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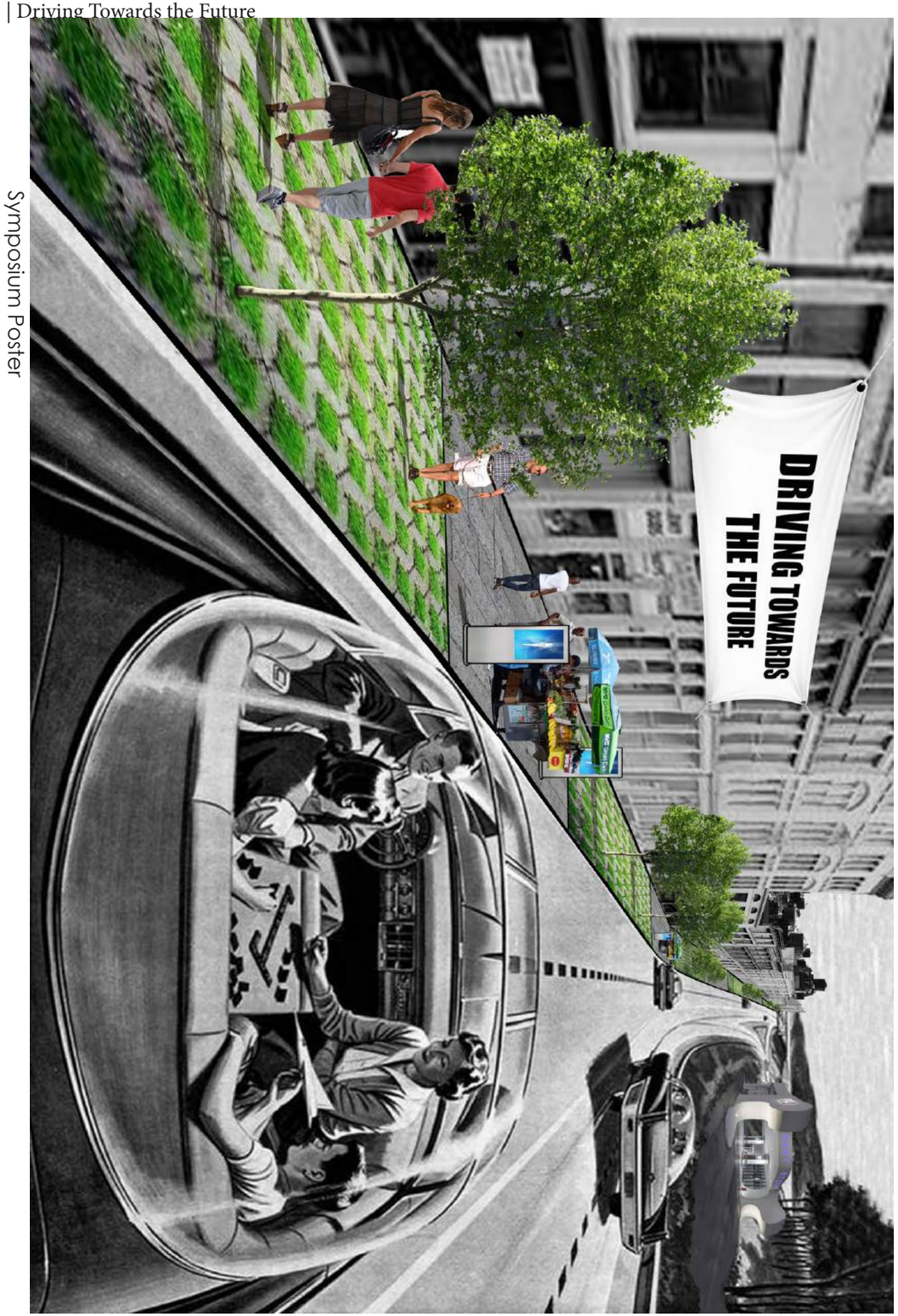

Driving Towards the Future: Developing the Autonomous-Electric Vehicles Identity and its Impact on Architecture.

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ABSTRACT

For over a hundred years, the internal combustion engine has been the primary method powering our vehicles. Initially perfected in Germany and France, American Henry Ford would bring the automobile to the masses with the development of the assembly line. Along with the development of the automobile, mortality rates have increased due to vehicular accidents and environmental pollution.

For a few years, automobile companies have been developing new vehicles that use less gasoline, produce fewer emissions, and prevent accidents. Autonomous-electric vehicles bring about a future of enhanced comfort and convenience. Time spent while traveling will be revolutionized, cityscapes roadways and parking lots will require less space, and stress from driving will be outdated. Most importantly, lives will be saved and the planet will be less polluted, creating a new transportation method whose identity will be of comfort.

To develop an understanding of why autonomous-electric vehicles will be about comfort and convenience, analytical research will focus on the understanding of "Identity", the understanding of the public psychology of the innovative technology, and projected architecture as a result of this new vehicle typology.

This understanding of why autonomous electric vehicles identity is comfort will then be used to develop an architectural design project to illustrate a new typology for the built environment.

INTRODUCTION

For over a hundred years, the internal combustion engine has been the primary method powering our vehicles, beating out steam power and electric batteries (ironically). Initially perfected in Germany and France by men such as Nicolaus Otto, Gottlieb Daimler, Carl Benz, and Emile Levassor, American Henry Ford would bring the automobile to the masses with the development of the assembly line. Since Ford's turn of the twentieth century innovation, automobile travel has helped transform our landscape. People have moved out from the crowded cities to sprawling suburbs, using the car to get to and from work. The Federal Aid Highway Act of 1956, championed by President Dwight D. Eisenhower, brought the development of interstates, fashioned after the development of the Autobahn in Germany two decades earlier[1], allowing families and individuals the ability to take long road trips with ease. Before long, new roadside lodges started popping up along these highways offering travelers a place to sleep or

[1] Weingroff, Richard F. "Federal-Aid Highway Act of 1956: Creating The Interstate System." U.S. Department of Transportation/Federal Highway Administration. Summer 1996. Accessed July 20, 2017. https://www.fhwa.dot.gov/publications/publicroads/96summer/p96su10.cfm.

eat. But with an ever-changing infrastructure, the development of the automobile as we know it has also brought death due to accidents and pollution due to exhaust emissions.

For a few years, automobile companies have been developing new vehicles that use less gasoline, produce fewer emissions, and prevent accidents. By developing vehicles that are driverless and run solely on electricity, the companies have lessened our reliance on gasoline and have lowered the number of accidents due to human error. But the development of these vehicles has not been without criticism. Studies show that the public has initial hesitations to adopt the new technology but are more accepting upon exposure to the new technology.

Upon the development of autonomous vehicles, new ride and car share programs are changing the notion of vehicle ownership, the amount of space dedicated in cities to roads and parking is shrinking, and time spend traveling in an automobile will be used more efficiently. Autonomous-electric vehicles will soon create their own identity, their own brand to the public, a brand of comfort and convenience. Architecture developed around the automobile with then evolve.

METHODOLOGY

To study what changes architecture will undergo with the development of autonomous vehicles, this paper discusses what is the identity of autonomous vehicles. Using analytical and literature research, our current state of vehicle travel is compared to that of autonomous-electric vehicles, with respect to safety, pollution, and public opinion. This research, combined with logical argumentation, is used to explain why the identity of autonomous-electric vehicles is one of comfort and convenience. Analytical research of how the autonomous-electric vehicle works and of psychological surveys about autonomous-electric vehicles are used to support why comfort and convenience is autonomous-electric vehicles identity.

This research culminates in a design project developed to illustrate how the identity of comfort and convenience is engaged in the marketing and experience autonomous-electric vehicles.

CURRENT STATE OF VEHICULAR TRAVEL

For over a hundred years, the internal combustion engine has been the primary method powering our vehicles, beating out steam power and electric batteries (ironically).[2] "Initially perfected in Germany and France toward the end of the nineteenth century by such men as Nicolaus Otto, Gottlieb Daimler, Carl Benz, and Emile Levassor"[3], American Henry Ford was able to bring the automobile to the masses with the development of the assembly line. Since, automobile travel has helped transform our landscape. People have moved out from the crowded cities to sprawling suburbs, using the car to get to and from work. Interstates appeared allowing families and individuals the ability to take long road trips with ease, stopping every so often to sleep of eat at new road lodges that were popping up along the highways. With the everchanging infrastructure, the development of the automobile as we know it has also brought death and pollution.

In 2015, the number of traffic deaths in the United States was 35,092, up 7% from 2014, the largest percentage increase since 1966.[4] Of these traffic deaths, 81% are the result of human error.[5] Globally, reports indicate that the

[2] Mitchell, William J., Chris Borroni-Bird, and Lawrence D. Burns. *Reinventing the automobile: personal urban mobility for the 21st century*. Cambridge: The MIT Press, 2015. (pg. ix)
[3] "Automobile History." History.com. 2017. Accessed May 15, 2017. http://www.history.com/topics/automobiles.
[4] Worland, Justin. "Low Gas Prices Contribute to Record Traffic Deaths." Time. August 30, 2016. Accessed March 11, 2017. http://time.com/4472374/traffic-deaths-gas-price/.
[5] "Are We On The Road To Self-Driving Cars? [Infographic]." Infographic] | Mustang News Blog | CJ Pony Parts. August 20, 2014. Accessed March 03, 2017. https://blog.cjponyparts.com/2014/08/are-we-road-self-driving-cars-infographic/.

percentage of traffic deaths caused by human error may swell up to 95%.[6] The possible ways a driver may cause a fatal accident are numerous: texting, eating, messing with the radio, etc. Sometimes the driver may just make an error in judgment of when to change lanes or turn.

Environmentally, in 2008, the world was consuming 18 million barrels of oil each day driving cars and vehicles and emitting 2.7 billion tons of carbon dioxide each year.[7] In 2014, BP (British Petroleum) estimated that the world only has 53.3 years of oil left[8] and "EV World" reports that gas cars reporting fuel efficiencies of 20 miles per gallon emit 366 grams of carbon dioxide per kilometer[9].

Our current state of vehicular travel has also had a large impact on our infrastructure. 85% of personal travel in the United States is by automobile. "Americans drive three trillion miles a year, on four million miles of roads, consuming 180 billion gallons of fuel each year dispensed from 170,000 service stations."[10] In cities across the United States, traffic is getting more congested and interstates are getting wider. "In dense city centers, average urban speeds today can be well under 10 miles per hour".[11] However, a vehicle spends upward to 95% of its time parked.

THE POTENTIAL FUTURE OF ARCHITECTURE BECAUSE OF AUTONOMOUS/ELECTRIC VEHICLES

In 2010, the late William J. Mitchell, an architect, urban planner, and dean at the School of Architecture and Planning at Massachusetts Institute of Technology, collaborated with Dr. Christopher E. Borroni-Bird, and Dr. Lawrence D. Burns to publish *"Reinventing the Automobile: Personal Urban Mobility for the 21st Century,"* a "comprehensive vision for the future of automobiles, personal mobility systems, and the cities they serve"[12]. At the time of the publication, Dr. Christopher E. Borroni-Bird was the Director of Advanced Technology Concepts and Electric Networked Vehicles (EN-V) Program at General Motors and Dr. Lawrence D. Burns was the Vice President of Research and Development at General Motors. Sounding like something out of science-fiction, "Reinventing the Automobile: Personal Urban Mobility for the 21st Century," proposes the development of autonomous-electric vehicles using technology that is already available. Using sensors and wireless communication to navigate and operate, these battery plug-in, hydrogen, and/or extended range vehicles will be able to transport passengers from one location to another without the driver ever needing to touch the wheel, all the while being able to detect objects and stop accordingly to avoid any accidents.

With a future of autonomous vehicles looming ahead, what will be the future of the architecture to vehicle relationship? Architect Le Corbusier was fascinated with cars, to the point that author David Balsuto notes "the aesthetics of this functional, mass produced machine deeply influenced his designs"[13] and that Le

[6] Smith, Bryant Walker. "Human error as a cause of vehicle crashes." Center for Internet and Society. December 18, 2013. Accessed May 13, 2017. http://cyberlaw.stanford.edu/blog/2013/12/human-error-cause-vehicle-crashes.
[7] Mitchell, William J., Chris Borroni-Bird, and Lawrence D. Burns. *Reinventing the automobile: personal urban mobility for the 21st century*. Cambridge: The MIT Press, 2015. (pg. 3)
[8] Fool, Matt DiLallo The Motley. "The world has 53.3 years of oil left." USA Today. June 28, 2014. Accessed May 11, 2017. https://www.usatoday.com/story/money/business/2014/06/28/the-world-was-533-years-of-oil-left/11528999/.
[9] "Gasoline Verses Electric Car Emissions Compared." Evworld.com. April 28, 2014. Accessed May 13, 2017. http://evworld.com/news.cfm?newsid=32951.
[10] Mitchell, William J., Chris Borroni-Bird, and Lawrence D. Burns. *Reinventing the automobile: personal urban mobility for the 21st century*. Cambridge: The MIT Press, 2015. (pg. 3)
[11] Mitchell, William J., Chris Borroni-Bird, and Lawrence D. Burns. *Reinventing the automobile: personal urban mobility for the 21st century*. Cambridge: The MIT Press, 2015. (pg. 3)
[12] Mitchell, William J., Chris Borroni-Bird, and Lawrence D. Burns. *Reinventing the automobile: personal urban mobility for the 21st century*. Cambridge: The MIT Press, 2015. (pg. ix)
[13] Basulto, David. "Robots, Cars and Architecture." ArchDaily. October 14, 2013. Accessed May 11,

Corbusier believed houses should be "machines for living". He would exemplify this by designing floorplans to accommodate a car's turning radius. So how will the future of architecture change once autonomous vehicles becomes the primary source of individual travel?

Imagine the following. Waking in the morning, getting ready to head to work, and during breakfast, you pull out your phone and order an autonomous car to come pick you up. When you walk outside, the car that you just ordered is out front waiting for you. The roads are narrow, and the sidewalks are large. Up and down the roadway are no parked cars, and the parking lot down the road is now a new dog park. Once in the car, you are not shifting gears, working the pedals, or experiencing road rage from the vehicle that just cut you off. Once in the autonomous vehicle, you sit back, relax, and check your emails on your phone. Once at your office, the autonomous vehicle does not drive around looking for a parking spot but instead drops you off at the front door. After being dropped off, the autonomous vehicle takes off, to pick up another individual to be dropped off at their job.

Now imagine you are getting ready to head out on a road trip. You have ordered your autonomous vehicle, packed it full, and are on the interstate as your autonomous vehicle drives just inches away from other autonomous vehicles. After a while, your electric powered autonomous vehicle is low on energy. So, you pull off the interstate to a new state-of-the-art rest stop to charge your battery, exchange batteries, or exchange whole automobiles.

The history of rest stops dates to before 1925 when campgrounds, known as 'auto camps', would offer amenities like running water, restrooms, and picnic grounds. In 1925, the history of roadside motels and rest stops would change with the opening of the Milestone Mo-tel in San Luis Obispo, California, costing $1.25/night. In the 1930's and 40's, motel chains like Alamo Plaza Hotel Courts, Best Western, and Travelodge began to appear, and by 1950, 50,000 motels across the United States would be catering to 11 million vacationers[14]. Today, even though the golden age of roadside motels has passed, safety rest areas, not offering much more than the original 'auto camps', can still be seen along highways across the United States.

At the rest stop of the future, there are a variety of restaurant choices, shopping locations, rentable rooms with showers, and a park to stretch your legs. With autonomous-electric vehicles being able to drive themselves, it is not too unimaginable to think that travelers would just sleep in their cars while driving. Because of this, the new rest stops would be used as a place to stretch, eat, use the restroom, or to maintenance the vehicle. Roadside attractions, like shopping malls or oddities, maybe even used to coerce and entertain travelers while they wait for vehicle maintenance.

IDENTITY

With autonomous-electric vehicles coming into fruition at a time when future generations seem to be leaning towards car and ride share programs instead of ownership, one wonders what the identity or brand of autonomous-electric vehicles will be.

Originating from Latin, identity (or *idem*) meant "the same". Later from Middle French, *identité* would mean "sameness, oneness, state of being the same"[15]. In the study of philosophy today, identity means "relation each thing bears just to itself" and in the social sciences and study of psychology, identity stands for the qualities, beliefs, personality, looks and/or expressions that make up a person or group.[16] Simply put, an 'identity' is the makeup of outward projections and relationships one has with the surrounding world.

In business, "Corporate Identity" is everything a company uses to image itself such as logos and store/internet designs. The difference between corporate identity and a brand is a brand is the impression people have about a company. Branding is then the "process of crafting messages and communications that will help to form the impressions people will have about a company"[17]

Branded as a sleek, innovative technology company, Apple's identity revolves around avant-garde computer technology and contemporary product and store design. Vehicle manufacture Aston Martin's identity is that of luxury sport cars. Branded that way from their consistent production of high end performance based vehicles. For autonomous vehicles, the sum of the outward projections on enhanced safety, lower emissions, less congested roadways, more efficient use of cityscape and time, and internet connectivity help create an electric-autonomous vehicle identity of comfort and convenience.

With the ability to rent an autonomous vehicle through mobile devices, the electric-autonomous vehicles presented in the earlier scenarios are also able to be connected to the internet for user convenience. Internet connectivity will allow for passengers, being driven by the vehicle, to check emails or a social network. The autonomous vehicles will also be able to be communicate wirelessly with other autonomous vehicles, broadcasting its position, heading, and velocity to other vehicles to help prevent collisions and to help with travel efficiency.

The more efficient roadways and travel times also means that time travelling will be more predictable, more efficient, and more comfortable for a user to schedule around.

Autonomous driving will also mean those who were previously unable to operate a vehicle, like the elderly or disabled, will be able to get around freely.

Indirectly, neighbors will be able to physically connect with their neighbors more easily do to larger sidewalks, as noted in architectural critic Jane Jacobs work "The Death and Life of American Cities". The larger sidewalks will be gained from the enhanced efficiency that autonomous vehicles bring. Being able to communicate with one another, the cars will be able to travel more uniformly with one another, travelling mere inches from each other. This means that roadways will be utilized more efficiently, needing less lanes, and thus greater potential for larger sidewalks.

For architecture, this impact will be felt the greatest in the suburbs and rural areas where vehicular travel is more prudent. Single use buildings that people would drive to and from, from one stop to another, will become mixed used, single destinations stops. Strip malls with large parking lots will become outdated, as will drive thru's. Vehicle sharing will also mean that less space will be needed for vehicle parking, similar to the road trip in an autonomous vehicle scenario presented earlier, where the roadways were clear of parked vehicles and a former parking lot was able to be renovated into a new dog park. In return, this will mean that drivers will spend less time looking for parking spots. Ride sharing will also mean more efficient use of vehicles meaning less vehicles will be needed.

UNDERSTANDING AUTONOMOUS-ELECTRIC VEHICLES AND THEIR BENEFITS

Such a prediction may sound like science fiction, but it is coming sooner than what people may think. Thanks to ride-share mobile apps like Lyft and Uber, as well as vehicle share programs like Columbus, Ohio's 'CAR2GO', the number of people owning their own cars is decreasing. According to the American Census Bureau, car-

2017. http://www.archdaily.com/438388/robots-cars-and-architecture.
[14] Sedghi, Sarra. "Time Travel: The History of Motels." Pastemagazine.com. November 24, 2015. Accessed June 17, 2017. https://www.pastemagazine.com/articles/2015/11/time-travel-the-history-of-motels.html.

