Crossroad* that provides seamless connection between North and South and East and West.

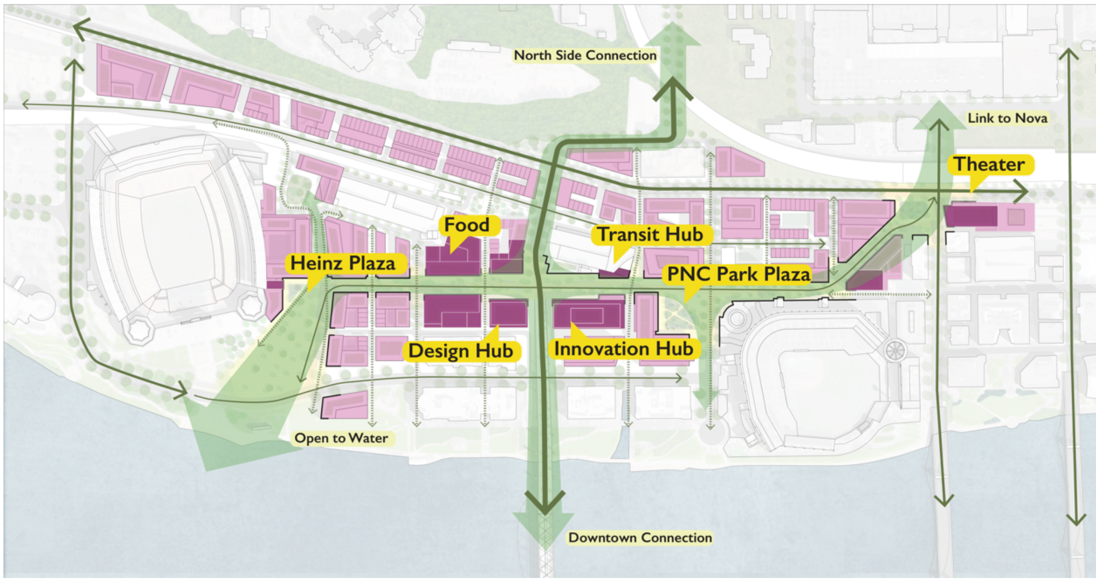

Figure 7.12: *Main concept for the urban design as the Crossroad at the center of North Shore, anchored by the transit hub. (Source: Author)*

The strong urban amenities will be centered around the transit hub to make a strong core for the district. With the proposed design center and innovation hub to align with the city's growth in the new industry, the north shore district will attract those highly skilled young professionals who enjoys the proximity to mass transit and to the diverse urban programs. An abundance amount of housing is also proposed to ensure the affordability in the area that benefits from the mass transit and the new mobility on site. The proposed vision firmly believes that the physical mobility and social mobility are an inseparable force that ensures the prosperity of a growing cities like Pittsburgh.

