

THE INTERSECTION BETWEEN AUTONOMOUS VEHICLE AND BUILT
ENVIRONMENT

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By

MD MAZHARUL ISLAM

Miami University

Oxford, Ohio

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Advisor _____
Murali Paranandi

Reader _____
Craig Hinrichs

Reader _____
J E Elliot

The Intersection between Autonomous Vehicle and Built Environment

Abstract

Autonomous and semi-autonomous vehicles are likely to replace the conventional vehicle in the near future throughout the world, however, the response and adaptation to this new change will vary in different countries in accordance with their cultural, economic and infrastructural provisions. How would Bangladesh as a low-income and dense country but having rapidly expanding economies respond in the transition from conventional vehicles to autonomous and SAV? Can its adaptation be traced and guided in a way that will address the community's needs? How would the architectural and infrastructural implementation look like in a developing country that would differ from the developed world? Even though Bangladesh is a small developing country and it has been advancing with its own pace and path, where will Bangladesh differ from other developing countries? Like many other developing countries, in Bangladesh, the evolution of public vehicles forwarded according to the community's need in a vernacular way without proper patronage and business structure. An urban community's needs for transportation and commuting influences the architecture. Transportation systems alter urban fabric; it will do so in the future. Tesla, BMW, Audi and other giant automobile companies are working on different prototypes of autonomous cars and that they have launched. However, the US and Europe market and policies are skeptical to fully replace the conventional cars. On the other hand, China, as an upper-middle income country and 2nd in the population density is more likely to be the first to fully execute autonomous vehicles. From that point of view, the new cities in Bangladesh have the potential of implementing AV in public transportation and auxiliary infrastructure. Hence, the architectural implementation is most likely to vary from macro level to micro level, business district to mixed-use and residential and so on. By juxtaposing these scenarios and analyzing the factors to respond, this essay investigates

the most probable infrastructural, architectural and transportation-based adaptation would take place in developing and populated countries like Bangladesh.

Introduction

Is it technology that can upgrade civic lives, or is it the infrastructure or architecture? As it is a multi-disciplinary and broad question to answer, architecture has its own role to play in this intersection. But from an Architect's point of view, the intersection of different discipline is the place where an Architect can play his or her role. Public transport and infrastructure, hence, creates a junction where the architecture has significant role to play. In developing countries, it is more diverse. The man, who has to wait for the bus for 20-30 minutes every business day to go to his office, fights to find a spot on the door of the bus as at peak hour the bus is over-crowded. However, launching a new transport system like water taxis, MRT(Mass Rapid Transit), BRT(Bus Rapid Transit) will provide commuters with new facilities. What if the bus was autonomous in this dense city? Would the commuter have to still struggle? What could be the pedestrian connections with AV facility? The architectural adaptation would surely influence his lifestyle, the pavement on which he walks, the sitting place near the street or the bus stoppages. Here the modification of public transport comes with respect to the affordability and consumer's need which is conducted by low-profile industries, and architecture can respond with respect to that. As autonomous vehicles will replace the conventional vehicles in a matter of time surely, is there any possibility that it will create its regional characteristics in developing countries, and what will be architectural interpretation in that case? This paper will focus on the architectural scopes in developing countries in the era of autonomous vehicles, and also the transition time on the basis of analysis of current literature and case studies of new transportation systems such as the autonomous vehicle and the affect upon architecture, as well as opportunity for new architectural interventions. On order to do that, the paper will investigate the potential of AV in the new proposed township in Dhaka, capital of Bangladesh.

The Purbachal New Town Project is the biggest township in Bangladesh. The objective of the

project is to reduce the population pressure in Dhaka, balance the environment with urbanization and expand new economy. Nonetheless, self-driving technology is not very familiar in Bangladesh and the implementation of this technology is very unpredictable now, but the infrastructural development can address the technology. According to the current economic condition and infrastructure, the topic might seem irrational. But it is not ignorable that technology develops and spreads so fast. Like the way automobile and computer reached the remote areas within few decades, AV technology is likely to do so. Especially where people can't afford private car and likely to share rides, public transportation has the potential to incorporate AV tech. Unfortunately the utopian views of smart cities are mostly developed country-oriented. The developing countries especially new born cities could be an ideal spot to investigate the architectural response to AV. As a new township, Purbachal consists of residential, CBD, diplomatic zone, market places and other amenities. In micro-scale the infrastructural adaptation will be different for each of these zones, The paper will explore the unique architectural interpretation responding to AV. The development of roads, buildings, marketplaces and community spaces can be designed with respect to the flexibility for autonomous technology.

Methodology

The paper will explore the possible architectural interpretation for AV technology in the new township project in Dhaka division named Purbachal. If autonomous buses become the preferred mode of transportation in urban areas and surrounding communities, what possible architectural interventions could engage with the new transportation technology in Purbachal? Although the master plan is developed in several phases and it is under-construction phase, what type of architectural adaptation can be undertaken?

In the urban context, the most crucial time will be the transition time from the conventional vehicles to autonomous vehicles(AV) and semi-autonomous vehicles(SAV), and how they influence lifestyles. Similar to any other places in the world, this transition can lead to utopia or to the sufferings from dystopia. That is why, the newly expanding cities or city peripheries can respond to cultural, political and

sociological aspects of urban life, as well as the economic viability of the urban context to support a population. Therefore, the first step is to look onto the potentials of AV in Bangladesh specifically in the new township projects. This includes the utopian and dystopian outlooks considering the current states of the older part of the cities.

The current pilot projects in Europe are essential to consider the use of new transportation technologies, and their affect upon the urban condition. The transportation practice in China, the neighbor country of Bangladesh, is to be researched as it has the cultural and socio-economic resemblance with Bangladesh. At the same time, the current transportation condition in the urban context of Dhaka, both in macro and micro scale, is analyzed and compared. This juxtaposition guides to understand the potential urban context of future Dhaka. In Purbachal, considering the demography and urban infrastructure, the parameters to adopt the possibility of AV technology can be explored, especially, how the AV tech can respond to demography and cultural needs that reflects the infrastructure.

The case studies incorporate the potentials of architectural responses to new transportation models, for example the exhibition "Designing London's Future Road System", January 2016 on the future of London during the era of AV and drones where different architectural firms presented their ideas addressed landscape, streetscapes, shopping mall, and parking. Hence, in developing countries, the approach could be different based on the context. Similarly, the project "Sidewalk Toronto" is relevant as it has also approached the neighborhood development of Toronto that focuses on advancing solutions to the challenges facing cities, such as energy use, housing affordability, and transportation. Interestingly, the article "Building the smart cities of the future" by Christine Wong, has addressed the utopian and dystopian views of the smart cities including the "Sidewalk Toronto" project. These case studies' a critical analysis can be considered while approaching the urban context in Dhaka during the era of AV.

The NACTO's(National Association of City Transportation Officials) publication addressed the way for a brighter autonomous future

incorporating architectural interventions in urban contexts. The publication provides ideas of treating road intersections and nodes that can be approached in Dhaka's newer areas.