[15] Harper, Douglas. "Online Etymology Dictionary." Online Etymology Dictionary. 2017. Accessed May 10, 2017. http://www.etymonline.com/index.php?allowed_in_frame=0&search=identity.
[16] James, Paul (2015). "Despite the Terrors or Typologies: The Importance of Understanding Categories of Difference and Identity". Interventions: International Journal of Postcolonial Studies. 17 (2): 174-195.
[17] Quinn, Chris. "Branding, Differentiation, Corporate Identity and Positioning Defined." Insight180. February 02, 2011. Accessed May 11, 2017. https://www.insight180.com/branding-differentiation-corporate-identity-and-positioning-defined-feb-2011/.

less households are on the rise, with 9.1% of American household's car-less as compared to 8.9% in 2010. [18] The Millennial generation is the largest components of no car ownership. From 2007 to 2011, the number of cars purchased by individuals between the ages of 18 to 34 fell almost 30%.[19] In fact, only 44% of millennial teens obtained their licenses within a year of gaining eligibility.[20]

Between 2004 and 2013 the "U.S. Department of Defense's Research Arm, DARPA, sponsored a series of challenges that pushed autonomous technologies forward."[21] In 2007, the 60-mile long urban environment challenge saw four vehicles complete the course in the six-hour time limit. Currently multiple manufactures like Audi, BMW, Chrysler, Ford, General Motors, Honda, Hyundai, Nissan, and Toyota, are in the process of developing driverless vehicles.[22] Tesla has come so far in driverless technology that in 2015 they were able to introduce an "Autopilot" feature in their Tesla Model S, enabling hands-free driving for highway and freeway driving.[23] Safety wise, the driving component behind the development for autonomous technology, the National Transportation Safety Board states that Tesla's with an autopilot option deploy their airbags, as a whole, every 1.3 million miles driven, as compared to their non-autopilot counterparts who deploy their airbags, as a whole, every 800,000 miles.

To reduce our dependence on gasoline, three main types of electric vehicles are in production today; battery plug-in, hydrogen fuel cells, and extended range electric vehicles. Battery plug-in and extended range electric vehicles use battery-powered electricity obtained by plugging the vehicle into charging stations. However, the extended range electric vehicle contains a small gas engine to be used as an alternative power supply for the motor, but only when the electric battery is depleted of energy. Hydrogen fuel cell vehicles on the other hand, obtain their energy from the electron of a hydrogen atom.

Except for steam produced by hydrogen fuel cell cars, electric vehicles emit zero emissions. In fact, for electric vehicles powered by solar energy, the total energy production emissions are only 79 grams of carbon dioxide per kilometer as compared to 366 grams of carbon dioxide per kilometer for gas vehicles with an average MPG of 20[24]. It is also cheaper to charge a battery plug-in car. For battery plug-in cars that are promised to be the most affordable electric car solution, the cost per mile of electricity used to recharge the battery comes out to be anywhere between one-third to one-sixth of the cost of gas per mile depending on

[18] Gershgorn, Dave. "After decades of decline, no-car households are becoming more common in the US." Quartz. December 28, 2016. Accessed May 10, 2017. https://qz.com/873704/no-car-households-are-becoming-more-common-in-the-us-after-decades-of-decline/.

[19] Ross, Darren. "Millennials Don't Care About Owning Cars, And Car Makers Can't Figure Out Why." Fast Company. September 13, 2016. Accessed May 11, 2017. https://www.fastcompany.com/3027876/millennials-dont-care-about-owning-cars-and-car-makers-cant-figure-out-why.

[20] Ross, Darren. "Millennials Don't Care About Owning Cars, And Car Makers Can't Figure Out Why." Fast Company. September 13, 2016. Accessed May 11, 2017. https://www.fastcompany.com/3027876/millennials-dont-care-about-owning-cars-and-car-makers-cant-figure-out-why.

[21] "A Brief History of Autonomous Vehicle Technology." Wired. August 10, 2016. Accessed March 03, 2017. https://www.wired.com/brandlab/2016/03/a-brief-history-of-autonomous-vehicle-technology/ This story was published by the Wired Brand Lab for the Ford Motor Company

[22] Messner, William. "Tomorrow's self-driving car looks nothing like today's." Newsweek. February 04, 2017. Accessed March 03, 2017. http://www.newsweek.com/self-driving-cars-tesla-innovation-550434.

[23] "A Brief History of Autonomous Vehicle Technology." Wired. August 10, 2016. Accessed March 03, 2017. https://www.wired.com/brandlab/2016/03/a-brief-history-of-autonomous-vehicle-technology/ This story was published by the Wired Brand Lab for the Ford Motor Company

[24] "Gasoline Verses Electric Car Emissions Compared." Evworld.com. April 28, 2014. Accessed May 13, 2017. http://evworld.com/news.cfm?newsid=32951.

the cost of gas ($2-$4)[25]. As for hydrogen, the energy efficiency for hydrogen fuel cell cars is approximately 60% in comparison to a gas car whose energy efficiency is approximately only 20%.[26] Examples of cars in production are the Nissan Leaf (Plug-In), Toyota Miria (Hydrogen), and Chevrolet Volt (Extended Range).[27]

PUBLIC PSYCHOLOGY OF AUTONOMOUS-ELECTRIC VEHICLES

When looking at the benefits that come from the development of autonomous and electric vehicles, one might wonder why these vehicles are not making their way to roadways faster. Besides technological barriers that may exist, the answer may be in the public psychology of autonomous and electric vehicles.

In 2014, the University of Michigan Transportation Research Institute released a public opinion survey report indicating that out of the 576 United States respondents, 30% stated that they never heard of autonomous vehicles and three-fourths of drivers in a 2016 AAA survey stated that they feared getting in and riding in an autonomous vehicle. Furthermore, when the University of Michigan Transportation Research Institute respondents were asked "How interested are you in autonomous vehicles? Very Interested, Moderately Interested, Slightly Interested, or Not at all Interested"; "Not at all Interested" was the number one response. But, this only accounted for 33% of the total respondents, meaning that 67% of the respondents stated that they are at least "Slightly Interested". As for the fear of getting in and riding in an autonomous vehicle, Brian Lathrop, a cognitive psychologist and Senior Manager of Electrics Research Lab at the Volkswagen Group of America in Belmont, California, states that "Even though (people) usually had a prior sense of distrust, people minds quickly changed after having a short positive experience with technology".[28]

For electric vehicles, the National Renewable Energy Laboratory released a consumer report on plug-in electric vehicles in 2016. Of the 1,015 United States respondents, only 48% said that they believed electric vehicles were as good or better than gas vehicles. 52% could not name a make or model of an electric vehicle and 41% never reported being in or around an electric vehicle. But, "respondents with a higher awareness of (plug-in vehicles) who could name one of the top nine best-selling (plug-in vehicles), or who have seen (plug-in vehicles) in parking lots were more likely to report positive views." 19% of respondents even stated that they would consider buying or leasing an electric vehicle, which is twenty times the current number of electric car owners.

What both these reports indicate is an initial hesitation by the public to adapt and trust the new technology. The reports go on though, to show that those who have had greater exposure to autonomous and electric vehicles are more likely to embrace and trust them, meaning that public favor of autonomous and electric vehicle relies on how much more often the public is exposed to them. This is ironic because of one of the identities of electric and autonomous cars is of comfort.

PRECEDENT STUDIES

Personal Rapid Transportation (PRT)

Personal Rapid Transportation (PRT), or podcars, is a new form of public transit similar to a monorail. However, unlike a monorail system, PRT does not in involve an individual boarding a train crammed with dozens of other

[25] Mitchell, William J., Chris Borroni-Bird, and Lawrence D. Burns. *Reinventing the automobile: personal urban mobility for the 21st century*. Cambridge: The MIT Press, 2015. (pg. 15-16)

[26] "DriveClean.ca.gov." Drive Clean - Hydrogen Fuel Cell. Accessed March 09, 2017. https://www.driveclean.ca.gov/Search_and_Explore/Technologies_and_Fuel_Types/Hydrogen_Fuel_Cell.php.

[27] "Compare Fuel Cell Vehicles." Fueleconomy.gov. U.S. Department of Energy. Accessed March 11, 2017. https://www.fueleconomy.gov/feg/fcv_sbs.shtml.

[28] Hsu, Jeremy. "75% of U.S. Drivers Fear Self-Driving Cars, But It's an Easy Fear to Get Over." IEEE Spectrum. March 07, 2016. Accessed March & April 2017. http://spectrum.ieee.org/cars-that-think/transportation/self-driving/driverless-cars-inspire-both-fear-and-hope

people, stopping at every station along the route. On a PRT, an individual, or group of individuals (2-6 typically) board a pre-reserved Podcar that takes them directly to their destination, not stopping at any other stations along the way. A PRT also does not operate like a traditional monorail. Where a monorail rides on/from a single beam and is powered by a third rail, PRT's are battery powered and operate on paved roads, using lasers from the car to guide its way to the destination. Because a PRT's infrastructure only needs to withstand a fraction of the weight of a monorail system, and because the track itself is lighter, the cost to erect a PRT system is less expensive.

To ensure the safety of the Podcars, PRT's run on three layers of controls: Central Synchronous Control, Autonomous Vehicle Control, and an Automatic Vehicle Protection System. The Central Synchronous Control ensures that vehicle journey's do not conflict. Autonomous Vehicle Control is the vehicles laser guided system and the Automatic Vehicle Protection System ensures vehicles will not contact each other.

The first PRT system was developed in Morgantown, WV in 1975 at West Virginia University. Since, PRT developments have popped at London's Heathrow Airport, Masdar City in the UAE, and in Suncheon, South Korea, to name a few.

Heathrow airport opened its PRT in October of 2010 with 21 Podcars. Developed by Ultra global PRT, the PRT connect Terminal 5 to the business passenger car park and has a total route distance of 2.4 miles. Currently, the average wait time for a Podcar is 10s and the PRT has a 99% reliability rating. Environmentally, the PRT uses 50% less energy than the buses they used to drive the same route and at 10 meters away, the noise produced by a Podcar at full speed is 35dbs (less than the expected background noise at a library).

In Masdar city, a planned city in Abu Dhabi, UAE, personal vehicles are banned. When one enters the city in their personal car, they are to park their vehicle in a parking garage at the edge of the city and then use either mass public transit or PRT. What this design has done for Masdar City is allow for more narrow streets. These narrow streets help provide shade in the desert and channel cool breezes. Like Heathrow Airport, Masdar City's PRT has a near 99% reliability rating.

Driverless Future Challenge[29]

In 2017, Blank Space, an architectural firm located in New York City, hosted a public competition titled "Driverless Future: A Blank Space Challenge to Shape Autonomous Transportation Partnership with the City of New York". This challenged was brought forward to explore different ways the City of New York could take full advantage of the benefits of autonomous transportation. After many entries, a panel consisting of individuals from the City of New York's Mayors Office of Tech and Innovation, New York City Department of Transportation, American Institute of Architects New York, Blank Space, and many others, narrowed down the field of entries to four; Public Square, Urban Oasis, sAVe, and QueueY.

The focus of the four finalist varies from transforming former curb parking into interchangeable public spaces, to autonomous grocery carts that travel throughout the city. Public Spaces concept was that of interlocking, everchanging, public built-in infrastructure. Using 8'x'8 unitized squares that can be easily installed and uninstalled, reclaimed street side space can be changed into almost anything; green space, sitting area, retail area, play equipment, etc.

Urban Oasis will use autonomous technology to solve the problem of food deserts throughout the city. After being loaded with fresh groceries from nearby farmers, the autonomous grocery carts will transport themselves to these food deserts where a local employee will sell the fresh groceries. This technology could also be used to deliver groceries to those who are disabled.

The last two entries focus more on the capabilities of autonomous vehicles themselves. sAVe is a proposed ride share program where autonomous-electric vehicles will travel around local neighborhoods offering rides to the nearest mass-transport station (ex. Subway station). These ride pickups can be booked through smartphone apps, community kiosk, and a customer service representative. QueueY is a proposed concept for new kiosk stations that may be used for hailing an autonomous vehicle. These stations would be placed at the exits of mass-transport stations like subways.

Public Space did go on to be announced the winner of the Driverless Future challenged and was award a cash prize, access to workspace and a fabrication lab, as well as a chance to pitch their proposals to New York City Commissioners.

CONCLUSION

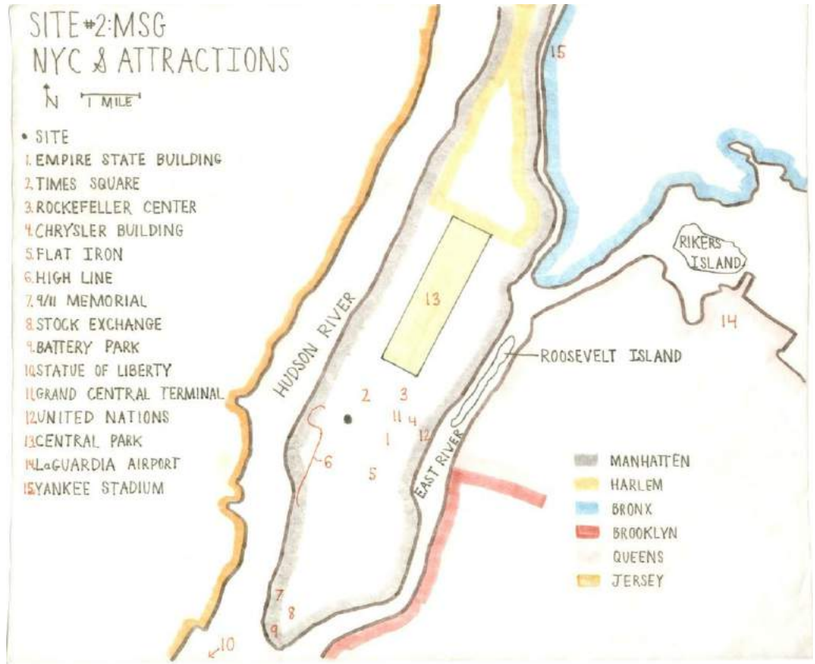
Architect Mies van der Rohe stated "Wherever technology reaches its real fulfillment, it transcends into architecture"[30]. After over 100 years of combustion engine travel, cars are transcending into autonomy. Developed with an identity of comfort and convenience, autonomous cars foresee a change in architecture that has grown around the mobility of vehicular travel. Roadways will be utilized more efficiently and vehicles will be more connected than ever. Cityscapes will experience less parked cars and parking lots, while sidewalks become larger for gathering. All these changes will occur from the development of electric and autonomous vehicles designed to make roadways safer and cleaner.

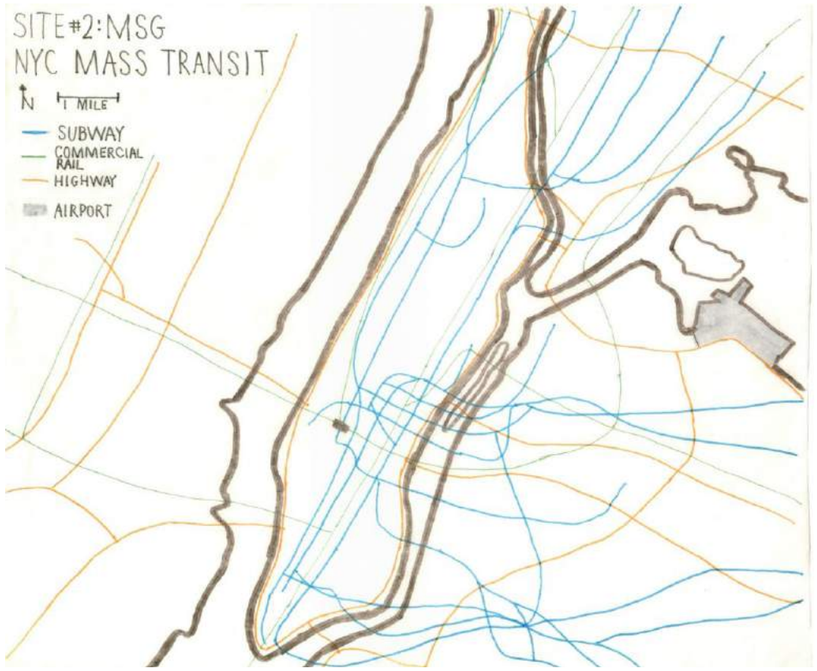
[29] "'Public Square' Wins Driverless Future Challenge." Driverless Future Challenge. Spring 2017. Accessed August 02, 2017. http://driverlessfuture.blankspaceproject.com/.

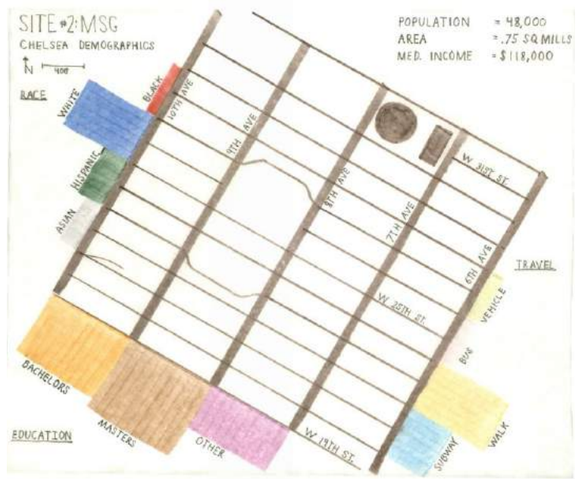
[30] Conrads, Ulrich. *Programs and manifestoes on 20th-century architecture*. Cambridge, MA: MIT Press, 1964. (Pg. 154)