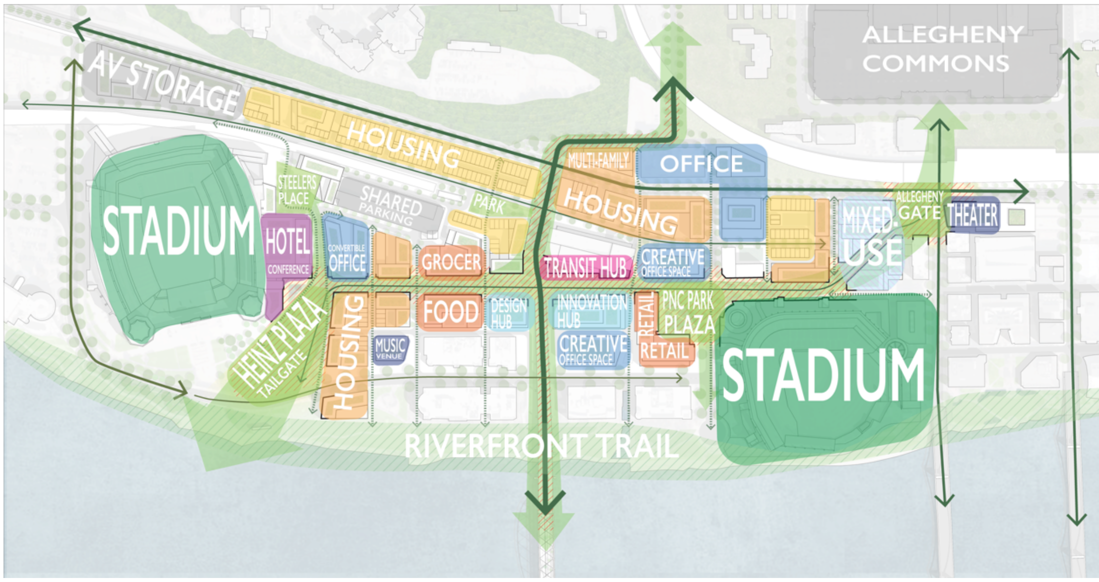

Figure 7.13: *Major urban amenities and programs proposed with the transit hub as the core and flanked by two stadiums to the East and West. (Source: Author)*

The strong spine that connects the two stadiums and beyond also offers beautifully designed public realms. Adjacent to the Heinz Field, the Heinz Plaza provides large spaces for tailgates during the football games, PNC Park Plaza at the corner of the baseball stadiums captures spectators before and after the ball game, and North Shore Landing as the heart of the development that provides great flexibility for mobility and for the ground floor programs.

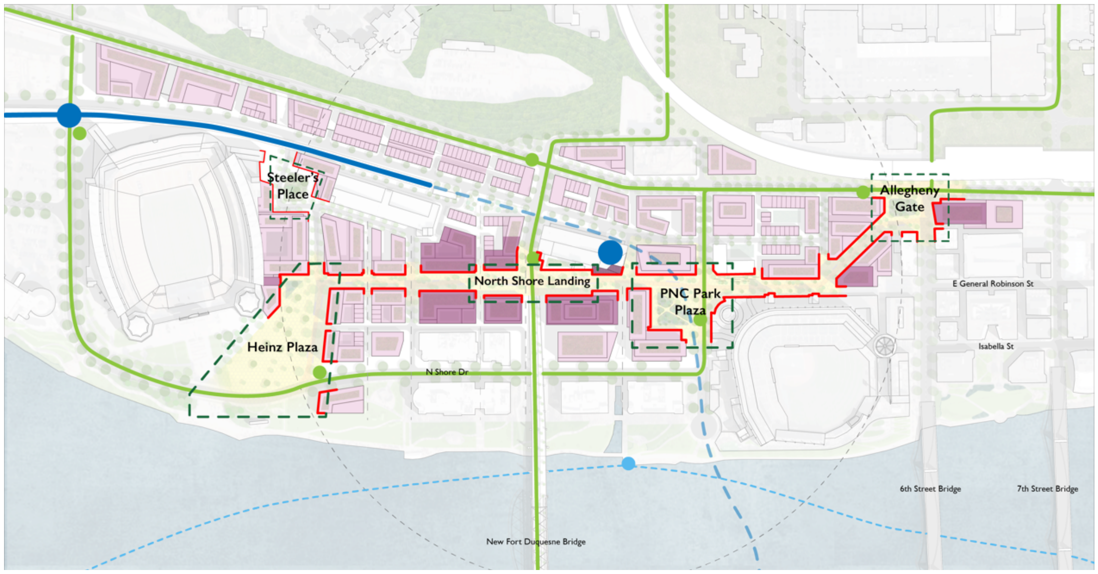

Figure 7.14: *Public places created with additional connections proposed throughout the site. (Source: Author)*

<u>Urban Mobility Strategy</u>

The development distinguishes different mobility of the future and controls how conventional modes of transportation and future mobility can safely roam within the district. While some streets can accommodate multiple modes of transportation, some are designated for pedestrians only and allow for more intimate streetscapes.