The analysis of policy and projects in different countries and the corresponding case studies provide an outline to set parameters in order to address Purbachol township. These parameters incorporate cultural and socio-economic context and generate a framework for an architectural response in the newer part of Dhaka. As Purbachal is a long-sighted and ambitious project which will be developed phase by phase, it provides with a tremendous opportunity to explore architectural adaptation to infrastructure and amenities in a city addressing the AV technology from a new point of view.

In order to predict the movement of people and vehicles, some assumptions are required. The assumptions can be utilized to design the urban fabric. Also, other means of commuting like bicycles, water taxis or shared vehicles need to consider. The architectural response to connectivity network and hub will be based on the land-use and zoning. To predict the most probable pattern of people and vehicles' flow, aid of parametric software can be incorporated. This process is a numeric analysis to pick the closest probability. For instance, location of marketplaces, bus stations, MRT stations can be constraints in a matrix where office buildings, retail can be variables. Prediction of suitable vehicular and pedestrians flow can be possible with numeric analysis and also considering qualitative factors. Some decisions can be made from this approach for the base work of design process. At Surabaya in Indonesia, walking routes to light rail stops were analyzed with the aid of Urban Network Analysis tool, a plug-in of 3d modeling software Rhino. Similarly, other parametric plug-ins can be used to predict circumstances. The use of computer simulation is not the only way to approach but it can narrow down the work for design.

Utopia or dystopia?

Within the autonomous vehicle, occupants are in a computer-controlled environment. The advancement of AV technology has made the vehicle as a portable room. Our future travelling experience may look to some extent like either driving or riding. The ability to sleep

in mobile rooms changes the dynamic for land travel. Protection, ground transportation, car maintenance and such are normally high on enterprises prone to be most affected, yet shouldn't something be said about different types of travel, urban plan and real estate itself? The vision of smart cities are focused on utopian view. In some cases, the patronage comes from tech industries that represents a partial scenario of future cities. Maybe the projections are garnished and enveloped by a sustainable future. But how much upgrade do we need? Is it superfluous or less responsive to community?

The question leads to the probable dystopian scenario where the urban context is either neglected or being seen from the inside of a car. Also, the business model that highly focuses on profit influences the architectural intervention. Like any other smart city, the planning of Purbachal township launched 27 years ago with a utopian view. In the meantime, technology and demands have changed rapidly. The MRT(Mass Rapid Transit) is under construction phase. The BRT(Bus Rapid Transit) connections will be coming soon. In addition, the township will be supported by three major ring roads as proposed by RAJUK, the development authority of Dhaka. Thus the location sustains the potentials for a smart city or another mess like current Dhaka. It might not be possible to design a perfect city for the future but considering the realities and possibilities, it is possible to design one with response to the needs of community and culture.

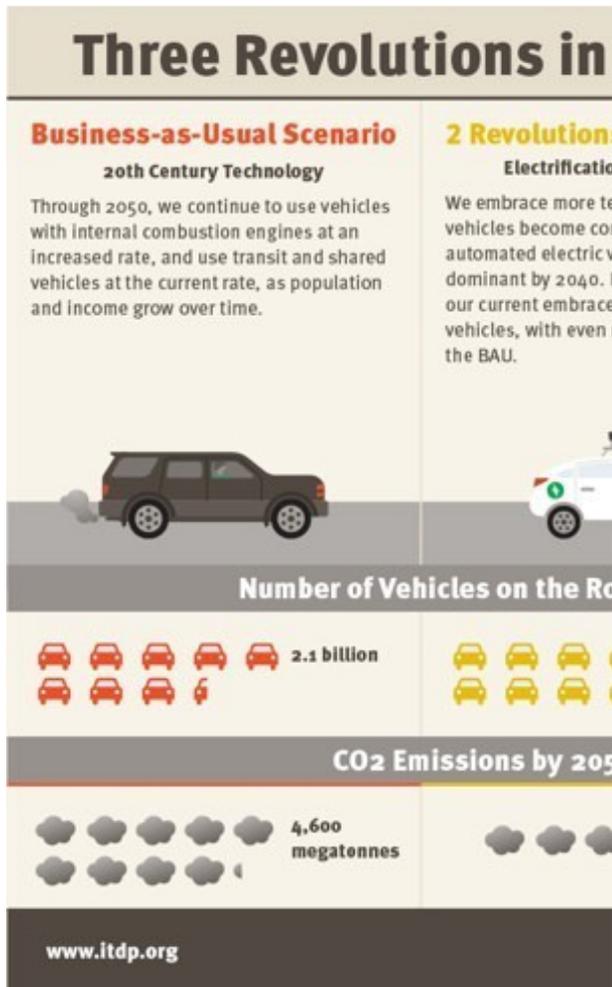


Fig: Potential futures per the Institute for Transportation and Development Policy (ITDP)¹

According to Kurt Kohlstedt's article,

As people sit back, relax and enjoy the ride, there's a real risk that automation could fuel further expansion and vehicle use. Taken to the extreme: potential cost, time and energy savings may get cancelled out. Instead of sharing, rich car owners might keep private vehicles in motion, having them

¹ Kurt Kohlstedt. "Crash Course: Are We Headed for an Autonomous Utopia or Driverless Dystopia" Accessed May 18, 2019. <https://99percentinvisible.org/article/crash-course-headed-autonomous-utopia-driverless-dystopia/>

run errands that expend fuel and take up space.²

When it comes to self-driving cars, probability of road accidents becomes the general criterion to assess. The precision of Autonomous Vehicle (AV) technology will eventually reduce the road fatalities, nonetheless, there are some other major factors that could generate annoying and encroaching circumstances in the urban context. The ease of maintenance and cost, availability of fuel and more time inside a car will encourage the automobile company chasing higher mileage. The ease of travel will encourage more time to be spent inside a car than on a pedestrian. The circumstances provide an opportunity to evolve new business models. Transportation might appear as Transportation as a Service (TaaS). It is going to be more like a mobile app that is funded by advertisements which can make the user experience uncomfortable for both private and shared vehicle users. But consumers are also likely to take the cheaper service regardless of the brand or service quality. Thus, the AV can generate a dystopian scenario for the consumers.

An autonomous luxurious car will not be affordable to the general public. A four-person Uber or Lyft car is not going to replace a 40-passenger bus. Similarly, sharing a vehicle might not replace the mass transit. But if we address transportation in the micro level, sharing could be essential, and in the macro level mass transit is effective. Thus, an unplanned urban planning policy, disregarding the macro and micro level impact, may begin with a utopian vision but has potential to lead to a dystopia one.

Autonomous vehicles in the USA and Europe

Autonomous vehicles will be ubiquitous in a matter of years throughout the world. The United States is more likely to set a precedent

²Kurt Kohlstedt. "Crash Course: Are We Headed for an Autonomous Utopia or Driverless Dystopia" Accessed May 18, 2019. <https://99percentinvisible.org/article/crash-course-headed-autonomous-utopia-driverless-dystopia/>

considering the economic resources and technological advancement. However, the private sector is more dominant in the United States as most of the public would like to have their own cars. As indicated by the report of autonomous vehicle pilots across America, over half of US urban areas are, as of now, setting up their roads for self-driving vehicles, up from under 10% three years prior. A portion of these urban communities have additionally begun testing self-sufficient vehicles.