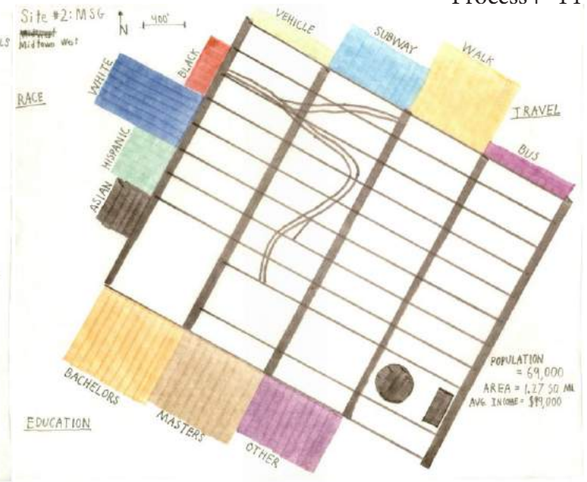
PROCESS

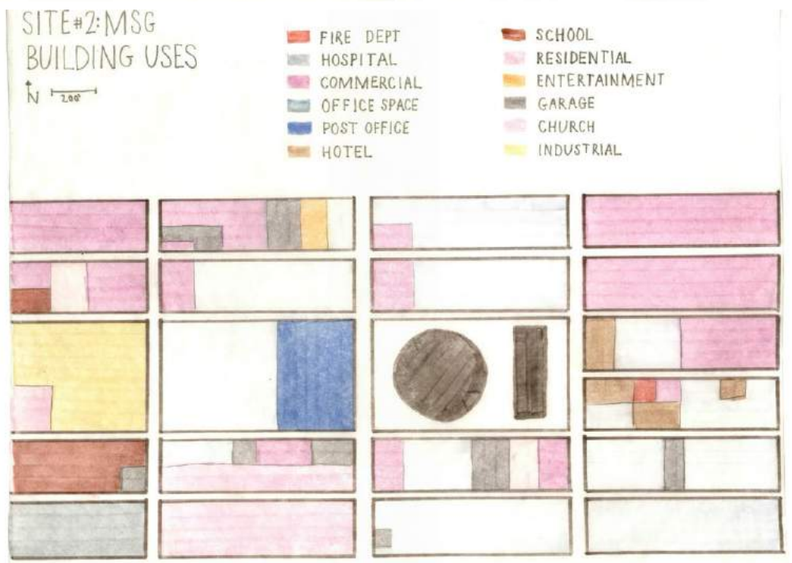
SITE DIAGRAMMING

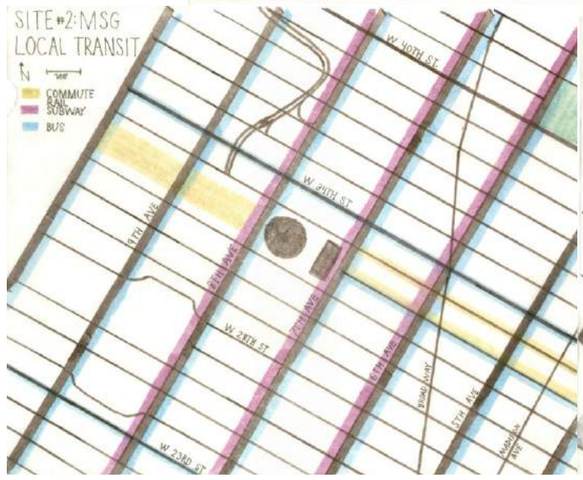


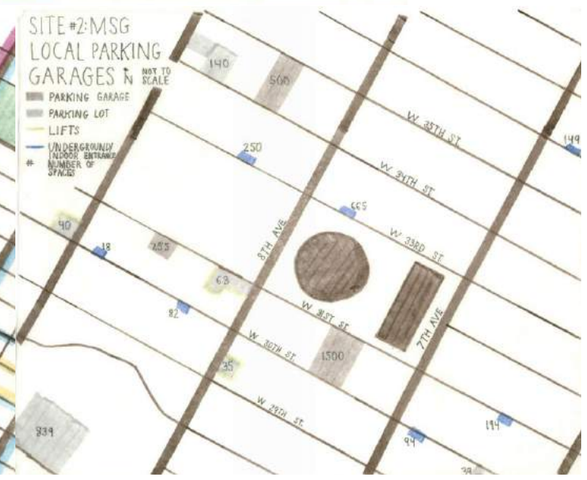


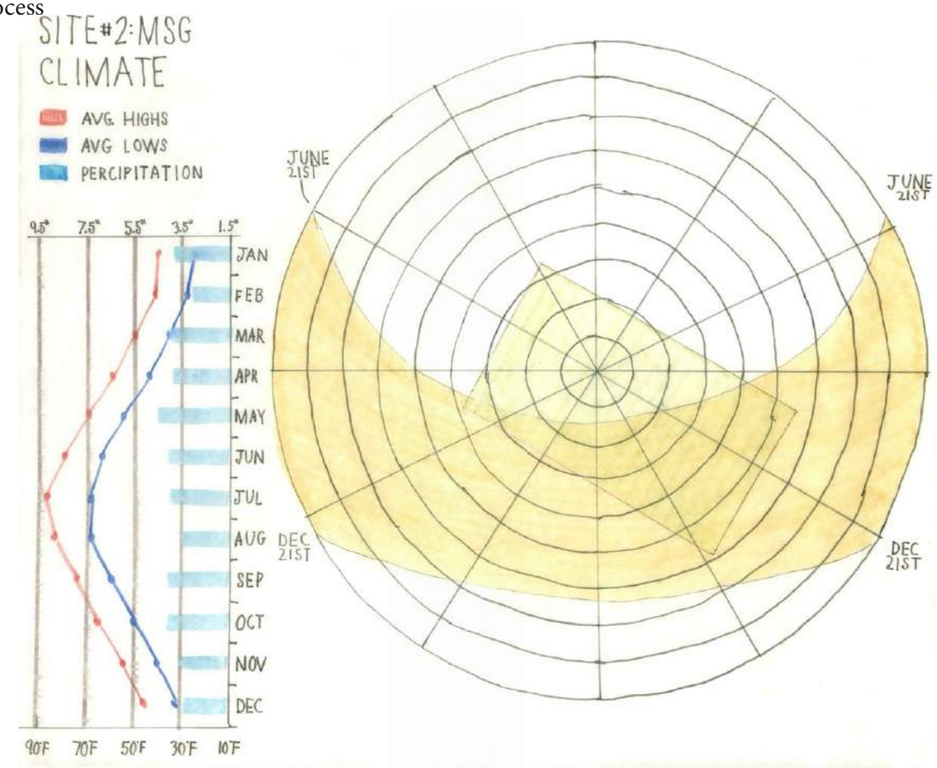


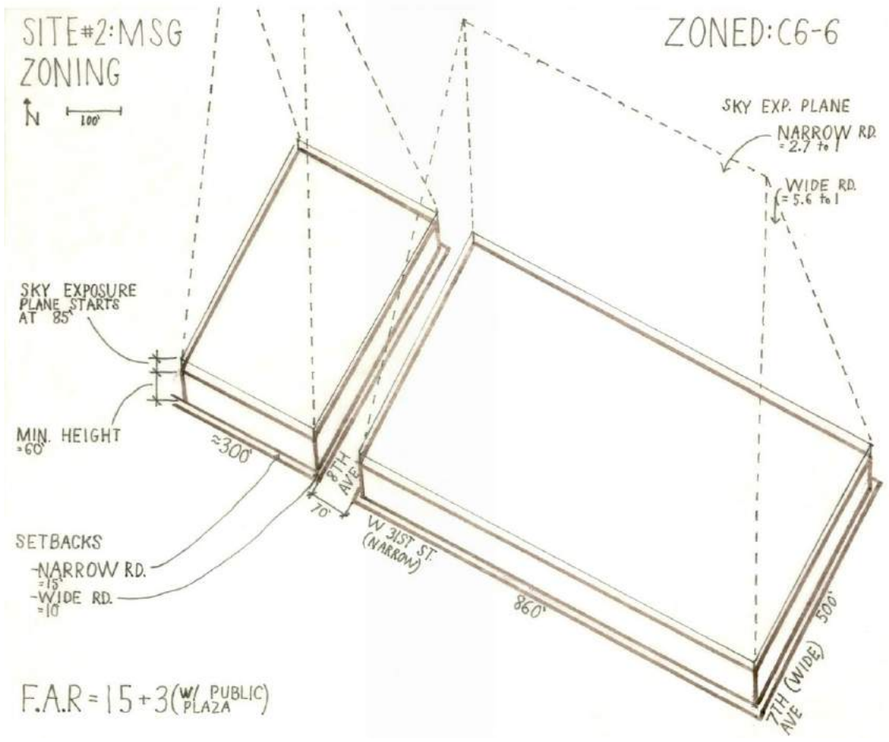












PROS

-THREE POSSIBLE PROJECTS
  -INFILL
  -RE-DESIGN POST OFFICE RENOVATON
  -NEIGHBOR GARAGE DESIGN
-PROJECT POSSIBILITIES (& AMENITIES)
  -RIDE SHARE CENTRAL HUB
  -TERMINAL PICK UP & DROPOFF
  -MSG CONVENTION CENTER EXPANSION
  -BAR & RESTAURANT
  -HOTEL & SHOWER
  -OTHER PUBLIC & TERMINAL AMENITIES
-OPPORTUNITY TO RE-DESIGN STREET SCAPE (MENTIONED IN PAPER)
-OPPORTUNITY TO RE-DESIGN PARKING GARAGE (MENTIONED IN PAPER)
-CAN TAP INTO PENN STATION
  -MASS TRANSPORTION JUXTAPOSITION
-LOCAL NEARBY MASS VEHICLE TRANSPORTATION
  -LINCOLN TUNNEL
  -QUEENS MIDTOWN TUNNEL
-BOUNCE DESIGN CONCEPTS OF LOCAL URBAN FABRIC
-CAN INCORPORATE BOTH REST STOP & SUBURBIA AMENITY OPTIONS

CONS

-NO FULL AMENITY CONTROL
-LOW VEHICLE USAGE IN NEIGHBORING NEIGHBORHOODS
-GREATER SUSTAINABLE DESIGN DIFFICULTY
-MORE SITE CONSTRAINTS
  -BUILT UP NEIGHBORS
  -PRE-CONSTRUCTED POSSIBLE CONNECTING AMENITIES
    Ex. MSG & PENN ST.
-"ANOTHER "NYC" PROJECT"
  -NO UNIQUE TYPOLOGY
-DOG PARK DIFFICULTY

HELLS KITCHEN

-Formerly, one of roughest neighborhoods
  -Industrail
-Trendy "melting pot" now
  -Many cultures & art
-Busy streets (walking)
  -Close to Theaters & Times Square

GARMENT DISTRICT

-District shrinking
  -Outsourcing work
-Large shopping district
-Very 9-5
-Fashion Institute of Technology
-Chaotic during day
-Mostly industrial/ commercial

THEATER DISTRICT & TIMES SQUARE

-Foot traffic
-Tourist

HUDSON YARDS

-Closing "Super Block Divide"
-Largest $ development in US history
  $20B
-Mix use district
  -Commercial
  -Residential
  -Large Green Space
-"The Shed"
  -Help revitalize local arts
    -New location of fashion week
-The Highline
-Possibly too upscale?
  -Out of place?

UPTOWN
SITE
DOWNTOWN

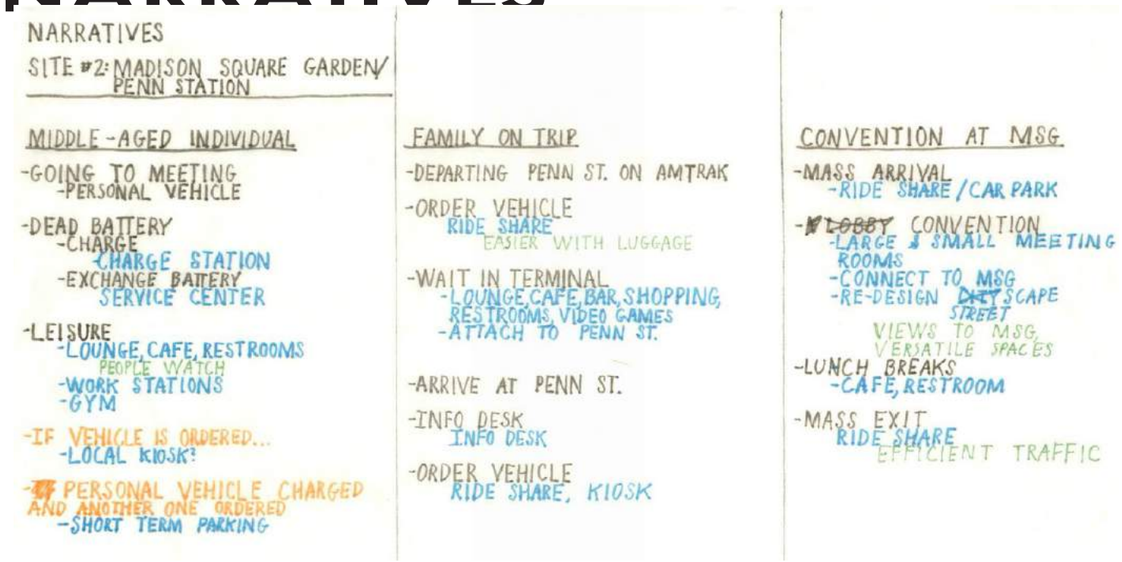
MIDTOWN

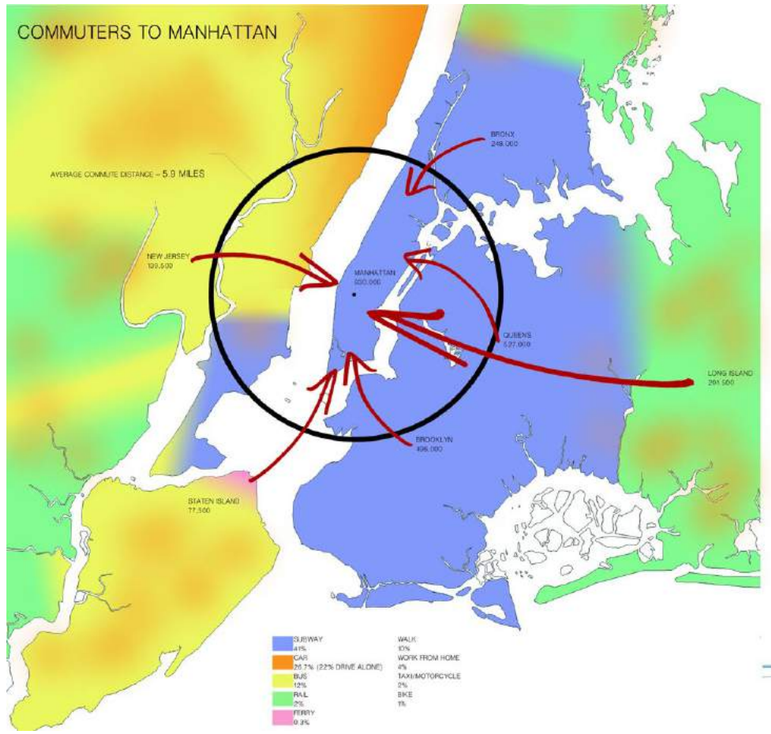
-"Tenderloin"
-Formerly "Red Light District"
-Heart of city

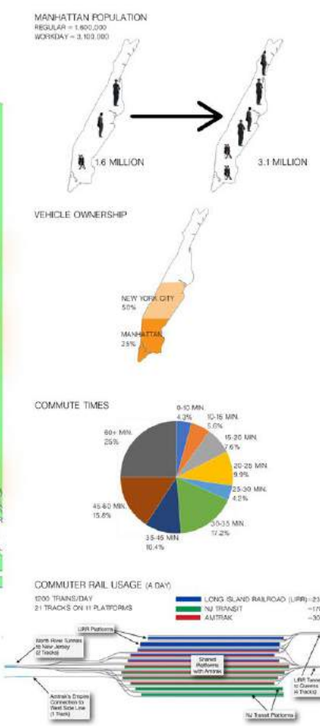
CHELSEA

-200 art galleries
-Large LGBTQ neighborhood
-Gentrified
  -Highly sought after neighborhood
  -Lots of culture but residential feel
    -Museums, clubs, markets, Off-Broadway theaters
  -Lots of culture but residential feel

NARRATIVES







PROGRAMMING

PROGRAM

URBAN PARK(S)
- -GATEWAYS
  - -TO MANHATTAN
  - -FROM ONE NEIGHBORHOOD TO ANOTHER
    - -CONNECT NEIGHBORHOODS
  - -ICONIC
- -REPURPOSING OF STREETSCAPE
  - -GREATER WALKABILITY
    - -LESS CONGESTIVE
    - -POSITIVE IMPACT ON LOCAL ECON.
- -MULTIPLE, DIVERSE, VERSATILE SPACES
  - -POCKET PARKS/DESIGNED ZONES
    - -EX. MILLINIUM PARK
  - -KEEPS IT LIVELY
  - -REFLECTIVE OF NEIGHBORING NEIGHBORHOOD
- -TRANSLUCENT
  - -WALKABLE
  - -WAY FINDING

RETAIL AMENITIES
- -REFLECTIVE OF NEIGHBORHOODS
- -COMPLEMENTS AEV's
- -DIFFERENT LONG/SHORT TERM AMENITIES
  - -LOCATE ON APPROPRIATE CIRCULATION PATHS
    - -VERTICAL

CAR
- -REDESIGNED CITY GRID
  - -LAYERED SUPERBLOCKS
    - -"LAST MILE"
    - -GREATER TRAVEL EFFICIENCY
    - -GREATER WALKABILITY
- -AUTOMATED PARKING
  - -BRANDS FOR AEV's
  - -SAVES SPACE
  - -SEPERATE ARRIVAL/DEPARTURE PLATFORMS
  - -OPEN LOBBY ENTRANCE
  - -SERVICE FLOOR
  - -MINIMAL RAMP WAY INTERFERENCE
    - -ELEVATED/SUB-GRADE RAMP WAYS

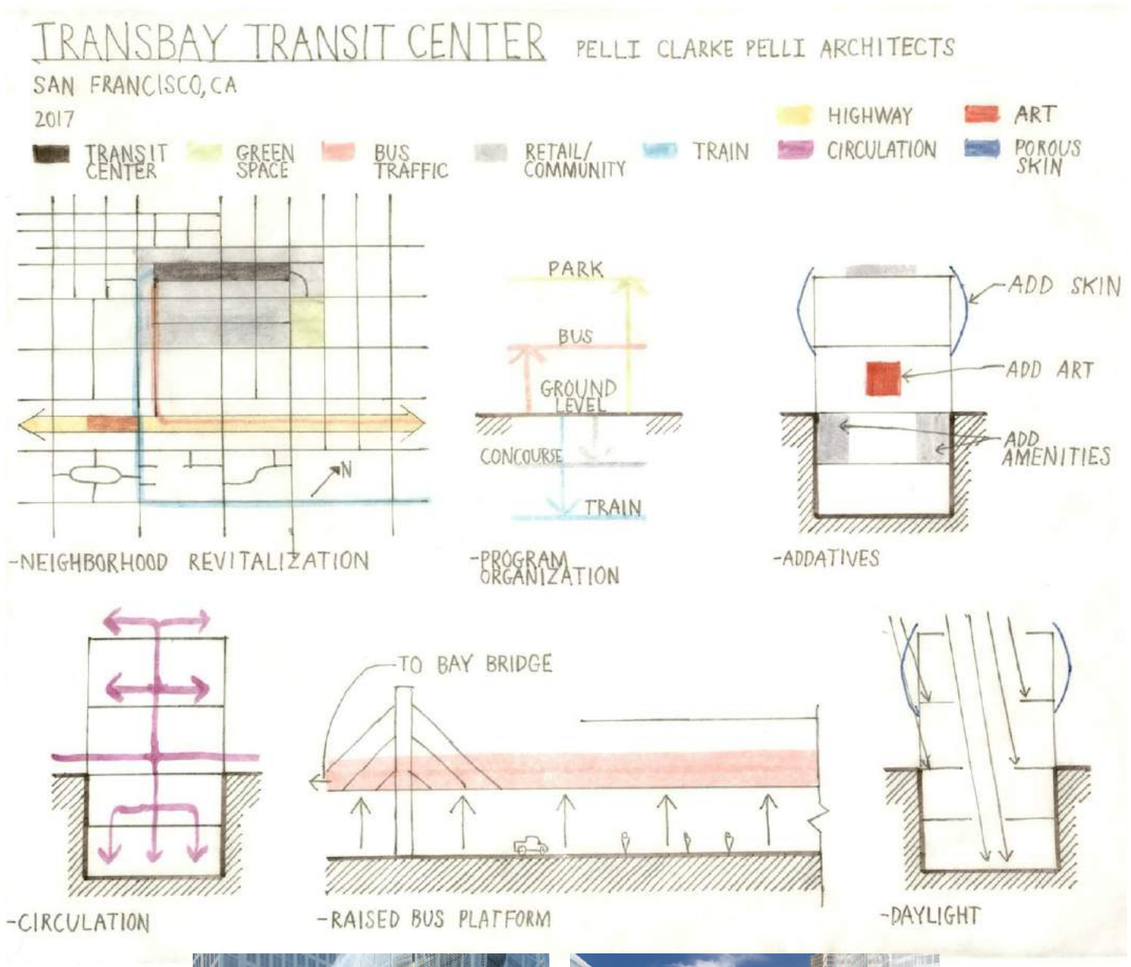
TRAIN/SUBWAY
- -GREATER CIRCULATION
  - -GREATER WAYFINDING
    - -SIMPLE CIRCULATION LAYOUT
      - -SHORT, DIRECT
    - -GREATER VISABILITY TO TRAINS
    - -LARGER PASSAGEWAYS
- -STACKED RAILROAD PLATFORMS
  - -GREATER NUMBER OF TRACKS
  - -OPPORTUNITY FOR LARGER PLATFORMS
    - -LESS CONGESTIVE

PROGRAM

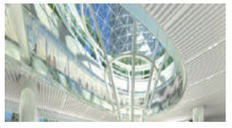
UTILITIES
- -TICKET BOOTHS/KIOSK
- -FIRST AID
- -SECURITY/POLICE
- -RESTROOMS/ DRINKING FOUNTAINS
- -ACCESSABLE CIRCULATION
  - -ELEVATORS
- -CUSTOMER SERVICES
- -LOST & FOUND
- -BAGGAGE CHECKS