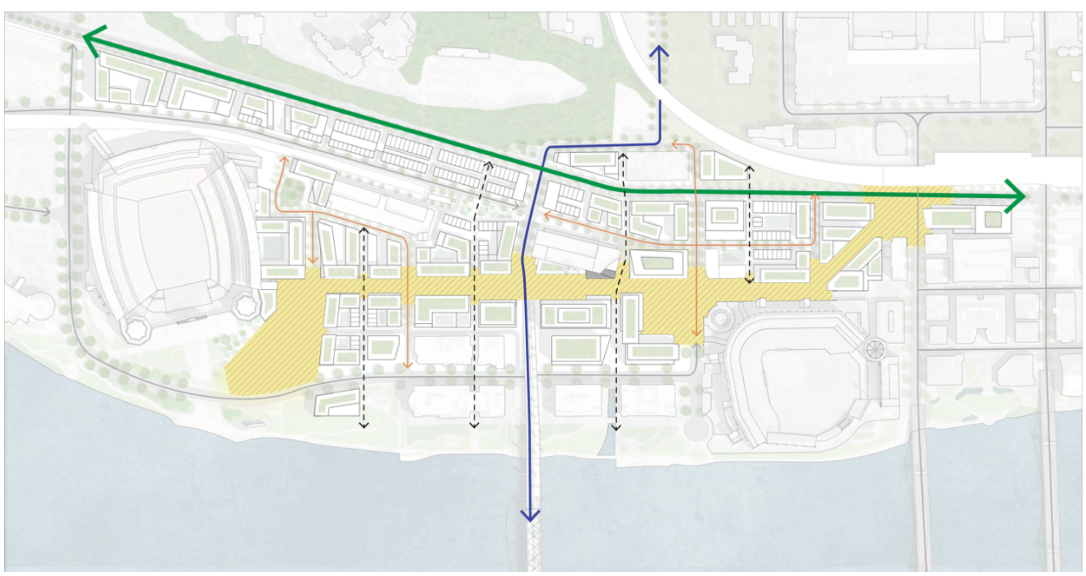

Figure 7.15: *Strategic mobility plan to control traffic with focuses on the pedestrian safety and experience. (Source: Author)*

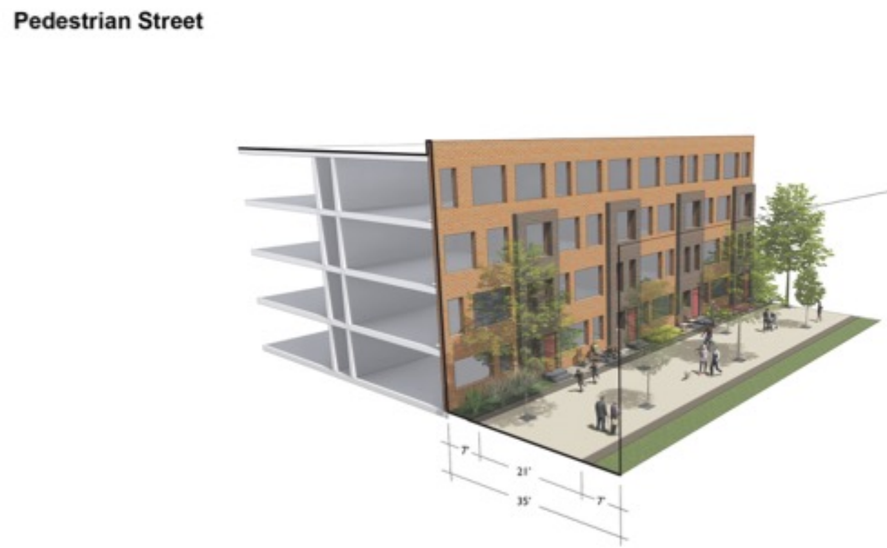

Figure 7.16: *Pedestrian-only street. (Source: Author)*

The pedestrian only streets focus on the residences and intimate scale with low density. The street allows for bikes and micro-mobility, but it encourages walking through the safe and quite streetscape. However, theses pedestrian streets are also designed to accommodate for emergency vehicles and special services access.

Figure 7.17: *Slow traffic street that allows controlled traffic with wide sidewalks for the pedestrians. (Source: Author)*

The Slow-traffic streets allows for vehicular access and for a higher density with retail programs on the ground floor. The design of the street controls the vehicular traffic while providing pleasant spaces for pedestrians and bicyclists.

Urban Boulevard

Figure 7.18: *Raised highway transformed into an urban boulevard with streetscape for pedestrians and bikers. (Source: Author)*

The urban boulevard will include ground floor retail and low-rise townhomes to be in sync with the scales of neighborhoods to the North. It is also designed to carry similar traffic volume from the raised highways, if not more, that connects the East and West highway network. The steep topography makes difficult to develop any programs to the North but provides excellent ecological benefits that the street can incorporate into the infrastructure.