In August 2017, Arlington, Texas, started testing a 12-traveler AV transport on a fixed course on non-open streets as a major aspect of an association with Arlington's Conventions and Visitors Bureau, the report stated. There are currently two transports in activity. The buses are staffed with "on-board data diplomats" who can physically work the buses if essential. Since origin, the bus has given in excess of 1,500 rides. A second period of on-road testing is straightaway, and the city has issued a focused request for proposals to convey self-governing traveler vehicles to a geofenced area of the city. The desire is for on-road AV administration to make a big appearance later this fall. Boston, Portland, Pittsburgh, San Jose, Chandler have also approached the practice. The Purbachal city has the potentials to incorporate the AV tech and support infrastructural development in a different way. Due to economical conditions, privet car is less preferable. Public ride or shared ride are more convenient here. Therefore the implementation of AV tech in Purbachal will be different and its influence on urban fabric as well. The architectural response in building and pedestrian levels can allow the flexibility to address the technology.

Europe has for quite long time been viewed as a pioneer in the transit space. Europe is pioneering a trail by moving the focal point of the robotization from private vehicles to public transport and guaranteeing that the fate of mechanization is available to everybody. At the point when numerous North Americans consider self-governing testing, they refer to the Silicon Valley display, where privately owned businesses like Tesla and Google are trialing expensive self-ruling cars costing a huge amount of money. In Europe, things are extraordinary: self-sufficient testing is less stylish, centered rather around utilitarian vehicles intended to serve various individuals. In Berlin, for instance, square shaped and plain-looking vehicles with space for 12

travelers are being tried as an open travel alternative. These the sorts of ventures are essential to guarantee self-sufficient innovation isn't constrained to extreme individual vehicles—a possibly hazardous pattern in the AV insurgency. The case studies will also incorporate the architectural responses regarding the AV in Europe.

In Europe, then again, governments are cooperating to manage and coordinate driverless innovation into the open travel segment. A year ago, 26 European nations consented to team up on testing self-governing innovations including robotized mini-busses. Through this structure, France and Germany have consented to construct a cross-outskirt passage for self-ruling testing, preparing for the reconciliation of worldwide self-governing open travel.

In the US, companies like Waymo, Tesla, BMW and Mercedes Benz are the main groups testing autonomous vehicles on American roads. The goal of these companies is to sell vehicles and make profit, which is expected to result in an increase in vehicle miles travelled as autonomous vehicles are released to the public.³

The European way to deal with testing has seen self-sufficient innovation as an open pleantry, with the two governments and colleges working together on arrangements. This methodology results in tasks like mySMARTlife, an activity subsidized by the European union which is approaching the open dispatch of independent transports in Finland. Besides, colleges are getting engaged with driverless innovation explore, bringing about progressively imaginative travel arrangements. For instance, self-sufficient water crafts are coming soon to the trenches of Amsterdam.

China could be first with self-driving vehicles

China could be first to convey self-sufficient vehicles at a large scale — and one marker is the way they've effectively taken the worldwide lead

³How Europe Can Lead the World in Autonomous Public Transit", DDS Wireless, Accessed May 20, 2019, <https://ddswireless.com/blog/how-europe-can-lead-the-world-in-autonomous-public-transit/>

in Electric Vehicles(EV) on account of government arrangements and buyers' expectations. Offers of electric vehicles are developing rapidly in China, where shoppers are additionally open to advancements like vehicle sharing. By moderating administrative rules and welcoming the way to self-sufficient vehicle testing, China is pulling far from different nations on new portability activities.

The details, from German consultancy Roland Berger, which tracks and scores countries on 26 indicators of auto industry disruption. The global shift toward electric vehicles is happening mostly in China, which sold more than 750,000 EVs through October, 2018. They doubled its EV charging infrastructure over the past year. At the same time put limits on registrations for gasoline-powered vehicles. They also welcome foreign automobile industry to test AV technology.

"China will be the first to commercialize at scale simply because the regulators will pave the way with pro-autonomous policies."

— Michael Dunne, president of China Automotive Consultancy ZOZO Go⁴

The main aspect that is relevant to Dhaka is the cultural context. Like China, here, community is more likely to share the ride due to economic limitation and willing to interact with people. China has developed their infrastructure that serves the electric car. How can the infrastructure or architecture be developed responding to community and technology in Dhaka? The infrastructure is supporting the EV. The uses of EV with the infrastructure must have impact on lifestyle. To what extent architecture can adapt with this? If the cultural context like ride sharing, dependency of public transport are being addressed the physical change in building and streetscape can be something new. Considering the cultural similarities with China, the ride sharing and AV tech can be incorporated while addressing the transportation system and supporting structures.

Prospects of public transportation in Bangladesh

⁴Joann Muller, "Why China could be first with self-driving cars", Accessed May 20, 2019, <https://www.axios.com/china-taking-lead-on-autonomous-vehicles-609dfc98-f671-4a66-a731-b62d8327bef4.html>

As the stakeholder's investment is mostly focused on financially strong countries, low-income and over-populated countries like Bangladesh, how would it deal with the transition from conventional vehicles to autonomous vehicles?

Despite the lack of any local car manufacturers, a state-run company named Pragoti Industries limited has been manufacturing vehicles for Japanese company Mitsubishi at a low rate.⁵

The lack of infrastructure and industries has opened the scope to modify the vehicles according to public's need and culture. MRT(Mass Rapid Transit) will be launched in 2020, BRT(Bus Rapid Transit) will also be launched at the same time. But it's not too far that the cityscape and architecture of Dhaka have to deal with autonomous vehicles. Therefore, the transition period from conventional vehicle to AV will be lengthy here and the new city design can respond to this inevitable fact. The new township project, Purbachal, possess great opportunity to address AV tech and architecture. The location of the township as well as proposed road network and waterways has widened the opportunity. The addressing of the intersection between architecture and AV tech in a developing country, public transportation and pedestrians add different dynamics than developed countries.

Literature reviews Meyboom, AnnaLisa, Driverless Urban Futures: A Speculative Atlas for Autonomous Vehicles

This book depicts a series of drawings and text that uncover the potentials of AV from macro scale to micro scale in a city. The research work is highly relevant in order to explore the potentials of AV in Dhaka city. It has covered the visionary infrastructure, analytic scenario, street scale impact, public transportation , and

⁵Naimul Kader, "An overview on Automotive industry in Bangladesh", Accessed May 20, 2019, <https://www.linkedin.com/pulse/overview-automotive-industry-bangladesh-naimul-kader-6%CF%83-certified/>

historical trajectory of transportation system. In street scale, the author proposed flat street, block-end-stop-off, reclaiming boulevard, drive through grocery, charging station with fast food store, traffic signal infrastructure. Similarly, in macro scale, highway autodrome, smart tarmac, shipping/delivery means are depicted in different point of views. Additionally, the author took inspiration from some North American practices in her proposals. The approach of taking inspiration from a region represents the importance to address cultural context. The author's critical analysis to address streetscape and infrastructure is exemplary, but maybe not reproductive. Therefore, the probable architectural solution is likely to have its unique characteristics in Purbachal.