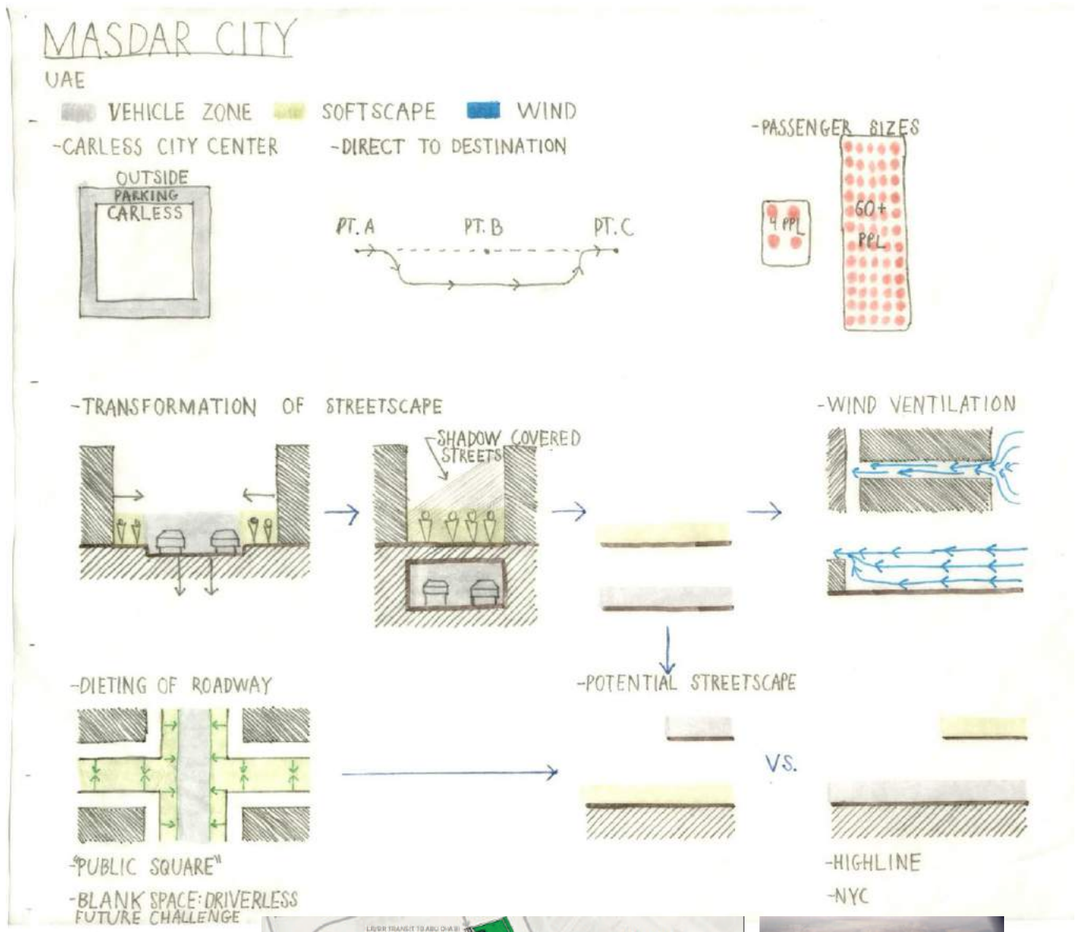
AMENITIES
- -RESTAURANTS
  - -SIT DOWN
  - -FAST FOOD
  - -QUICK CAFE
    - -STARBUCKS
  - -BAR
    - -(SIT DOWN)
- -SHOPS
  - -BOOKSTORE
  - -TECHNOLOGY STORE
  - -SOUVENIR
- -POCKET PARK(S)/ ROOF TOP PARK
  -

CASE STUDIES



Transbay Transit Center *Pelli Clarke Pelli Architects*
San Francisco, CA
2017

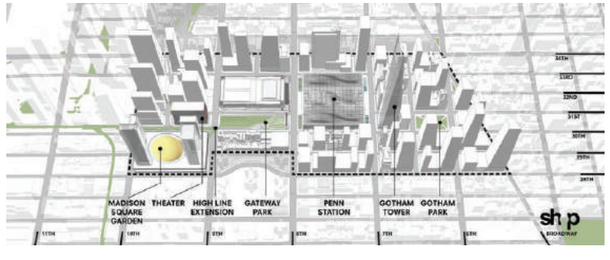




Masdar City *Foster and Partners*
Abu Dhabi, UAE
2006- Pres.