New Shared Spaces

Figure 7.19: *The proposed new shared 'spaces' designed to accommodate all modes of mobility with reconfigurable pavement system that can provide flexibility of programs. (Source: Author)*

The new shared '*space*' is the vision of the future of urban streets. A shared space that can carry all modes of transportation, provide safe space for pedestrians and for ground floor programs, and to include smarter technology and robust green infrastructure. The reconfigurable pavement system allows for a real-time change in the flow of traffic and transforms the spaces for entirely new programs.

Future Infrastructure

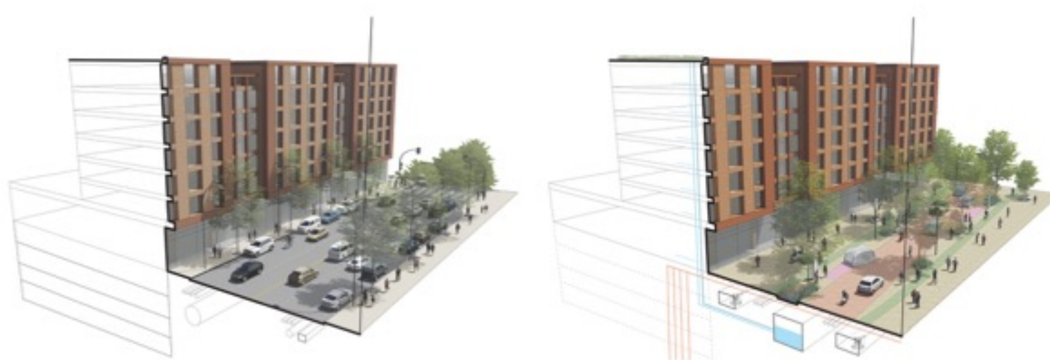

Figure 7.20: *Urban streets and infrastructure of the 21st century. (Source: Author)*

Urban Space Flexibility

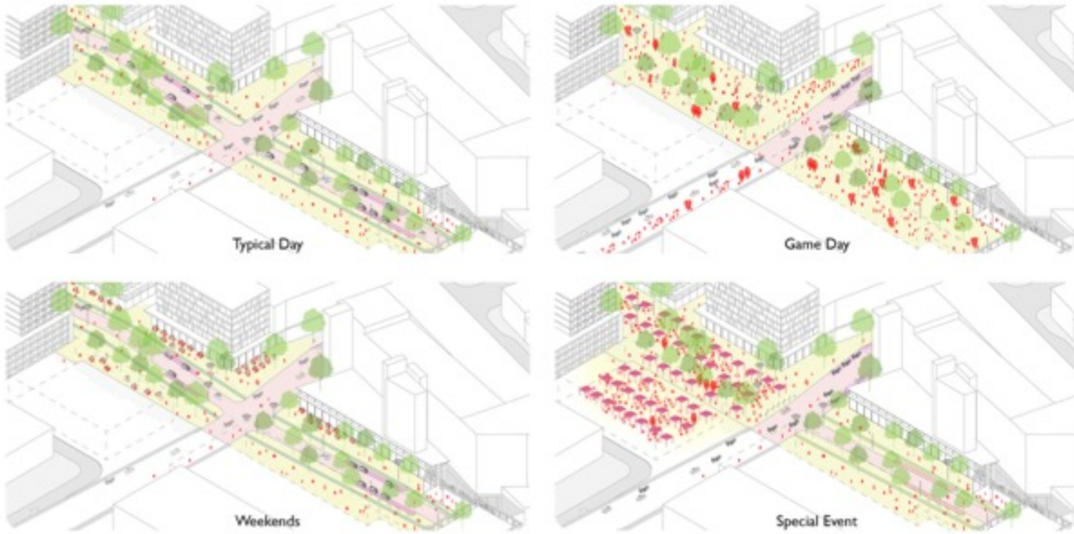

Figure 7.21: *The new shared spaces allow for flexibility and transformation for multiple programs and occasions. (Source: Author)*

Flexibility in public spaces and urban streets have become increasingly more important as the world combats the unprecedented pandemic. Cities all over the world have closed down streets to allow for more spaces for physical distancing, restaurants putting tables outside to keep the business open, and public spaces and parks flooded with people seeking breath of air during the lockdowns. It is evident that our urban streets must be something more than just a throughfare for vehicles. The streets have to carry the necessary traffic, but they must be able to transform and adopt to the unknown circumstances. It is inevitable that the world may face another pandemic and the urban streets must be prepared and be able to act as a critical component in public health of the future.