2019 Autonomous Vehicle Technology Connect event

Autonomous Vehicle Technology Connect is organizing a one-day conference and tabletop expo on September 26, 2019. This is a platform where professional from different disciplines will contribute and will incorporate architecture, engineering, construction industries and new-mobility technology. The conference will be featuring speakers and sessions focusing on the best solutions to connect these industries. This is a unique platform where professional and researchers from Government, academia, contractors, consultants, decision-makers and stakeholders will join.

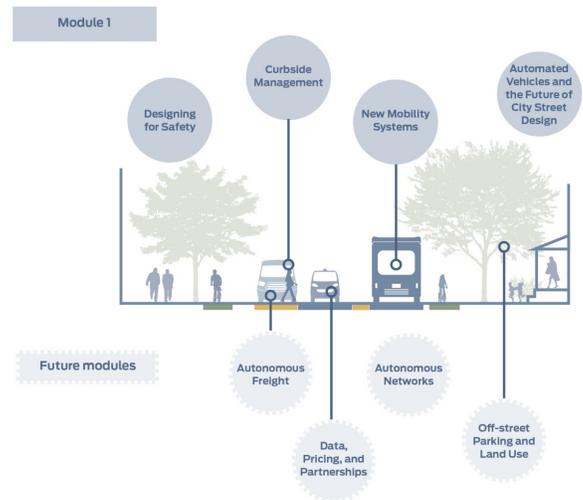
The Autonomous Vehicles Technology Connect's objectives are relevant to look into it. They incorporate the content that relates to the intersections of AV, connectivity, and mobility with architecture, build environment design and city planning.

Their focus subjects are,

- Architecture,
- Autonomy,
- Built Environment Building & Construction,
- Chips & Controllers,
- City Planning & Smart Cities,
- Connectivity,
- Construction, Delivery of Goods,
- Electrification & Charging,
- Investment Banking & Venture Capital,
- Legal & Liability,
- Mobility Equity,
- Mobility Services,
- Policy & Regulations,
- Sensors,
- Startups,
- Traffic

Management, Vehicle Development & Forecasting⁶

The focuses of the conference represent the necessity of the collaboration of professionals from different majors. Unfortunately, most of the smart city project is patronized by the tech leader companies where these projects are enveloped as social project. As a result, they fail to address designers outlook as well as community's need. For Dhaka city, the focuses might incorporate some of these ideas from the platform of different professionals but it must incorporate its regional and cultural context. The analysis of this conference's objectives and prospective speakers' speech is substantial to generate a manifesto to find out the architectural potentials in Dhaka city during the era of AV. In Purbachal, for instance, it can be for a CBD or marketplace or for a specific zone that will incorporate the program, policy, pedestrian activity, streetscape and relevant function.



This module of the Blueprint addresses some of the most pressing issues city transportation agencies face today but

• ⁶ "Call for Speakers", Autonomous Vehicle Technology, Accessed May 20, 2019, <https://www.autonomousvehicletech.com/connect/call-for-submissions>

acknowledges those issues will vary by city and over time.⁷

Today's streets and highways are the reflection of a century of investment in auto-oriented infrastructure, however, it has failed to provide reliable or safe urban mobility. More efficient and humane street design addressing cultural context is possible. Technological advancement provides with new opening to remake the streets adapt to new mobility system. In a developing and populated country, it can be more complex but possible as there is higher uses of public transport and ride-sharing. The way NACTO considered to create a blueprint for the member cities, it can be a manifesto for those cities. But for Dhaka city, it deserves its unique blueprint that will be addressing not only technical aspects but also cultural and socio-economic factors.



Downtown streets, perennially in high demand by many modes and as gathering spaces, are vital to the future of the city. Every element of the street, from sidewalks to loading zones, should allow a seamless walking experience for people, and high-capacity transit should be given the space it needs to operate reliably.⁸

Case studies Exhibition by New London Architecture

⁷ <https://nacto.org/publication/bau/>

⁸ <https://nacto.org/publication/bau/automated-vehicles-future-city-streets/>

Streets Ahead exhibition by New London Architecture and transport for London envisioned the era of London's road system where self-driven cars and drones will be dominating the transportation system. The exhibition "Designing London's Future Road System" in 2016 asked different architectural firms to share their ideas. The exhibition is significant as it has shown different means of addressing the influences AV in urban context.

Fosters and Partners have addressed both neighborhood and in-building programs like the drop-off area, drive through area, pathways etc. The concept is highly focused on the utopian view and also the community. In a developing country, according to the consumers' socio-cultural context, the architectural response would be much more different. As London has its own architectural adaptation, same for Dhaka city.



London's Future Roads – Visual Concepts
© Arup⁹

"streets define the character and quality of a city and are key to the health and wellbeing of its citizens. We must keep this in the forefront of our minds as we face a period of major change in the way we use our roads."¹⁰

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¹⁰Banks, Tom, "Designing London's future road systems", Accessed May 20, 2019, <https://www.designweek.co.uk/issues/25-31-january-2016/designing-londons-future-road-systems/>

The architectural ideas also addressed the roads for conventional cars. This is very pragmatic that conventional cars are not going to be replaced by AV by night. Therefore, the roads for conventional cars were address in a different way here. Also, the inclusion of solar roadways, space-saving car parking, dedicated lanes for bikes, more green spaces are advance and practical approach that they have made. In Dhaka city, in order to find out the framework and potentials scopes to address, the exhibition can provide with a guideline.

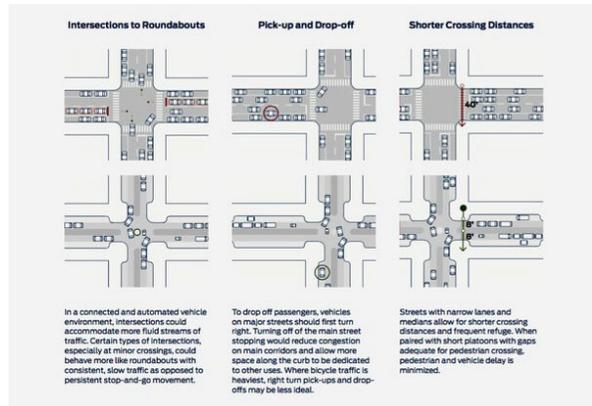


The (NACTO)National Association of City Transportation Officials

The (NACTO)National Association of City Transportation Officials, an international 60-city organization planners and engineers. They published a 50-page blueprint to that envisioned a brighter autonomous future. Their guidelines and focused on the treatment of the road and street of the future cities not only the near future but also the era of autonomous vehicles. Their guidelines to treat road intersections, nodes, lanes, and drop-off areas profoundly incorporated the technology of AV. For instances, AV requires less lane width that facilitates to the widening of pavements and green spaces. Also the narrowing down the road to the intersection is respondent to the AV's movement pattern.