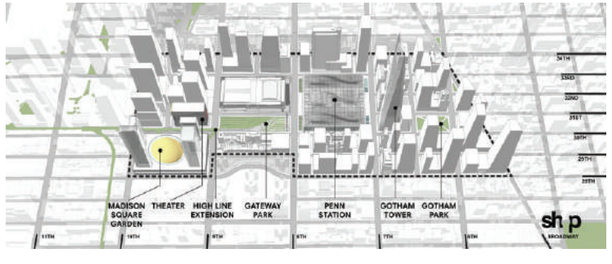
GOTHAM GATEWAY

SHoP Architects



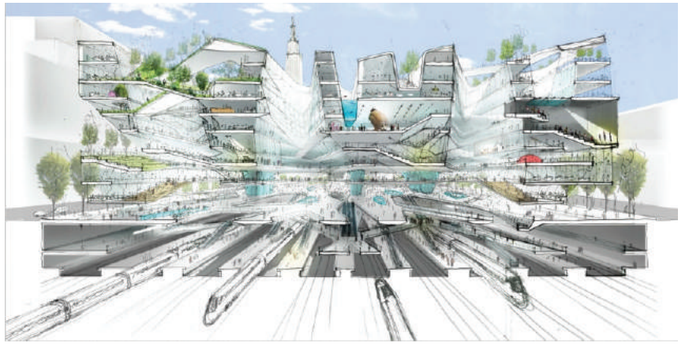
GOTHAM GATEWAY

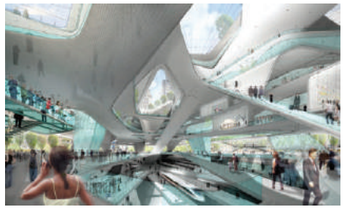
SHoP Architects

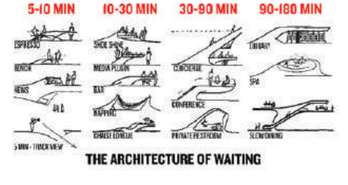


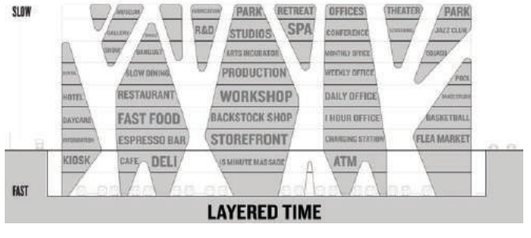
PENN STATION 3.0

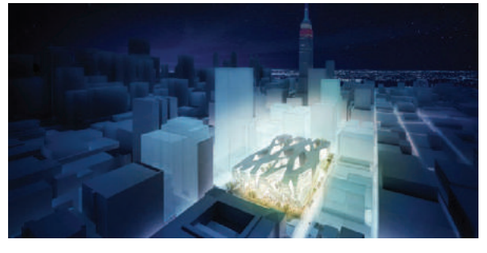
Diller Scofidio+Renfro



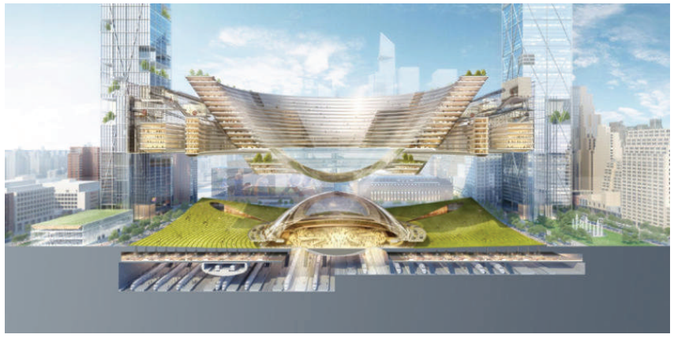




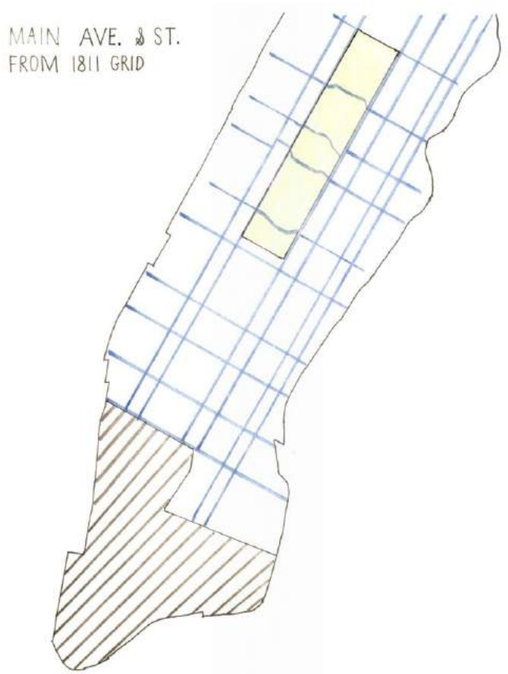


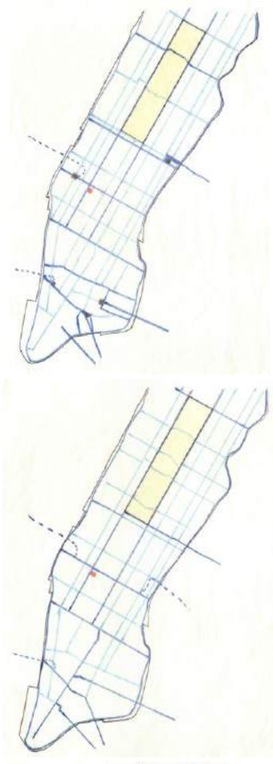


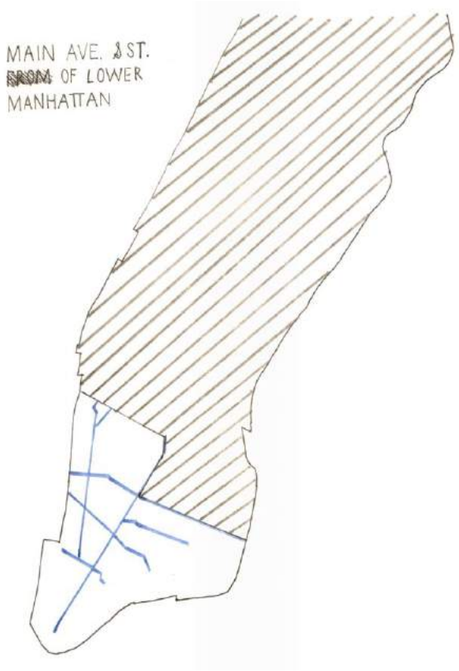
SOM Proposal

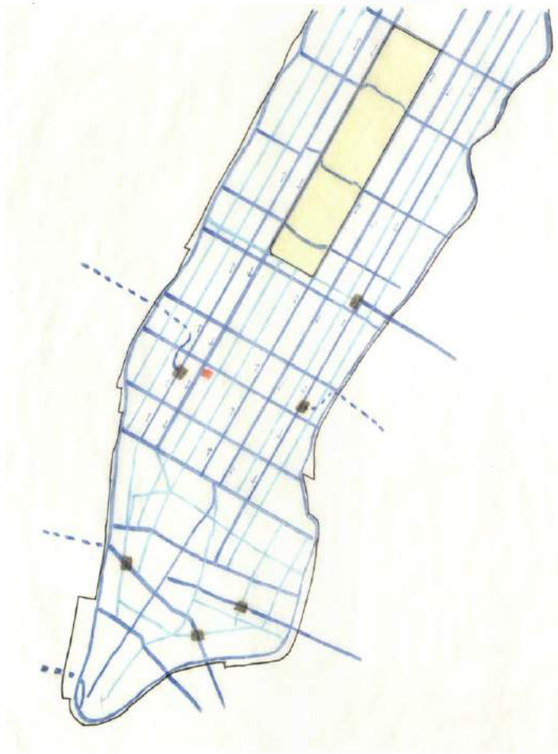


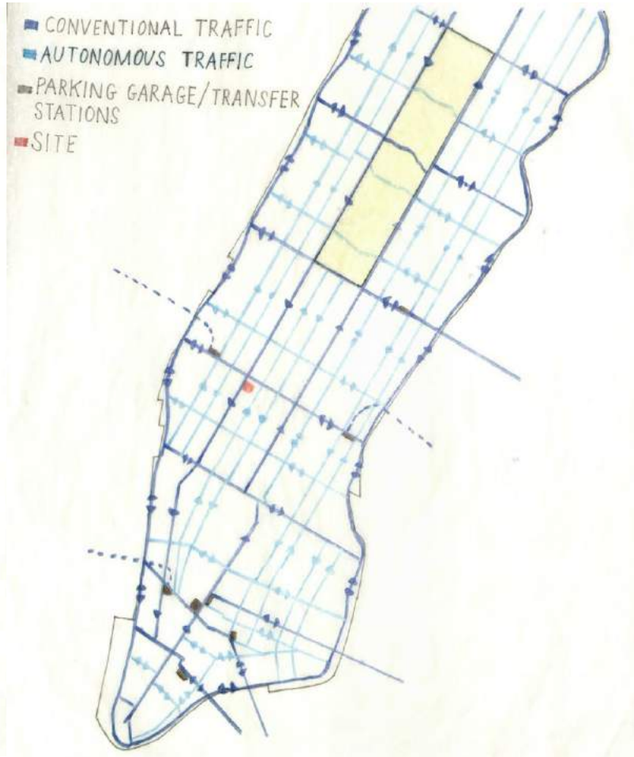
NYC GRID REDESIGN





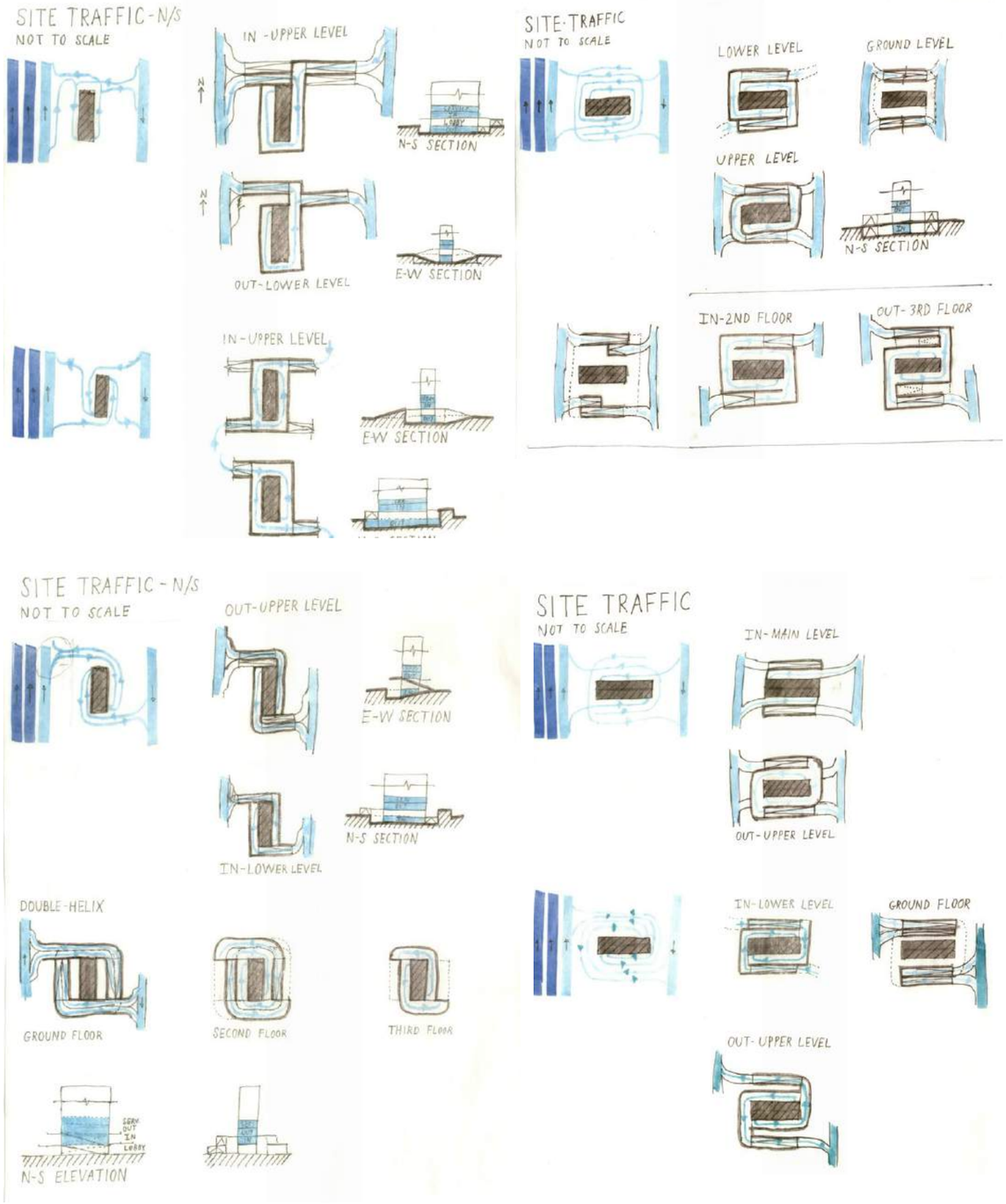


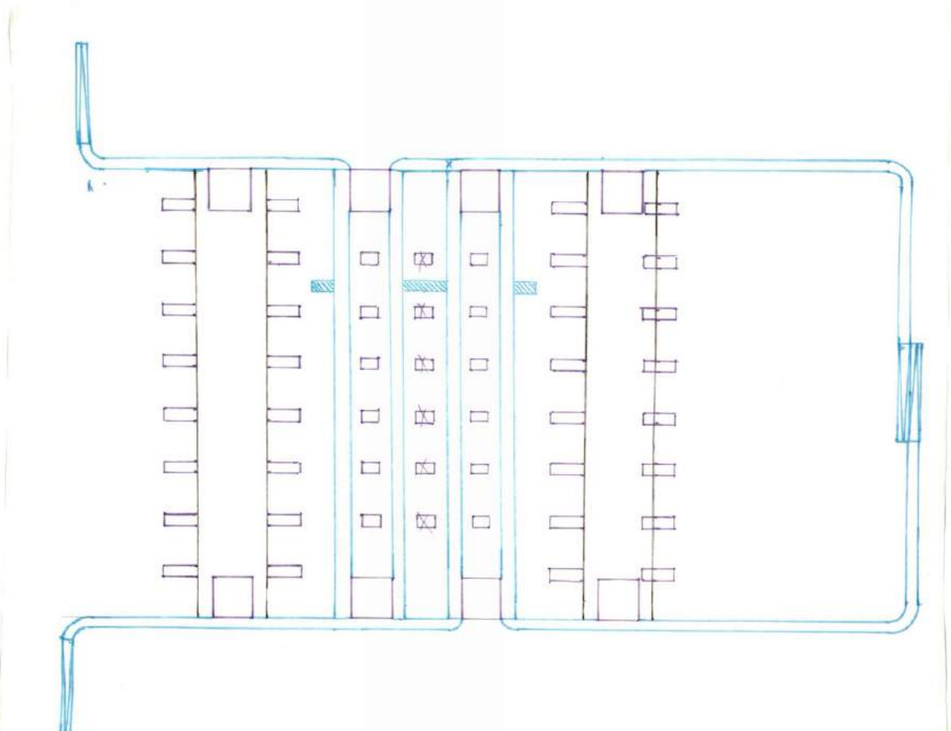




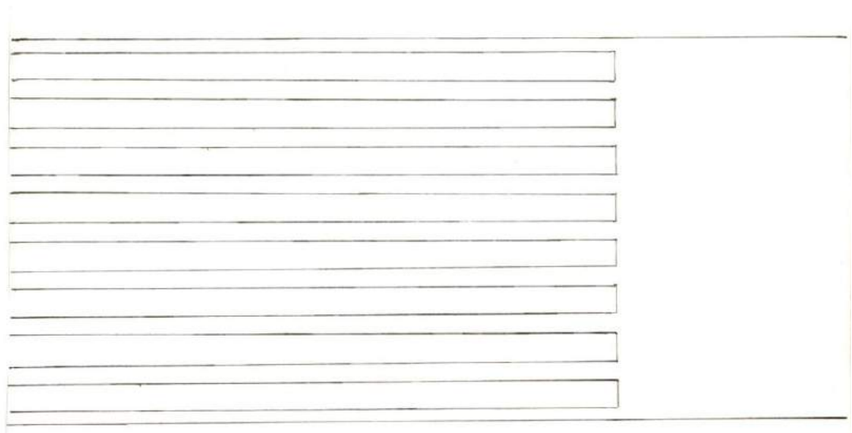
PRELIMINARY DESIGNS

AEV TRAFFIC

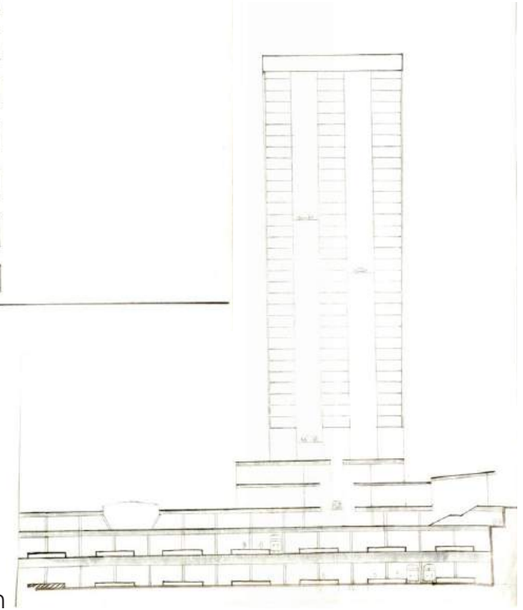




Concourse Plan

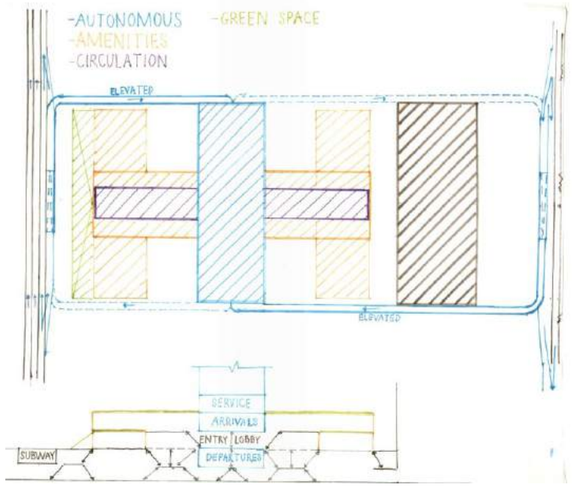


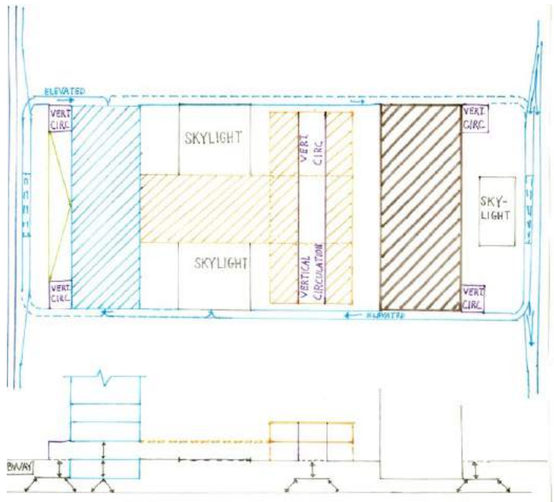
Platform Plans

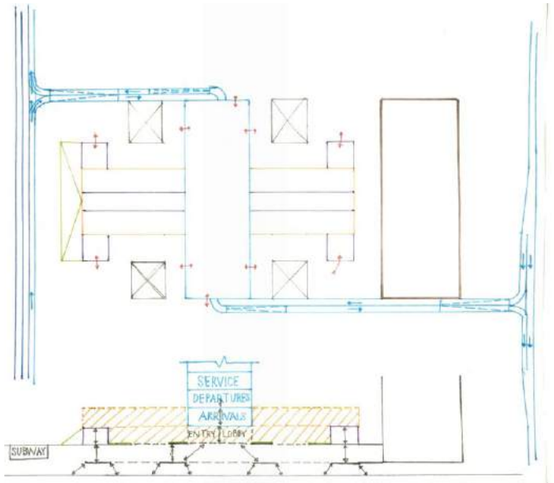


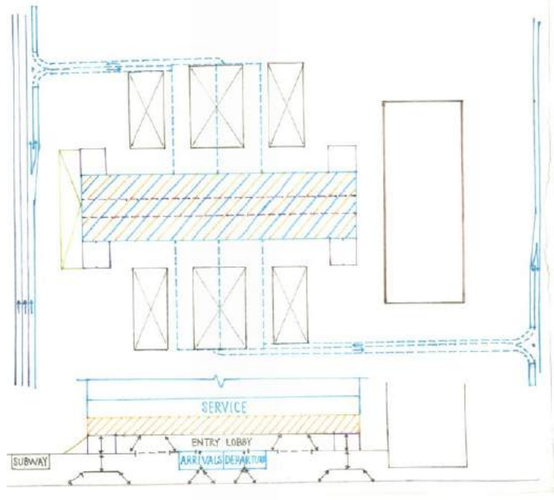
Section

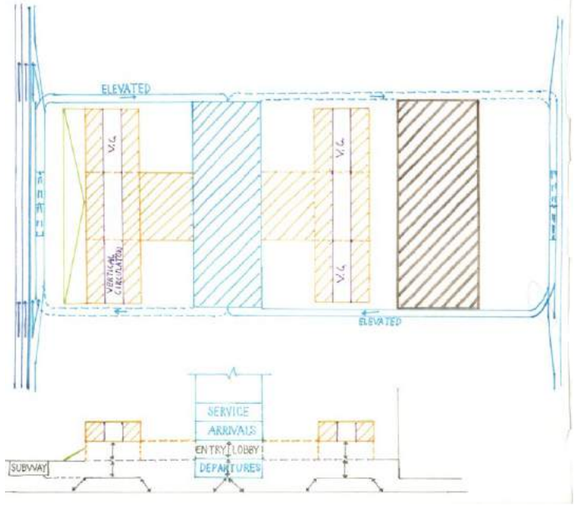
PLAZA AND TOWER

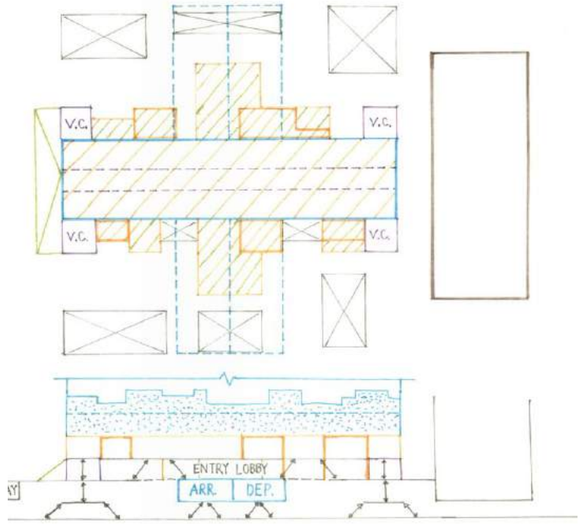


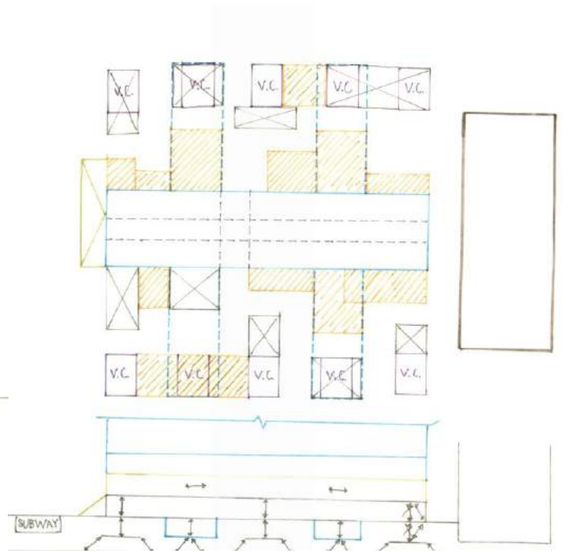


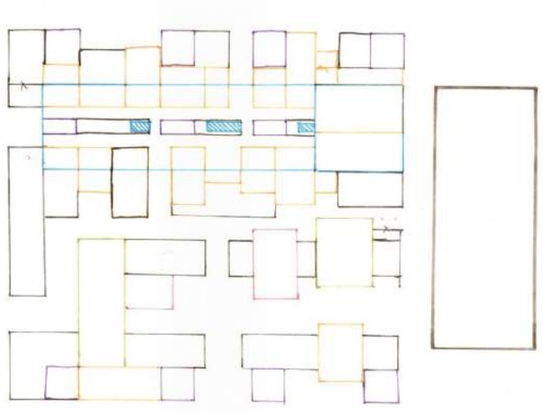


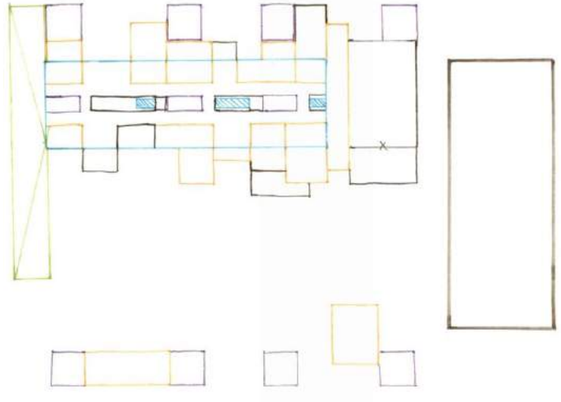




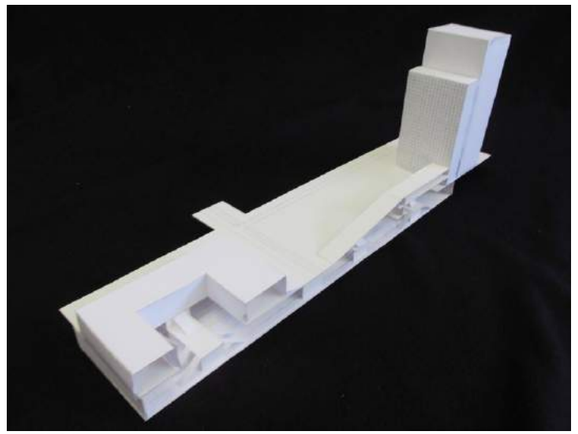




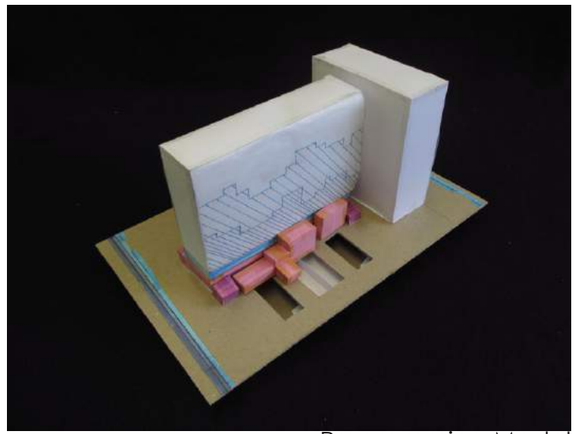




Process Models

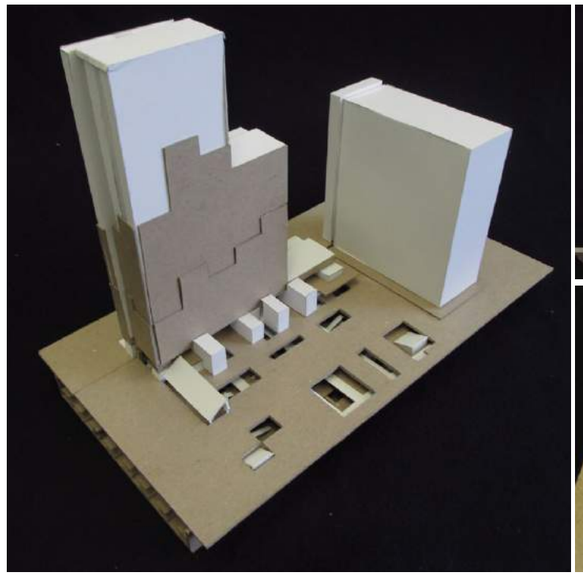


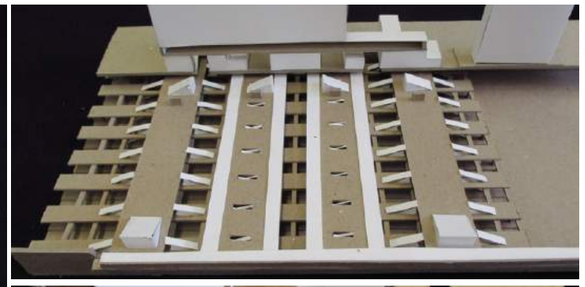
First Concept Model
Scale: 1/64”=1’-0”

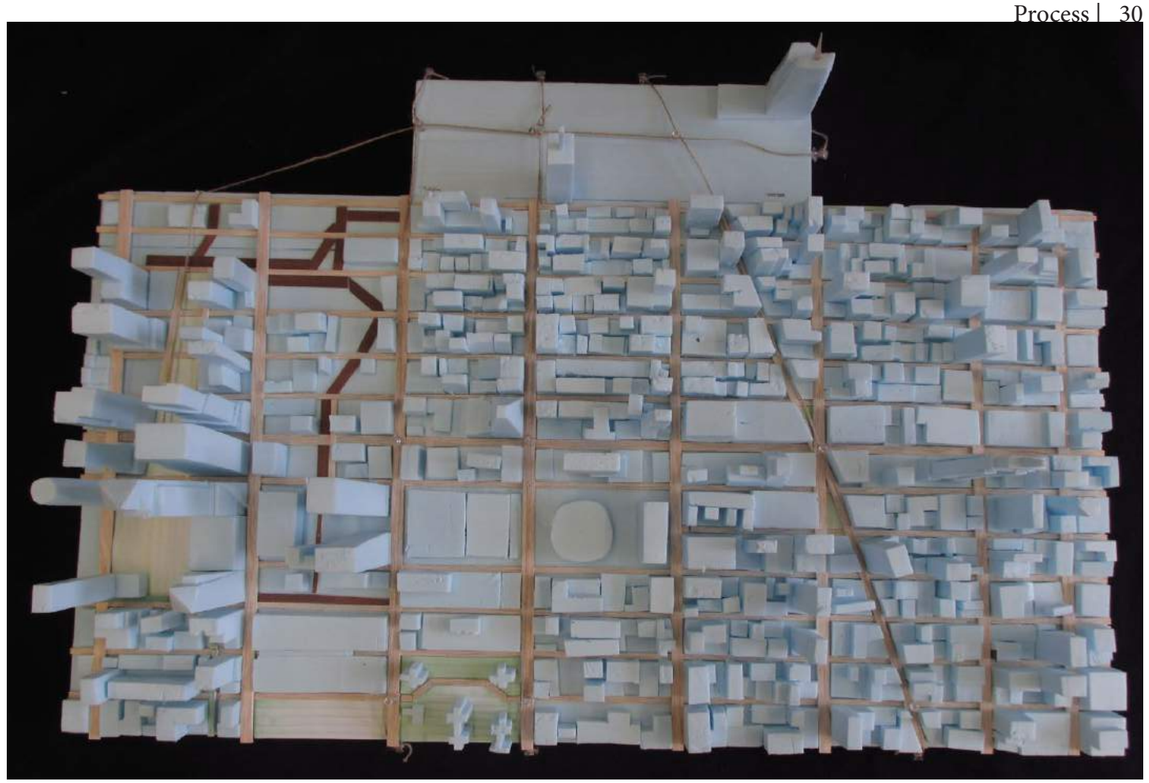


Programming Model
Scale:1/64”=1’-0”

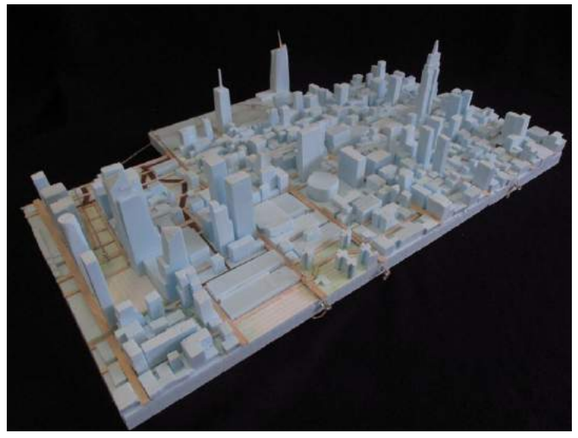
Second Concept Model
Scale:1/64”=1’-0”

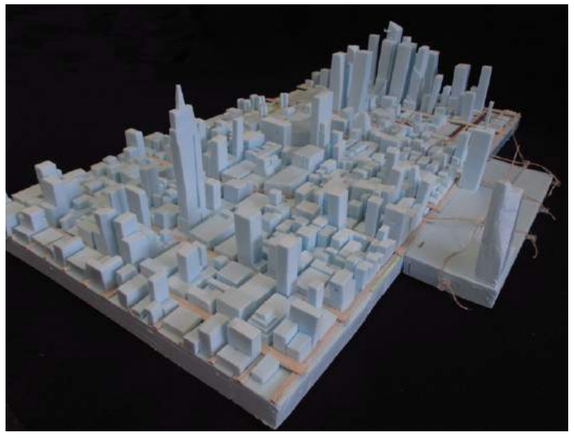






Site Model
Scale: 1”=200’





PENN STATION TOWER

PENN STATION TOWER

BRAD REED

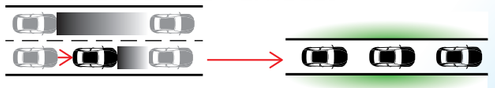
AUTONOMOUS-ELECTRIC VEHICLES & THE BUILT ENVIRONMENT

As a response to the cleaner and safer innovation of Autonomous-Electric Vehicles and more households giving up personal vehicle ownership in favor of developing ride-share programs, the built environment is being given the opportunity reclaim space from the urban infrastructure. If designed properly, this reclaimed space can be utilized to enhance a communal prestige within the urban fabric.

Penn Station Tower and the subsequent redesigned of the urban street typology are examples of how the built environment may embrace, respond, and brand themselves as positive examples of the enhanced communal built environment.