Flexibility in public spaces in North Shore district have even more relevance with the two major stadiums. The spaces must be able to transform to accommodate game-day goers and support the large crowds of people using the North Side Station to each stadium on foot. There also needs to be adequate spaces for drop-offs and pickup zones, as AVs will increasingly service the spectators to reach North Shore from other parts of the City as well as outside of it.

<u>The Future of North Shore, Pittsburgh</u>

Figure 7.22: *View of the new North Side Station. (Source: Author)*

Figure 7.23: *View of the PNC Park Plaza. (Source: Author)*

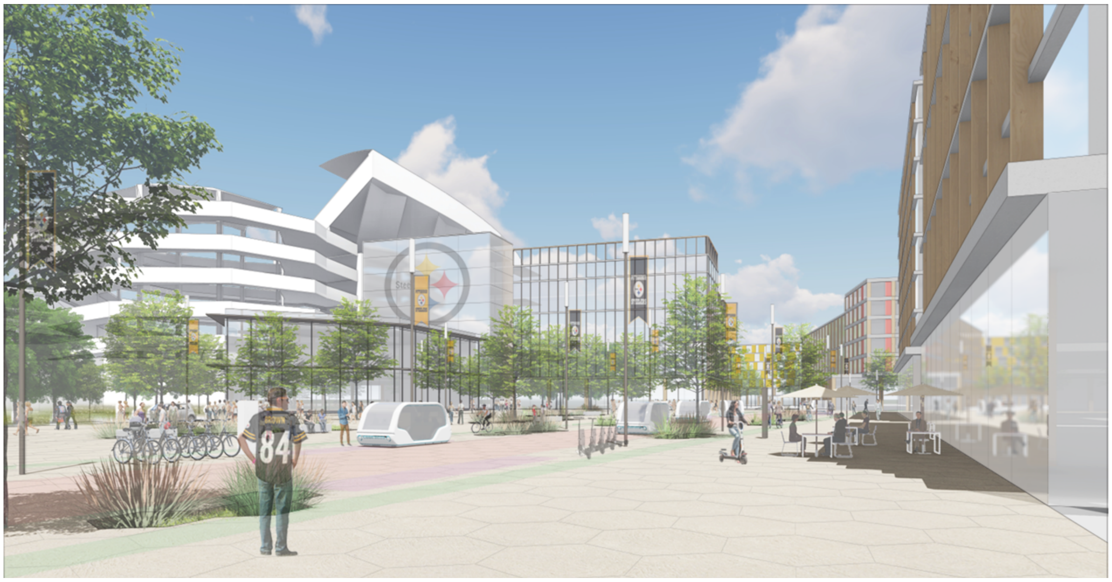

Figure 7.24: *View of the Heinz Plaza. (Source: Author)*

Figure 7.25: *Aerial view of North Shore in connection with the Downtown Pittsburgh. (Source: Author)*

The new North Shore District is the case study of how urban areas can reclaim its land from deteriorating urban infrastructure and recapture the value of its land through street and public space design of the 21st century. It also reconnects the district with the downtown Pittsburgh and North Side once separated by the same infrastructure that decreased the desirability of the land for any developments. Further, it explores the effects of the 21st century changes will have in our urban areas and design principles the cities will desperately need in the near future.

Figure 7.26: *Aerial view of North shore in connection with North Side, beyond the old, raised highways that has transformed into an urban boulevard. (Source: Author)*

The district prioritizes pedestrians and public realm of the future, visions for the advancement of all mobility, and the implementation of robust green infrastructure that prompts healthier urban life. The pedestrian oriented, yet multi-modal streets or public spaces aren't brand-new ideas. Perhaps the bustling scene from Mulberry Street in 1900 tells us even more story today. Perhaps urban streets can be designed to prioritize people over vehicles and be flexible with programs spilling to the outer spaces. Perhaps when designers design urban spaces rather than engineers plan arteries, the city can create beautiful, safe and functional streets that are transformative, adoptable and flexible for the rapid changes of the 21st century. Perhaps it is taking us a century to realize how we can design our urban spaces.

Figure 7.27: *Life on Mulberry Street, NYC c.1900. (Source: Detroit Publishing CO./Wikipedia Commons, 2008)*

Figure 7.28: *Life on Streets of North Shore District, Pittsburgh, tomorrow. (Source: Author)*

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