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developing and populated country, it can be more complex. The way NACTO considered to create a blueprint for the member cities, it can be a manifesto for those cities. But for Dhaka city, it deserves it unique blueprint that will be addressing not only technical aspects but also cultural and socio-economic factors. There are different types of public transport and people's



activity is diverse as well. Thus, a planning for different zones in Purbachal for future transportation system can be inspired from the blueprint stated above.

Sidewalk Toronto

Sidewalk Labs focuses on using new technology to address urban challenges at large scale. It also incorporates the betterment of the lifestyles in cities. They brought together the specialists in urban design who also led New York's post-9/11 revival with the help of technology.

Sidewalk Toronto is a joint effort by Waterfront Toronto a Sidewalk Labs. Their potential neighborhood project will begin at the southeast of the downtown Toronto. Their approach to improve the quality of the life is versioned to create a new kind of mixed-use urban zone that focuses on advance solutions such as energy use, housing affordability, and transportation.

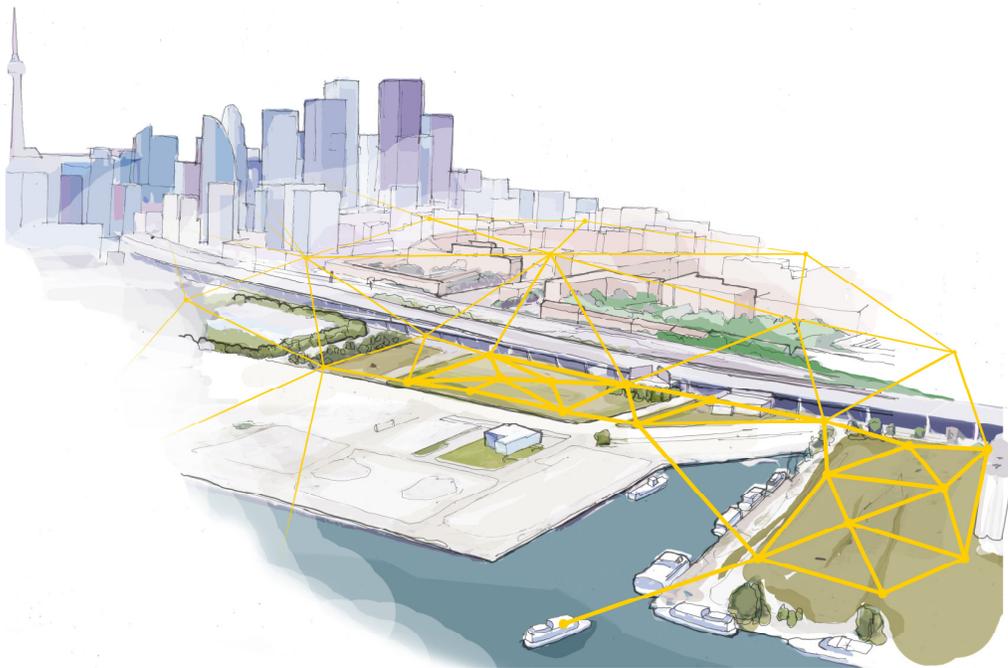
Nonetheless, the project is highly focused on the global scale of a city where transportation system is a segment, the policies and street-based intervention can be studied to explore potential scopes for Dhaka city.

Luxurious smart city in South Korea couldn't meet its goal neither in user number nor in completion. Similarly, SideWalk Toronto has encountered resistance regarding data privacy and security of citizens. Hence, these projects have had obstacles to sustain their promise. The vision for higher quality of life incorporates both infrastructural and data analytics. Some smart city projects in Louisville, Dallas, Kansas City, and Beijing have showed maturity and gained impressive result. Smart city projects improved community and reduced the energy cost. However, the benefits of smart cities might not be accessible to all classes of people. Rather, it might serve to certain group of people that encourages Public Privat

Partnership. It may fail to sustain a community in order to serve the connectivity. The new smart city could be a digital means of segregation. The author also incorporates the security and privacy of users' data as it is a sensitive issue.

How autonomous vehicles are influencing urban design

Most of the time during last century, urban and suburban design were focused on private car uses. The advancement of AV technology has the potentials for reduction of car ownership and increasing of ridesharing. This will affect



the urban fabric, will provide with more spaces for pedestrians. Autonomous vehicles will require less space due to its precision. Parking lots can be converted into pocket parks. Dedicated garage and driveway might be less necessary in future housing. Wide boulevard can be modified as greenways. The way, Berges de Seine Paris and Rhone River Bank Lyon converted the road into public space that was once dominated by motorized vehicles, can be exemplary because the present road have to be ready for AV in near future. This is an opportunity to reassess urban design for future. At the same time, AV technology will also require infrastructural support to run safely in streets.

theory which can be implemented in the growing and newer part of the Dhaka city.

The technology behind autonomous vehicles is progressing at a fast pace. While policy and infrastructure design might be slightly behind the technological advances, it is time designers started to think about the changes that will come and plan for a future in which the car is no longer.¹¹

Conclusion

Technological development is influencing Architecture. The AV's impact on urban scale is both on macro and micro level. This change can be one-sided as garnishing the technology or it can be sensitive to community. The AV technology won't be fruitful without auxiliary infrastructure and plan. Where the AV technology research is mostly based on developed world, Purbachal can be a unique place to explore the intersection between architecture and AV technology in developing world. The township can be prepared for the future so that it can transit from conventional to AV technology period smoothly without compromising community's need. The designers and planners have scope to work in design and policy level and generate new code. What could be the definition of the smart cities in developing countries? The research process leads to a manifesto with the architectural

¹¹Jolma Architects, "How Autonomous Vehicles are Influencing Urban Design", Accessed May 20, 2019, <https://land8.com/how-autonomous-vehicles-are-influencing-urban-design/>

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Addendum

Written Thesis to Design Thesis Transition

Google Transit Village: The Intersection between Autonomous Vehicle and Built Environment

Following the written part of my thesis, I reframed my thesis questions, methodology and expanded investigation on site and probable architectural program. Previously, the thesis question and site was focused on developing countries especially on the new township at Purbachal, Bangladesh. It had different dimensions in complexity of social and contextual issue. I was also searching for other sites where I can implement the design ideas ideally as an abstract. I came to know about the proposal of Google Transit Village at San Jose, CA. The program seems to me perfect to address thesis question both ideally and practically within a real proposed program. Hence, I rearranged my methodology, researched on case studies and relevant thesis from other schools and defined my scope of work for the final project. This addendum section contains new abstract, methodology, case studies, site analysis and final design proposition.

I studied profoundly about the proposal of Google Transit Village at San Jose, CA. Google has bought 60 acres land to redevelop the site as well as the neighborhood and a campus that can allocate 20,000 employees with housing facility for the employees as San Jose is already dealing with its housing crisis. The complex program also consists of hotel, retail, public park and cultural complex. I have used their proposed program as a base program to explore my thesis question. The program and site appeared to me potential enough to address implement design proposition in vehicular design and expanding architectural program.

Updated Abstract

From primitive wheels to a contemporary autonomous vehicle, modes of transportation played a pivotal role to create the artery of town and cities. Once the streets were for pedestrians are now for the cars and the city is for parking infrastructure. Regardless of the user and context, the space for people inside a

city has been and is being marginalized. Autonomous technology has created a new window to re-think the built environment to recreate humane habitat that is sensitive to the environment for both present and future cities by taking the advantage of the technology but not being dominated by the technology.