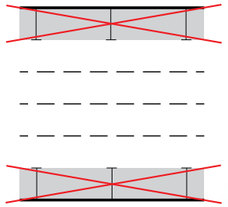
FOLLOWING DISTANCE

-TRADITIONAL VEHICLES



-AUTONOMOUS VEHICLES

REPURPOSED PARKING SPACES

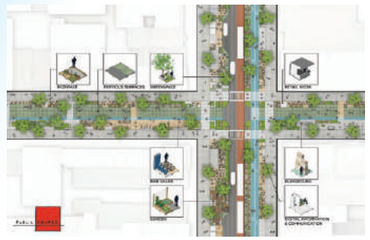


"PUBLIC SQUARE"

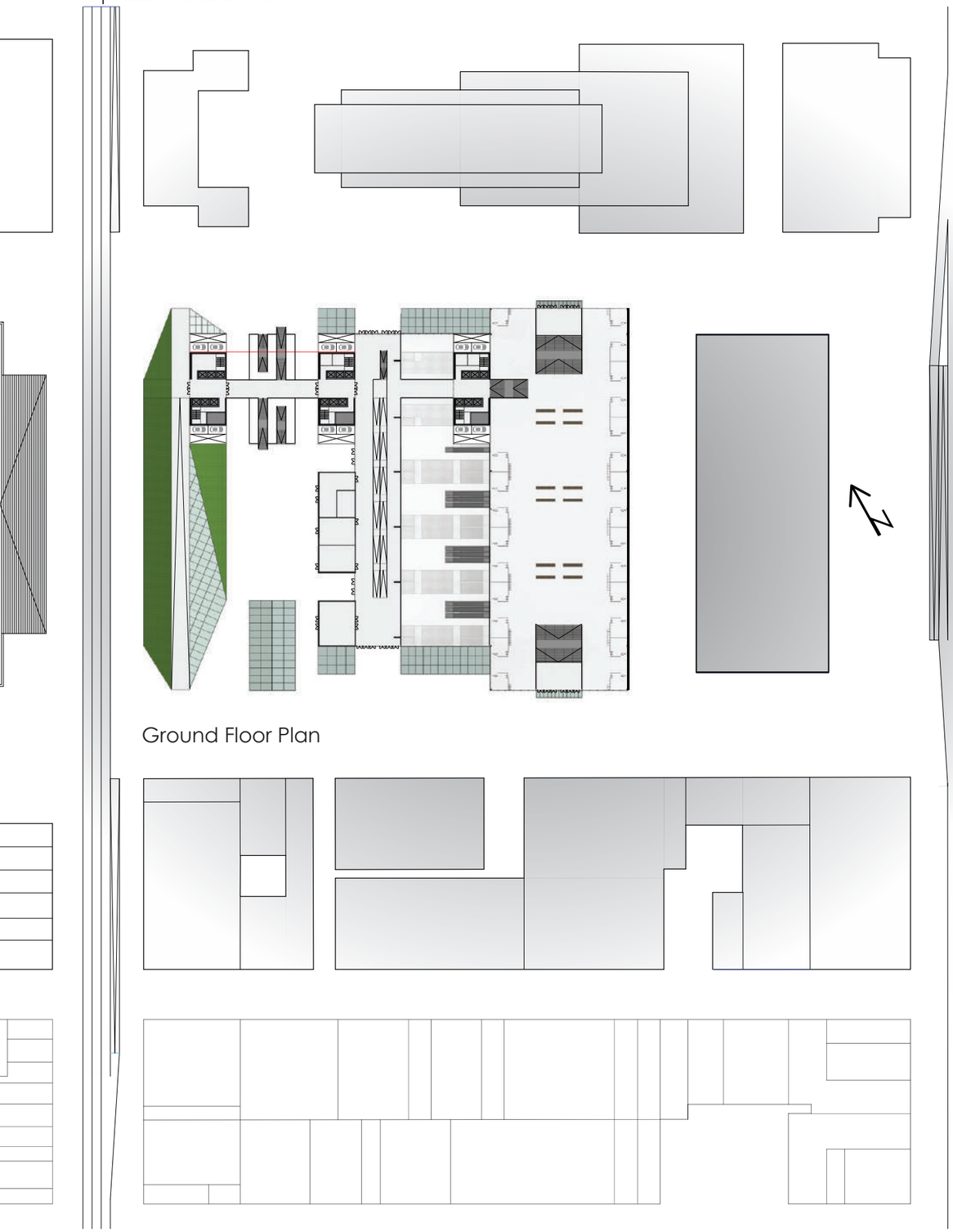
-FXFOWLE (WINNER)