The thesis explores the mutual feedback between the built environment and autonomous vehicles that will promote community and environmental welfare. The thesis presents a design proposition based on 'unconventional shared autonomous vehicles' that responds to user-specific needs and a new typology of urban planning and architecture addressing these autonomous vehicles. At the same time, a new typology of shared autonomous vehicles and supporting infrastructure is proposed that incorporates the basic packaging of the vehicles and range of services.

The Google Transit Village at San Jose in California will serve as a case study to explore the fusion of AV technology that eliminates the needs for dedicated traffic and parking infrastructure but promotes more greenery and a new typology for a sustainable office environment. The proposition can be adapted or extended in macro and micro scale.

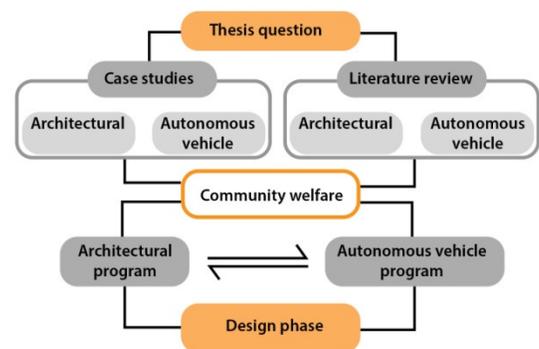


Fig: Updated methodology

New Case Studies & Literature Review

Following the symposium, further research was conducted on office culture in tech-giant Google to organize the program. As Google has their office culture, it served as a guideline in

research process. Google has informal office culture where office hours and sedentary jobs are flexible. Grocery, daycare, pet care, healthcare, laundry etc. services are available on campus to utilize the office hours. Relevant case studies were studied on similar projects like Facebook Headquarter design by Frank Gehry in LA and London to explore the potential program where autonomous vehicles technology introduced in building level.

Packaging system for traditional cars is studied as a base knowledge to propose vehicle design. The book *H-Point: The Fundamentals of Car Design & Packaging* equipped me with the basic understanding of car packaging system that helped in vehicle design phase.

Daya Zhang, Rethinking Streets: Urban Life with Autonomous Vehicles

The thesis focused on designing the streets of South Boston waterfront that envisioned a new typology of urban street addressing the potential of autonomous technology. The topic is certainly important in this era as autonomous vehicle(AV) is the future modes of transportation. It is high time to envision the future cities during the era of AV.

The research question began with the juxtaposition of different iconic urban characteristics of last two centuries. Different transportation modes have articulated the growth of the city from the beginning of civilization. Boulevard was the main feature of the urban places during 19th century as the highway is during 20th century. What is going to be the iconic feature of urban space during AV era in near future?

The author took the waterfront of South Boston as a case study to investigate the thesis question. The thesis also addressed the last mile problem to solve with the help of shared autonomous vehicles. Square footage occupied by conventional car parking, driveway, intersection as well as traffic infrastructure was the primary measure to demonstrate the negative effect of private automobile in South Boston. Due to car-oriented streetscape, people's space in a city has been marginalized. The author saw the possibility of autonomous technology as a utopian way to reclaim the urban space that is largely occupied by cars. Here, shared

autonomous vehicles are patronized to minimize the number of cars on streets.

Autonomous technology is highly precise in movement than a man-driven car. It required less space to move with lesser lane width. In addition, the AI of the AV would be respectful to pedestrian movement. All of these features of autonomous technology provides an opportunity to create an iconic urban character of the future city. The author named it as 'urban surface' where pedestrian activity and vehicular movement will take place in same surface. The urban surface will facilitate more greenery and wider space for pedestrian for public activities. The author has done numeric analysis to make arguments and propose some design ideas in future timeline. At the same time, he approached the site pragmatically. The author accepted the autonomous technology very linearly that did not answer some of his questions as if the research has any impact on autonomous vehicle design.

The thesis provides with new outlook to streetscape incorporating autonomous technology. However, the approach is highly site-focused and didn't address the architectural theory beyond this site. As the proposal is highly site-oriented, it could address other elements of built environment besides the streetscape. The author also presumed and welcome the co-current autonomous technology that worked as a parameter for the design proposal. In general, the thesis proposal still has a plethora of scopes to go deep, nonetheless, it is an inspiring work for researchers and professionals to shape the future addressing autonomous technology. Any redevelopment of an existing urban area can be addressed with future autonomous technology. The planner and policy makers can implement the autonomous technology for future redevelopment as well as future cities.

Paul Louis Short, It's not about the Car

The thesis has emphasized more on the infrastructure development. The author accepted the increasing rate of car usage as a fact and organized his arguments to emphasize on infrastructural development without hampering the urban quality. Boston is seen as a case study to explore the thesis questions. Like many other American city, Boston is divided by the depressed highway I-90 along

its entire length. The connecting bridges have been performing as a means of connectivity for divided parts of the city. The author proposed a new type of infrastructure named 'infrastructural deck', an evolution of parking garage. The proposal focused on utilizing the space over the depressed highway as parking space. The deck ensures the uninterrupted surface activity, at the same time connects the city via parking spaces and retail spaces. The proposal is a proponent of increasing car usage instead of envisioning a new means for transportation technology and new terminology for built environment. The technological development is facilitating innovation in built environment that the thesis failed to welcome to promote social welfare.

Franko Virani, Bitcar: Design concept for a Collapsible Stackable City Car

The thesis has focused on vehicle redesign to utilize spaces. Conventional cars take a lot of spaces in parking. The redesign of car that can be stackable can optimize space requirement. The design represents one and a very few schemes of vehicular design, however, the idea can be utilized in different context. It is not a versatile solution. The proposition introduces a different point of view to urban mobility where policy makers, planners and automobile industries have to work together. Drawing the historical examples and trajectory, the proposition envisions future cities that would be carved with the idea of new modes of transportation.

Other Case Studies

Facebook Head Quarter, CA, Architect: Frank Gehry

The Grand Central Terminal, NY

The Interchange, Minneapolis

Utrecht New Central Station, Netherland

Motion of Platform(Competition project)

Design Review Reflection

The Design studio ARC 701 and ARC 702 played a major role in final design proposition. Multiple design reviews in fall 2019 were essential to frame the overall thesis and get

ready for the final semester. During this time, I studied new case studies and consulted with the studio instructor and thesis committee. I choose the site at San Jose for Google Transit Village finally and worked of the probable architectural program that can respond to my thesis questions.

In final semester, besides working on final design drawing and presentation, I firmed my theoretical standpoint through several design reviews and desk critics. The reviews helped to stitch the theory and design phase rationally and move to the final presentation.

Working on different 2D and 3D media also helped for the final show. Production of different presentation drawings and diagrams were very useful exercise in design decision as well as brainstorming. The diagrams also helped in final presentation. As the final presentation took place virtually, the drawings were very useful.