DRIVERLESS FUTURE CHALLANGE

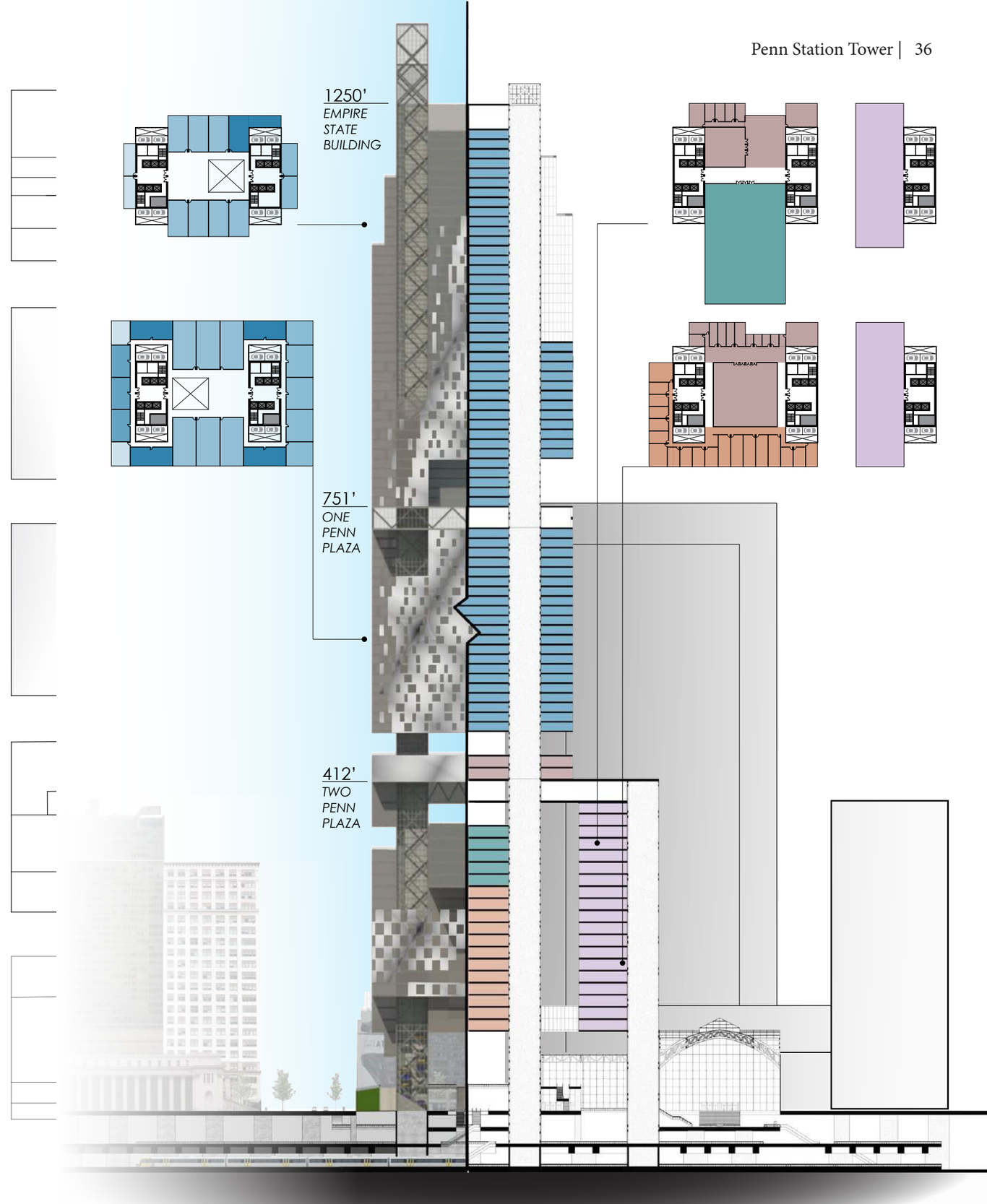
-BLANKSPACE

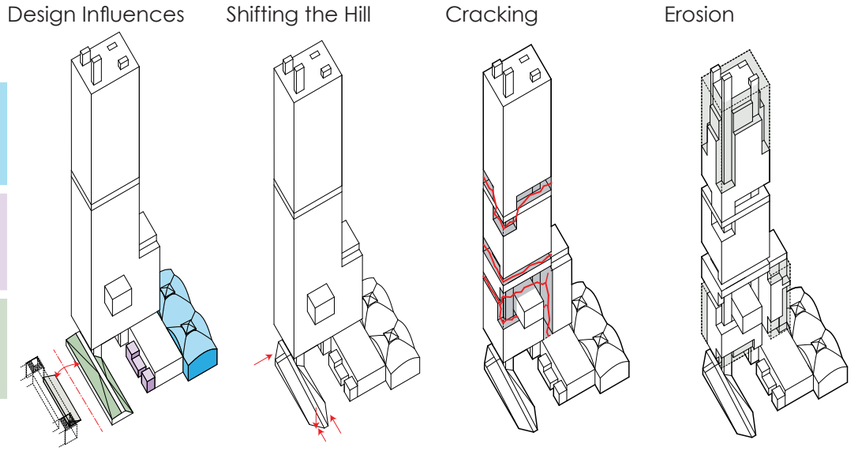


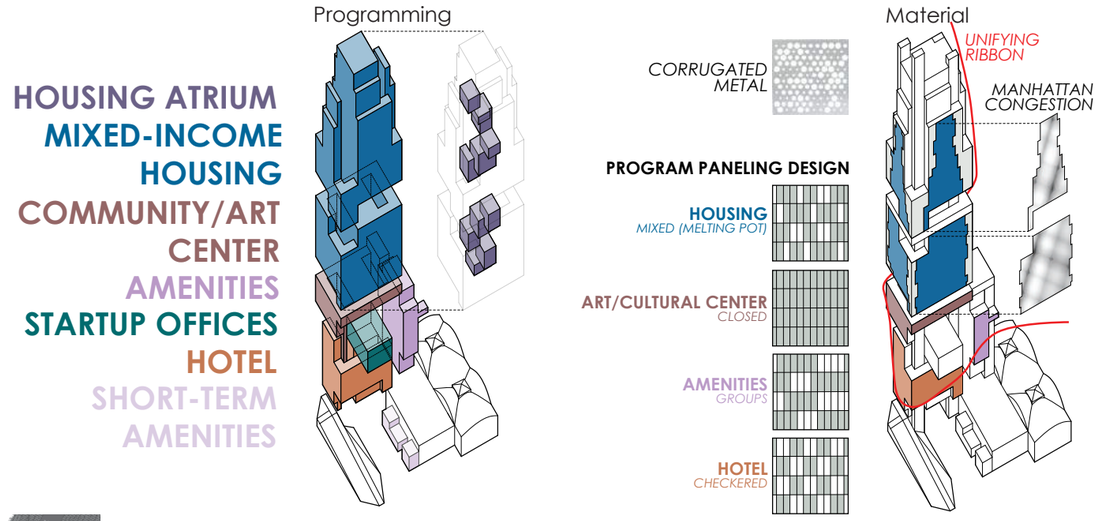
STREET TYPOLOGY EXAMPLE

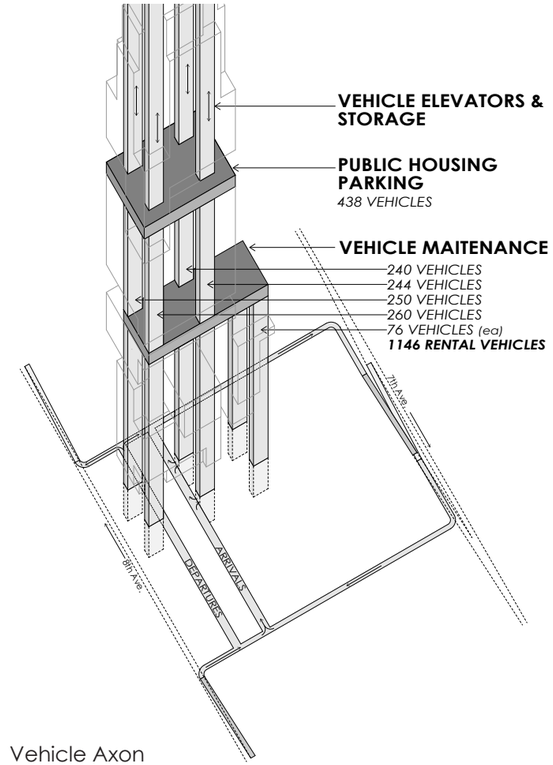


Ground Floor Plan

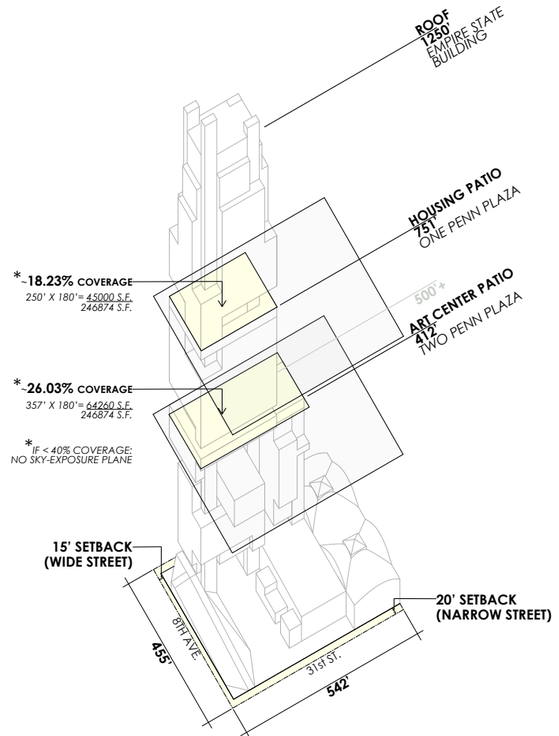




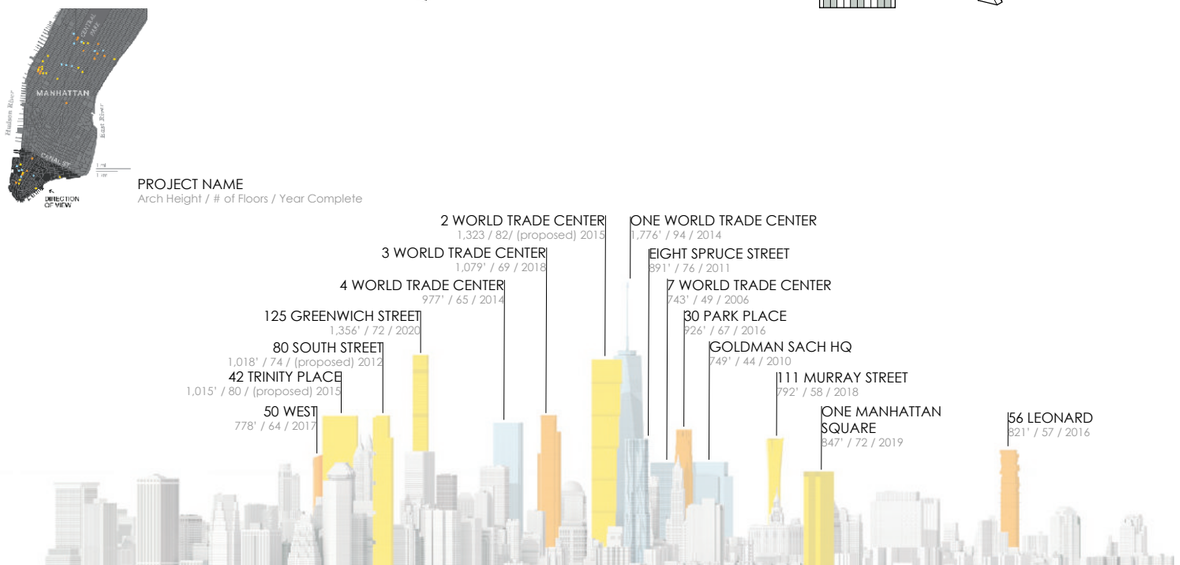


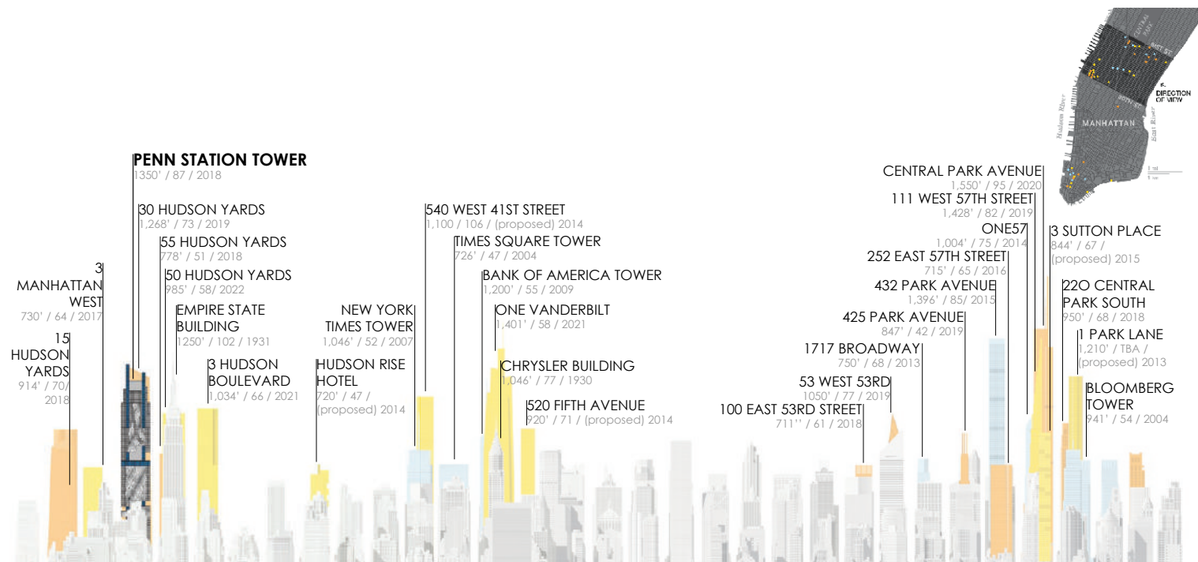


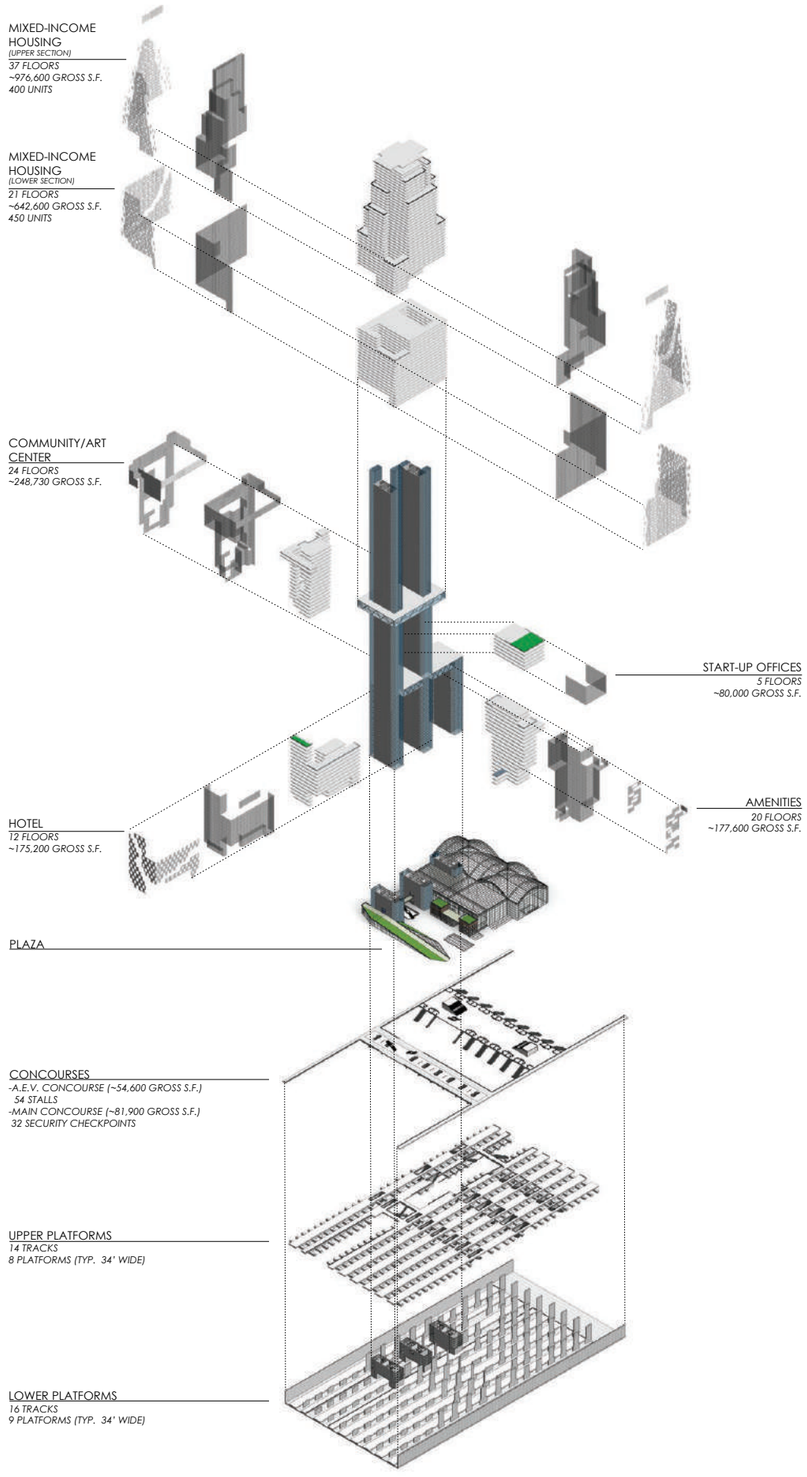
Vehicle Axon

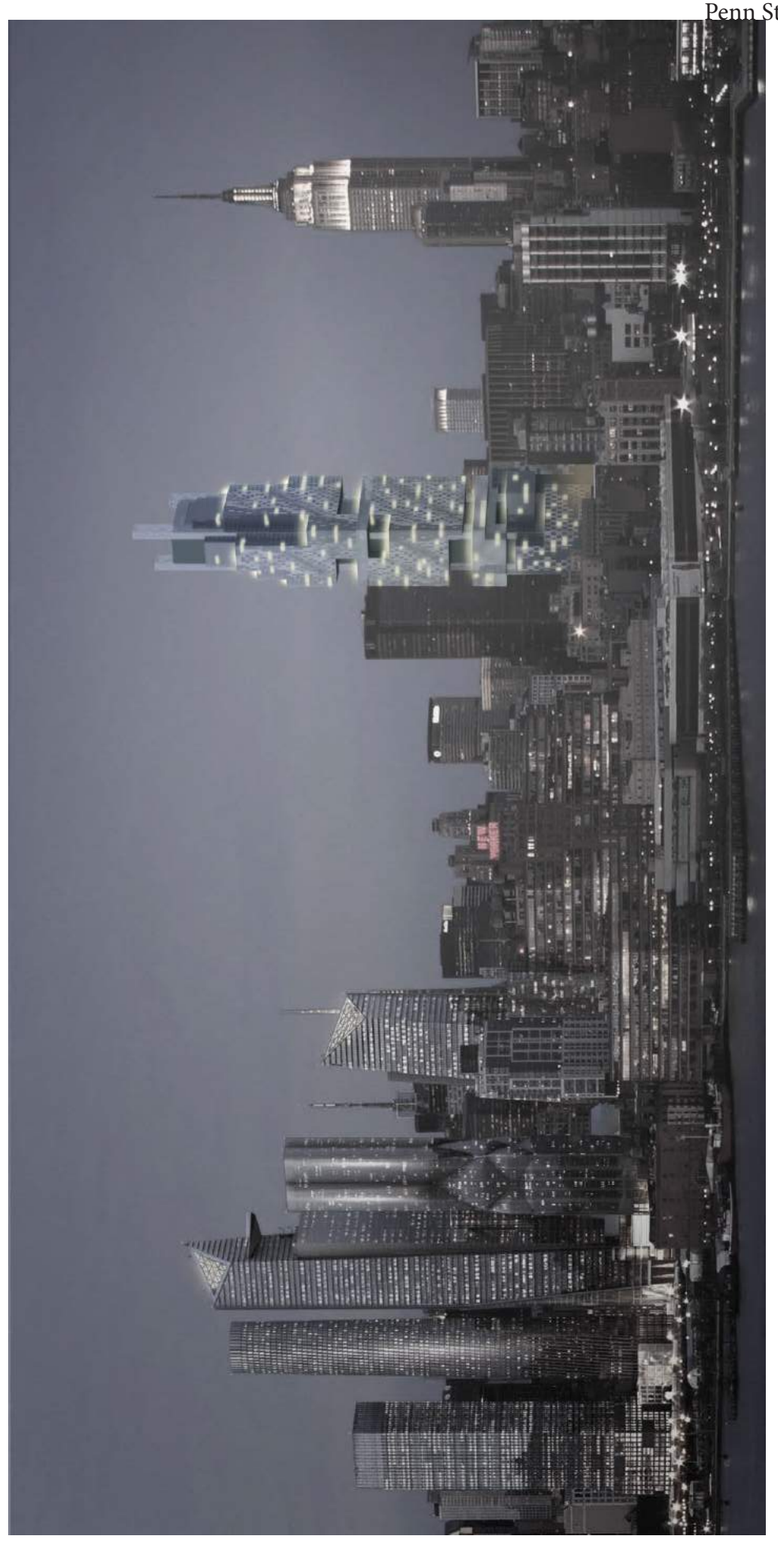


Code Analysis

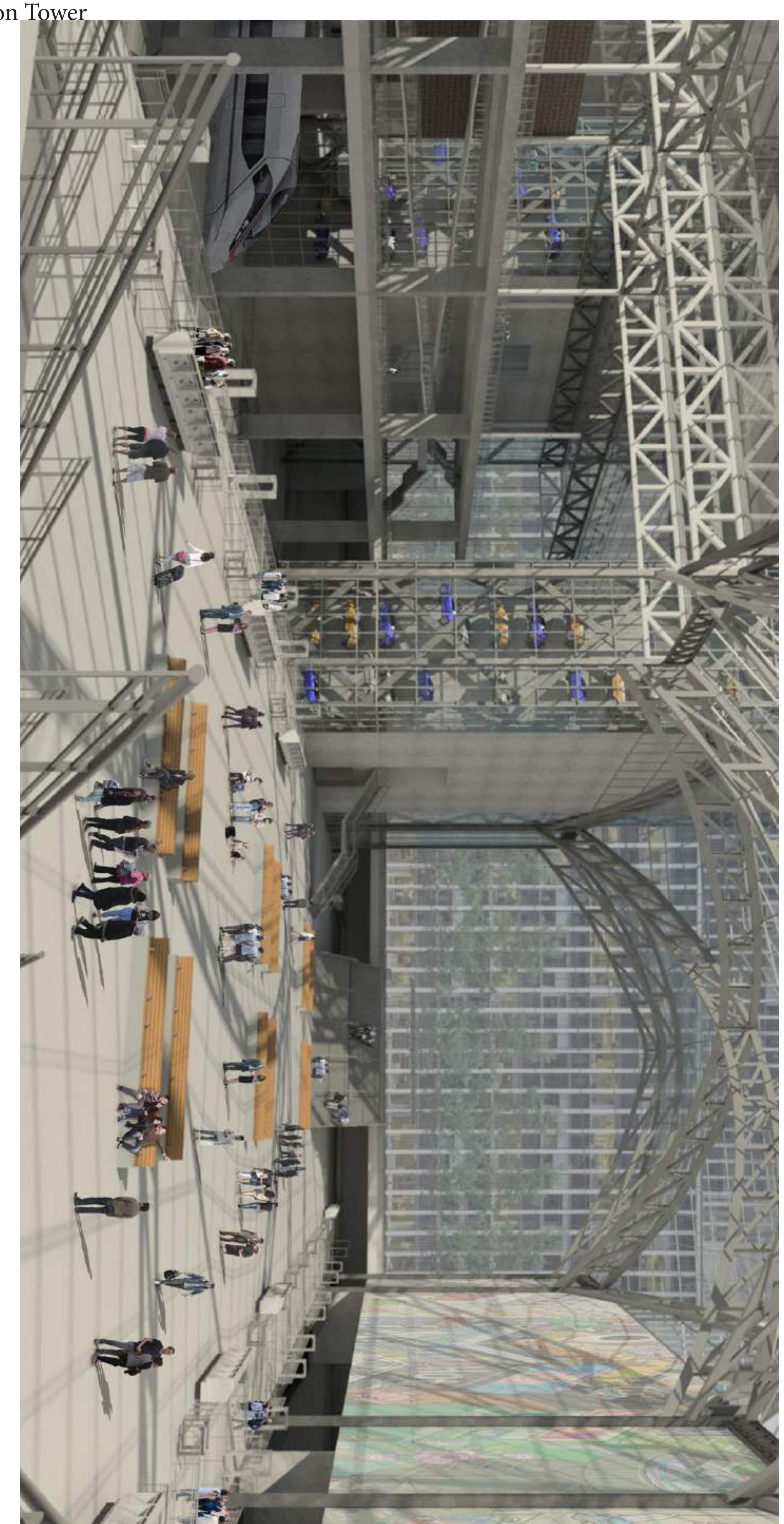






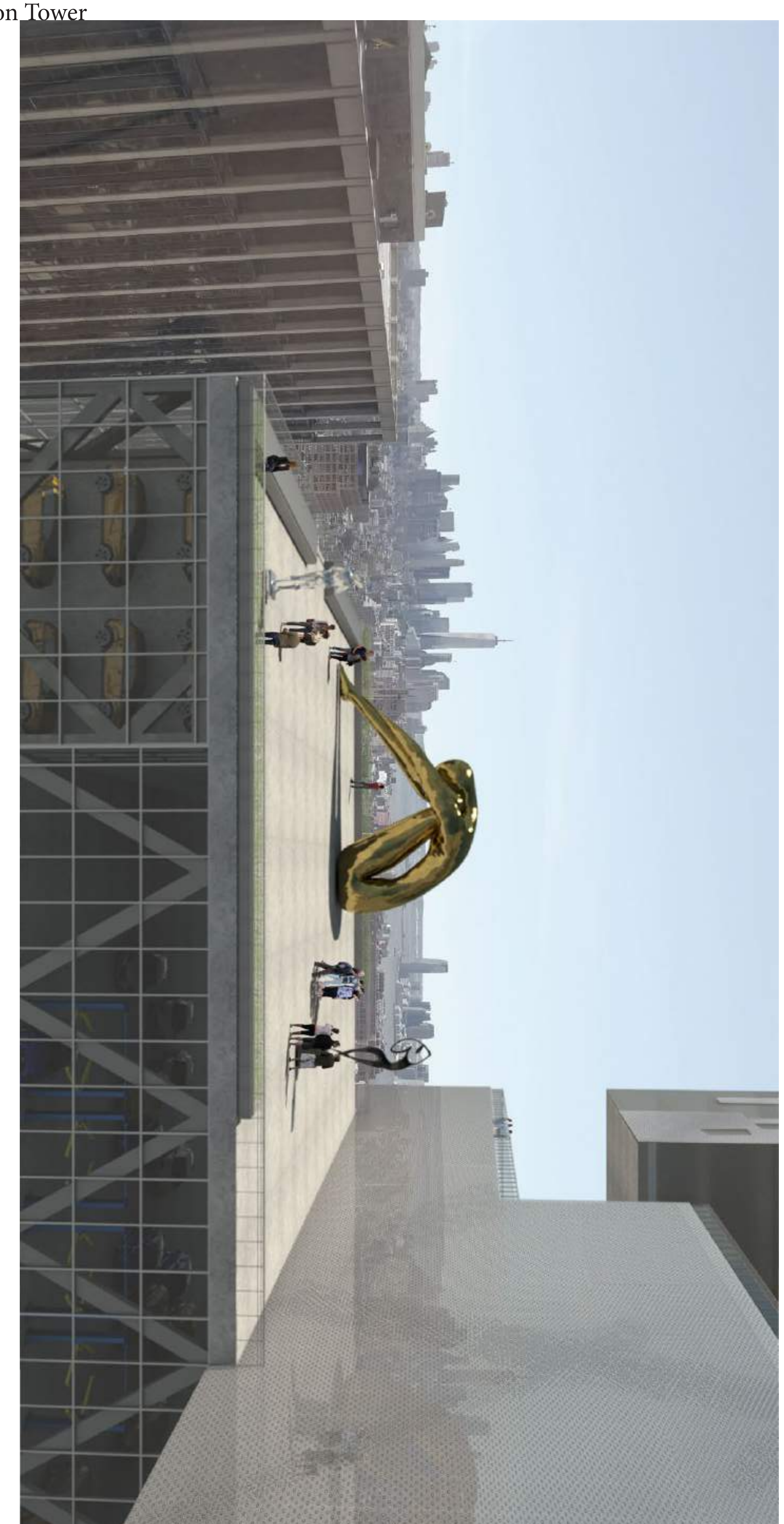


Evening From the Hudson

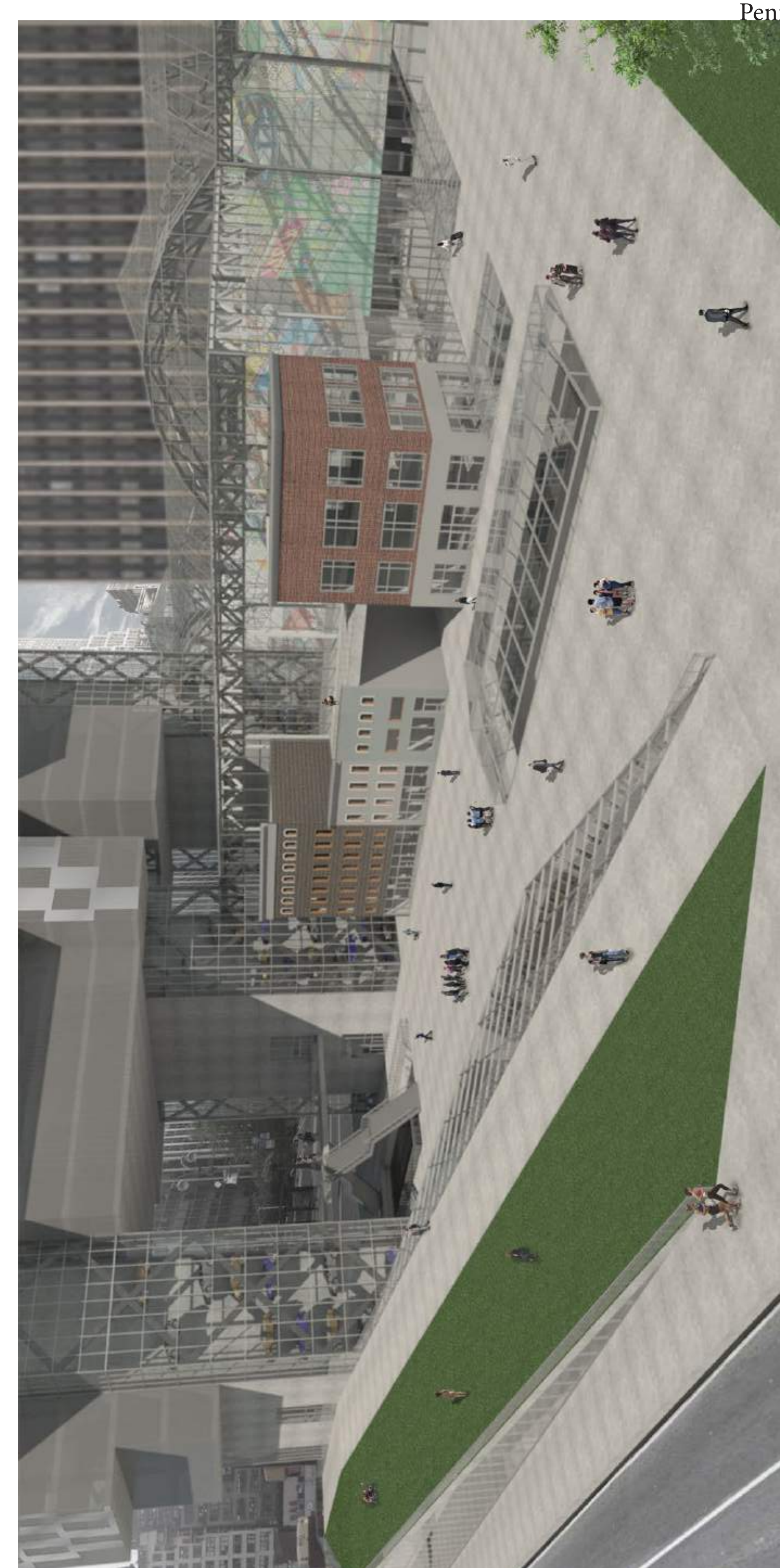


Pedestrian Concourse

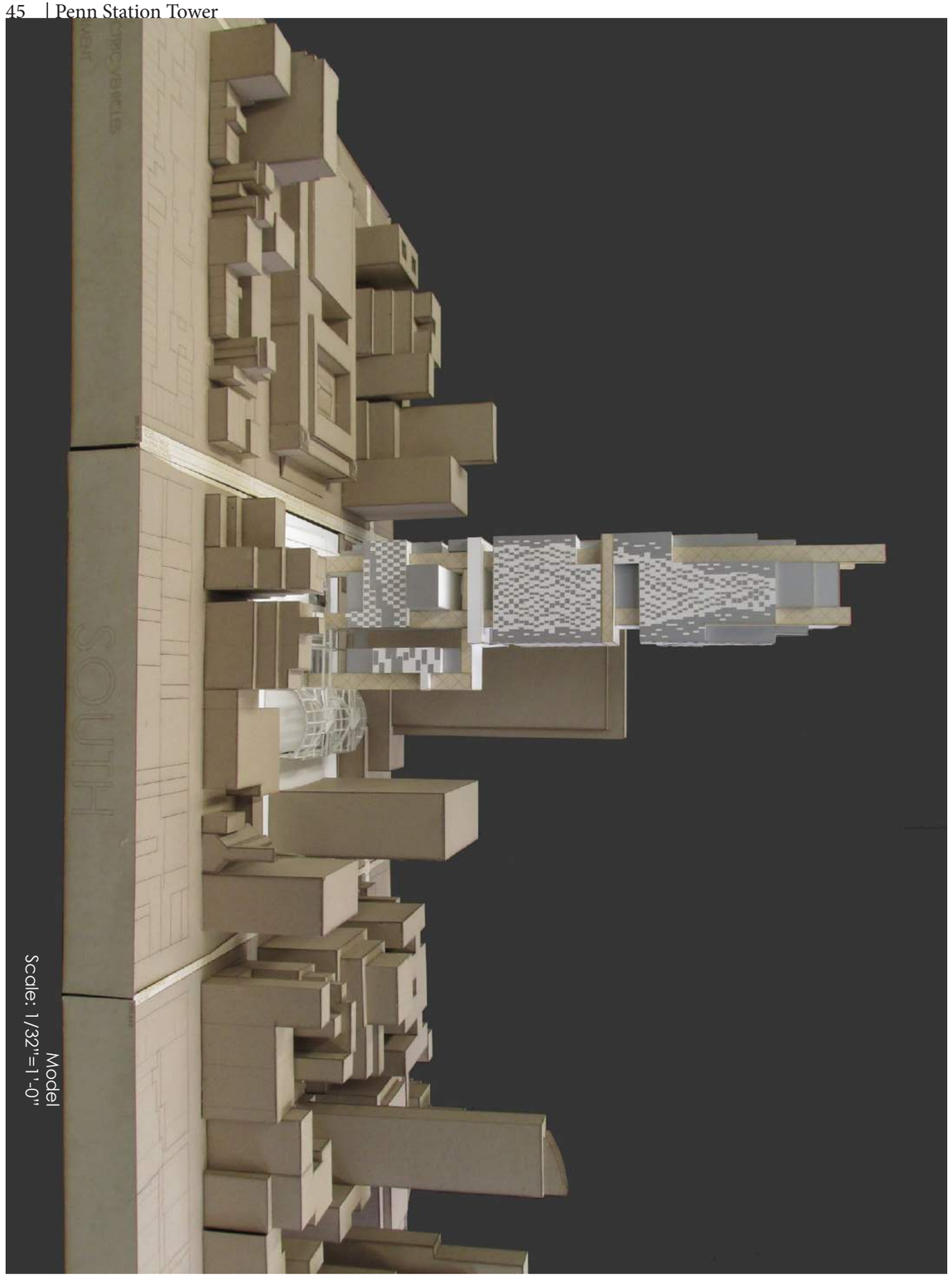
AEV Concourse



Art Patio

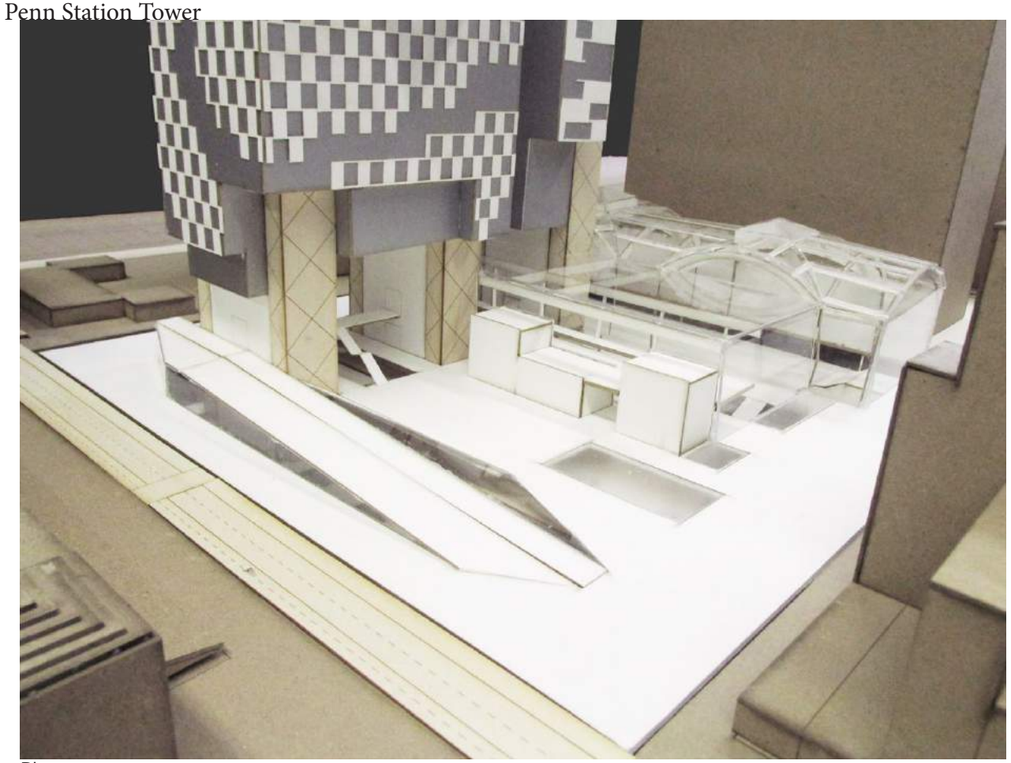


Plaza



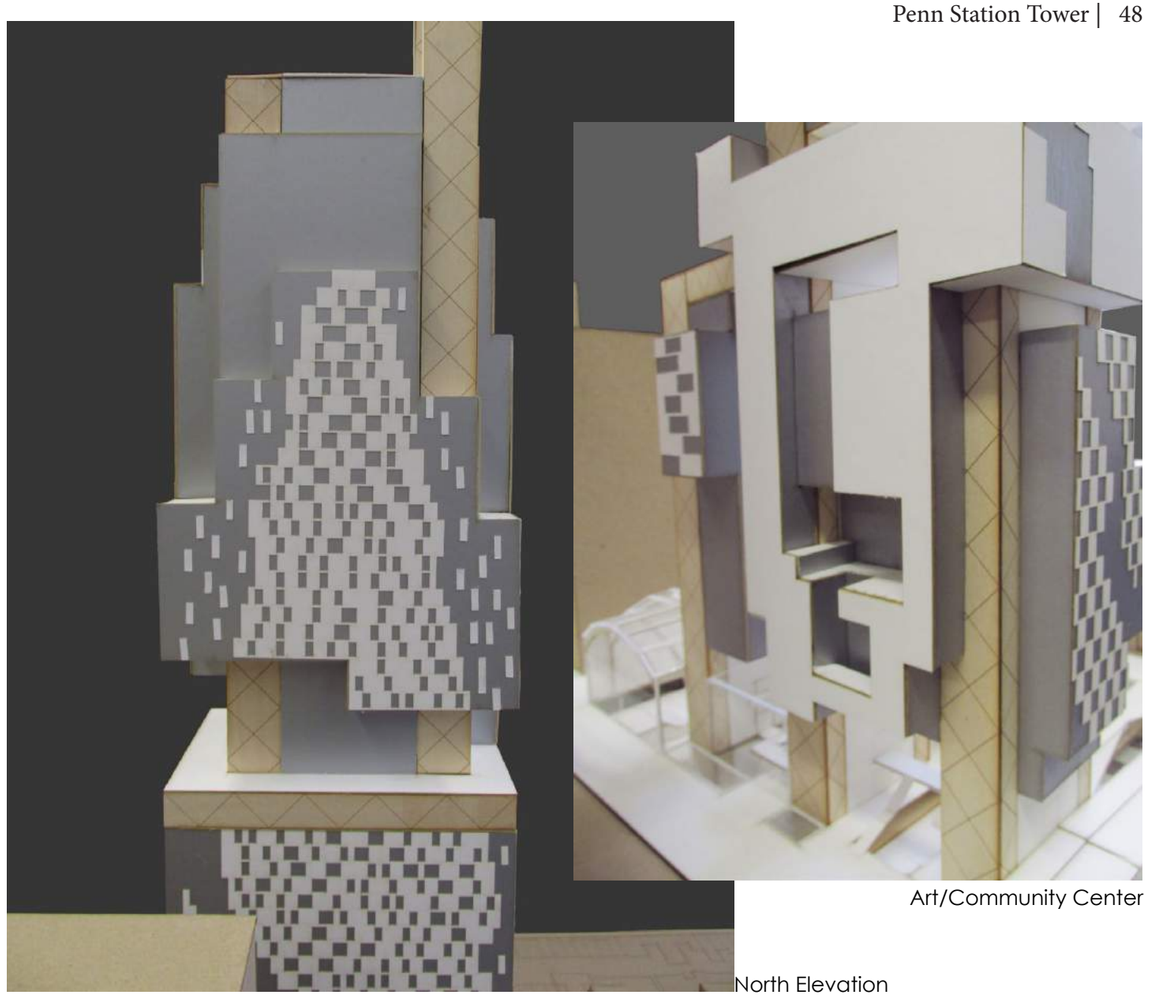
Model
Scale: 1/32"=1'-0"

South Elevation



Plaza

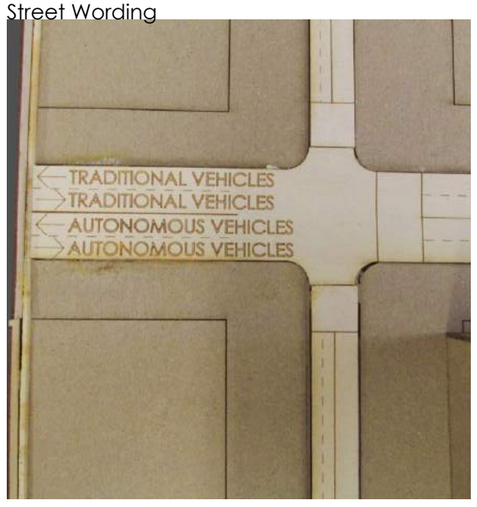
Train Station



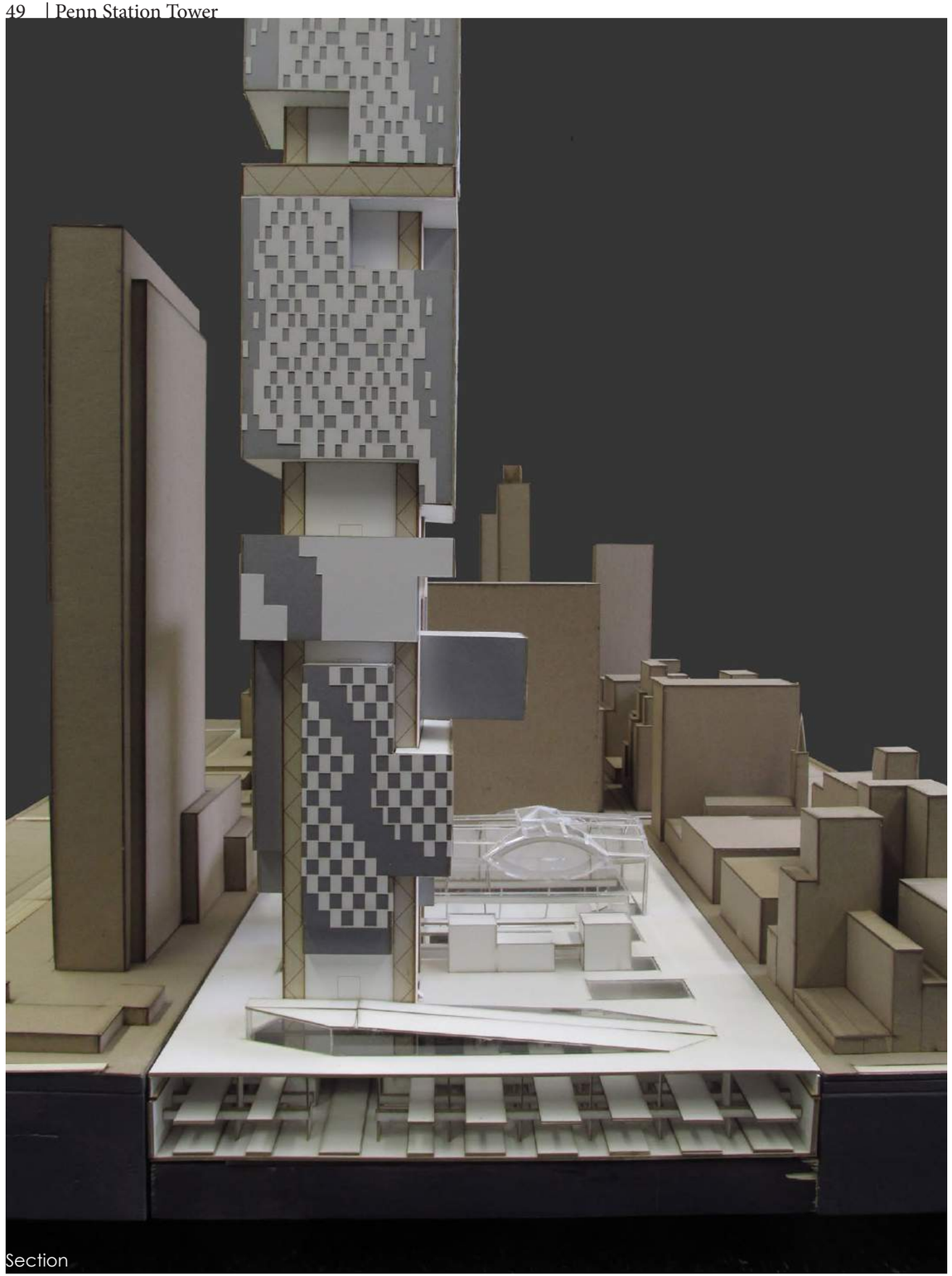
Art/Community Center

North Elevation

Street Wording

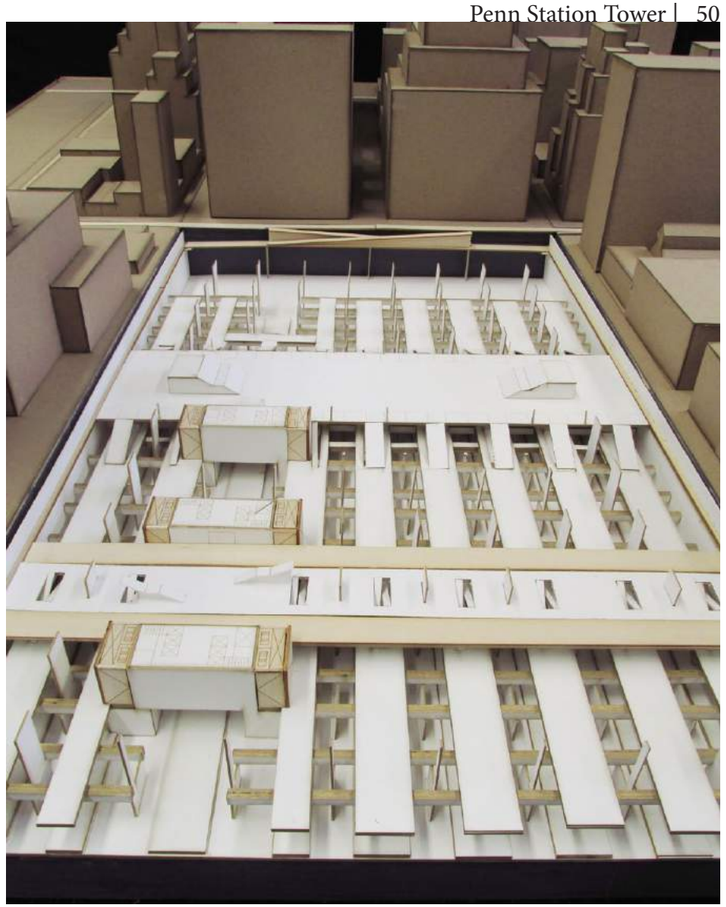


Vehicle Maitenance



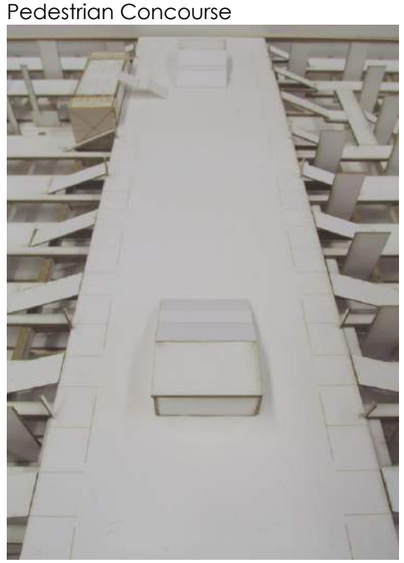
Section

AEV Concourse

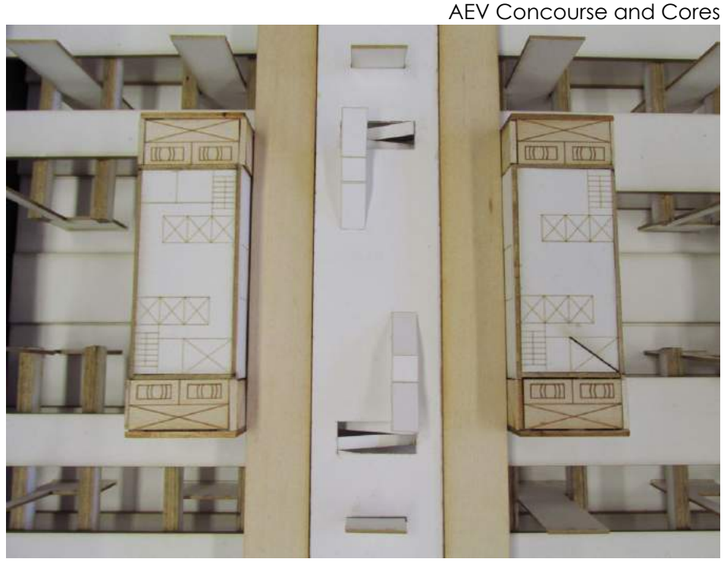


Train Station

Pedestrian Concourse



AEV Concourse and Cores



REFLECTION

Reflection

Bradley Reed
Miami University

At the beginning of this thesis exploration, the focus was to study branding through architecture. Early on during the research phase of the exploration, the question of what to brand arose. In finding an answer to this question, ethics in architecture and in possible subjects to brand had to be navigated. In fact, ethics would play a large part in the decision of choosing to brand the evolving innovation of autonomous-electric vehicles. At the time of the choosing of this topic the thinking was why not design something where the core concept of the topic did not seem questionable itself. Autonomous-electric vehicles were going to be the thing of the future thanks in large part to how they will help save lives and produce less emissions. Even though the question of HOW was architecture going to brand autonomous-electric vehicles was knowingly going to be debatable, what was not fore seen as being debatable amongst others was the ethical decision to place morality decisions into the hands of this AI technology.

From the choosing to brand autonomous-electric vehicles to the completion of the written thesis, the project did see some changes. In hindsight, these changes were positive changes because the question of how to brand through architecture for AEV's really seemed to dig deeper into the exploration of what would the overall identity be of the changes in the built environment because of AEV's, which inherently asked for the further exploration of what were some of the possible changes? As it would turn out, it was these deeper explorations that would ultimately guide the design project.

Overall, the design project was successful. The project was able to explore how the built environment could change as a response to AEV's if designed correctly and it did this on three different factions of the built environment: the city grid, urban street typologies, and within architecture itself. Even though the design project completely missed the overall concept of the written thesis, that the changes brought on from AEV's would be about comfort and convenience, the project was able to articulate a more evolved overall identity of theses changes… greater community connections.

The changes in the architecture portion went further on to exemplify both how architecture could physically change because of AEV's and brand itself in the new evolved identity of greater community connections. Whether the actual design of the tower and redesign of Pennsylvania Station were stand-alone successful pieces of architecture is objective. Looking back, there were architectural moments in the tower that could have been designed more successfully if given more time to explore and other moments that had inherent architectural design flaws that were not noticed until too late in the design process. The main problems deriving from the overall girth of the tower and the under-privileged opportunities in the center of volumes. Examples being of what to do with the spaces between the two taller cores in both the lower segment between the hotel and cultural art center and in the public housing. And even though the redesign of Pennsylvania Station had itself inherent design flaws, such as too much glazing that potentially could overheat the pedestrian concourse, the redesign of the station left may opportunities for further design developments that could make the station and plaza even greater. A few of these opportunities would be the development of the plaza space into something that could be more suitable for users and the development of the 'art wall' located above the pedestrian's concourse east security checkpoints. If given the opportunity to further develop the project, these architectural moments would not be of the highest priority.

If given the opportunity to further develop the project, the parts of the project that would be looked at for further development would be the changing of New York City's street grid and the changing of New York City's street typologies. Even though the main intentions of repurposing the streets as spaces the local communities could design, greater attention could have been paid to the developing of greater street typology examples and further developing exactly how the autonomous-electric vehicles may operate on the new city streets.

In the end, this project stands as only one potential example of how the built environment could change because of the development of autonomous-electric vehicles. Because no one exactly knows how the development of autonomous-electric vehicles will go, it is hard for anyone to almost predict with any certainty of how the built environment will change, or furthermore, what its identity would be. If given the opportunity to redo any portion of this thesis exploration, except for missed architectural opportunities mentioned earlier, I would not change anything in this project's thesis development. From the choosing of branding through architecture, choosing to brand autonomous-electric vehicles, digging deeper into the potential changes of the built environment, and the developing of the design projects program, I believe that this thesis exploration was overall successful in its exploration of an answer to a potential architectural problem.