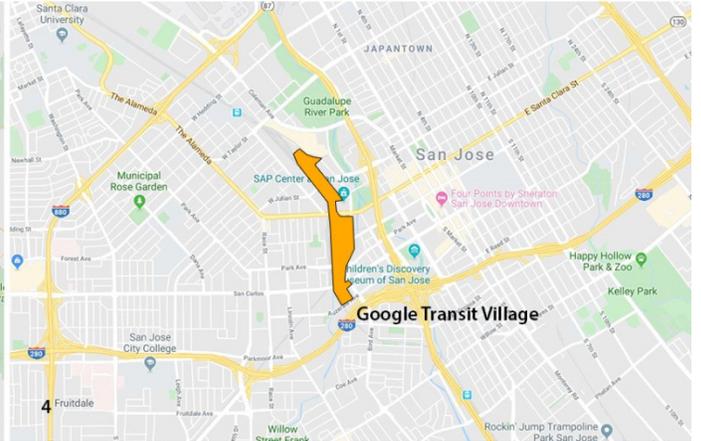
Conclusion

I would like to recap that I am using autonomous technology as an opportunity to enhance built environment for pedestrians as well as neighborhood. I also addressed last mile problem by design proposition that encourages pedestrian-friendly development. A 10 minute walk in a dense downtown maybe burdensome, but this short trip can be explored in different way without compromising people's activities. As we have speed limit in different zones, maybe that can be addressed in a different way. The hierarchical layout of AVs can serve in macro scale, not necessarily in average size blocked city. Maybe a new terminology for cities with new block size, hierarchical layout, reduced traffic infrastructure and so on. Hence, I addressed AV technology not to be consumed by its need but to create a neighborhood-friendly environment. I tried to prove that this kind of mutual approach can help us to envision better future development, future cities.

The entire thesis process was a significant part in my academic career. It was not just fulfilling credit hours or getting a certificate, it was a story. The whole journey developed my thinking process especially how to address a design issue with theoretically and in design.

The major development during the graduate program was framing the thesis question with validity and connecting it to the site issue and design proposition. Traditionally, in design studios, students have to highly focus on the requirement and drawings. It does not necessarily equip them with the philosophy and architectural theory he or she would like to pursue. From that point of view, the journey in the Master of Architecture program is very unique. The holistic experience is an asset to my future career.

Site Information



SAN JOSE TRANSIT VILLAGE, CA
Area: 85 Acres

San Jose Division is the central passenger rail depot for San Jose, California. It also serves as a transit hub for Santa Clara County and Silicon Valley. It is an historic transportation service site.

The station is on the Lower Pacific Coast Line (formerly Southern Pacific) at 65 Capitol Street in San Jose. The depot is listed on the National Register of Historic Places for its historic Renaissance Revival style architectural and historical significance.

The station is served by Caltrain, ACE, VTA Light rail, and Amtrak. This is in addition to bus services by California Shuttle Bus, Amtrak Thruway Bus, Monterey-Salinas Transit, Santa Cruz Metro (Highway 17 Express), local VTA and employer shuttles and buses.

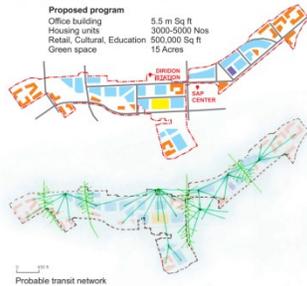
Bay Area Rapid Transit (BART) intends service to a new underground station is proposed to begin in 2020 with the completion of the Silicon Valley BART extension.

- Caltrain, ACE, VTA Light rail, Amtrak
- California Shuttle Bus, Amtrak Thruway Bus, Monterey-Salinas Transit, Santa Cruz Metro (Highway 17 Express), local VTA and employer shuttles and buses.

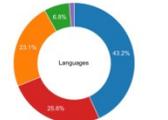
*Do you know the way to San Jose?
I've been away so long, I may go wrong and lose my way
Do you know the way to San Jose?
I'm going back to find some peace of mind in San Jose
L.A. is a great big freeway
Put a hundred down and buy a car
In a week, maybe two, they'll make you a star*

Lyrics: Burt Bacharach
Singer: Dionne Warwick

- Office Building
 - Housing
 - Hotel
 - Mixed-use
 - Retail, Cultural, Education, misc.
- Proposed program**
Office building 5.5 m Sq ft
Housing units 3000-5000 Nos
Retail, Cultural, Education 500,000 Sq ft
Green space 15 Acres

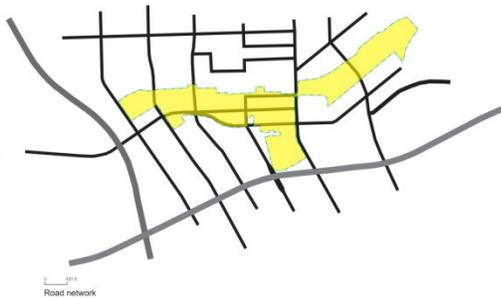


San Jose, California Population 2019 (Demographics, Maps, Graphs)

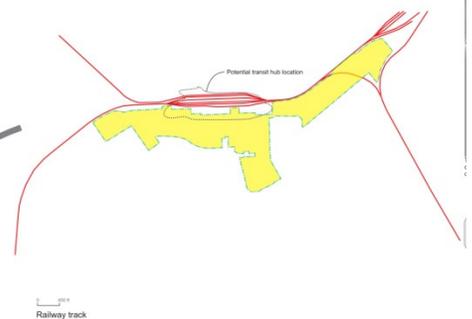


Year	Population	Growth	Annual Growth Rate
2018	1,030,119	-2,917	-0.28%
2017	1,032,136	1,777	0.17%
2016	1,030,359	4,260	0.42%
2015	1,026,099	11,661	1.15%

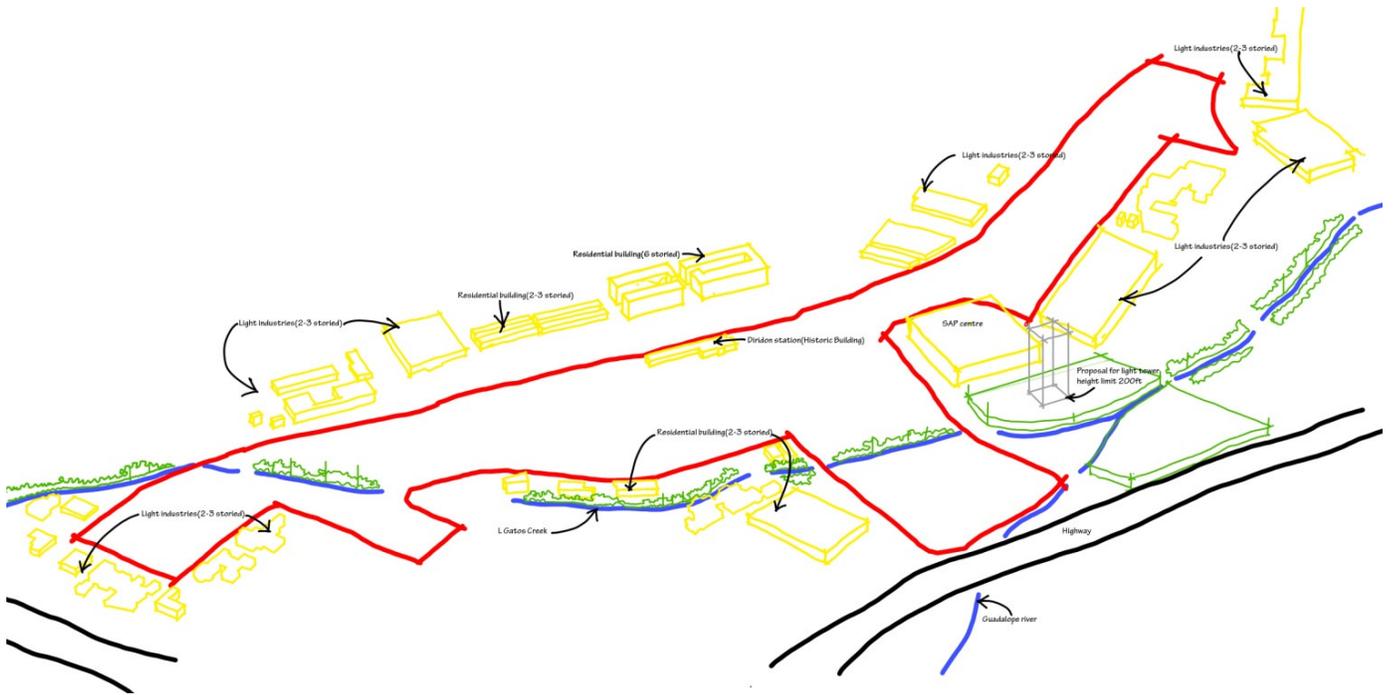
■ Only English ■ Spanish ■ Other Indo-European ■ Asian ■ Other



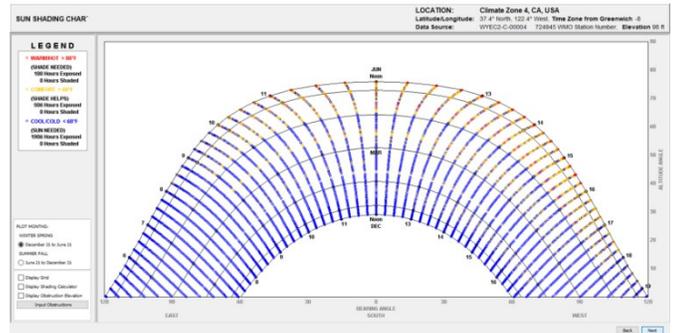
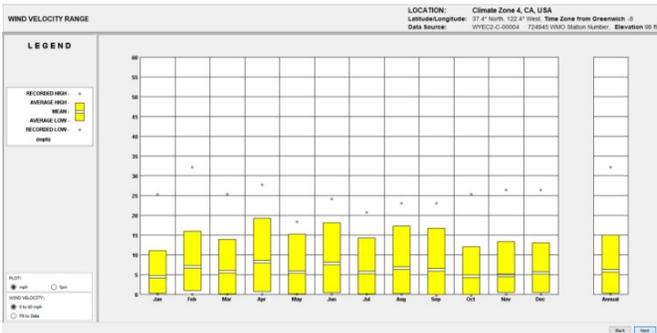
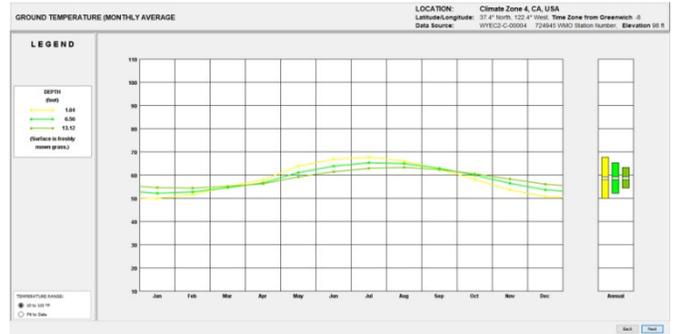
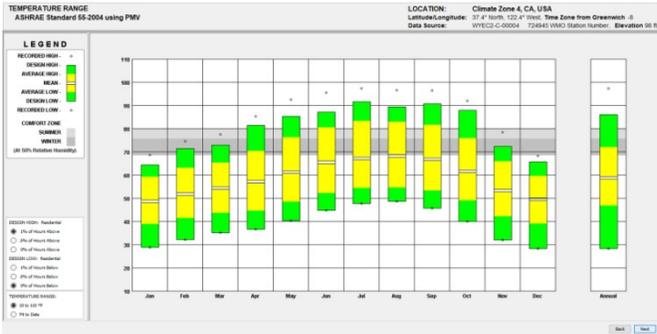
- Google chose this part of San Jose in large part because of Diridon Station, which in the coming years is set to become one of the largest transit hubs on the west coast -- with BART, Caltrain, bus service and perhaps even high-speed rail all arriving the terminal.
- Google's station, which will emerge from the station rail and the current steel structure of the parking lots but into a building above street level with new office buildings anchored by cafes and shops on the ground floor to draw people in.
- Several design concepts for the company's modern, architectural design of a transit center in central London.
- want to create some atmosphere to public traffic and extend others, a process that will involve working with the city's transportation department on everything from the dimensions of walkways and teleways to where shuttles can stop off employees.
- Google is saving development on roughly 60 acres.
- To the north, the company wants to create an outdoor sculpture park, with space for artists to be creative. To the south, Google's design focuses more on local retail and connecting with nature.



Site analysis

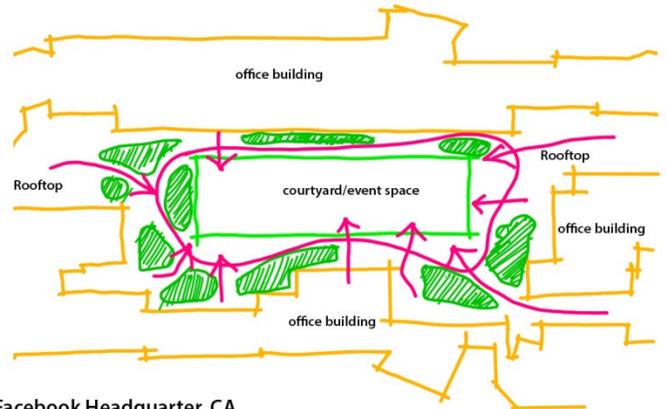


Site analysis



Climate data

Case Studies



Facebook Headquarter, CA

Architect: Frank Gehry

Designed to achieve LEED Platinum certification, MPK 21 features a 3.6-acre rooftop garden with 200 trees, 1.4 megawatts of solar panels, a water recycling system that will save around 17 million gallons of water each year, and a zigzag shaped roof to allow in more natural light, according to Facebook.

The new building is connected to MPK 20 via an "amphitheater-style courtyard" offering sheltered outdoor meeting and work spaces, and is equipped with five different eateries, open-plan office seating, and a 2,000-person event space.

ROOF GARDEN

EVENT SPACE

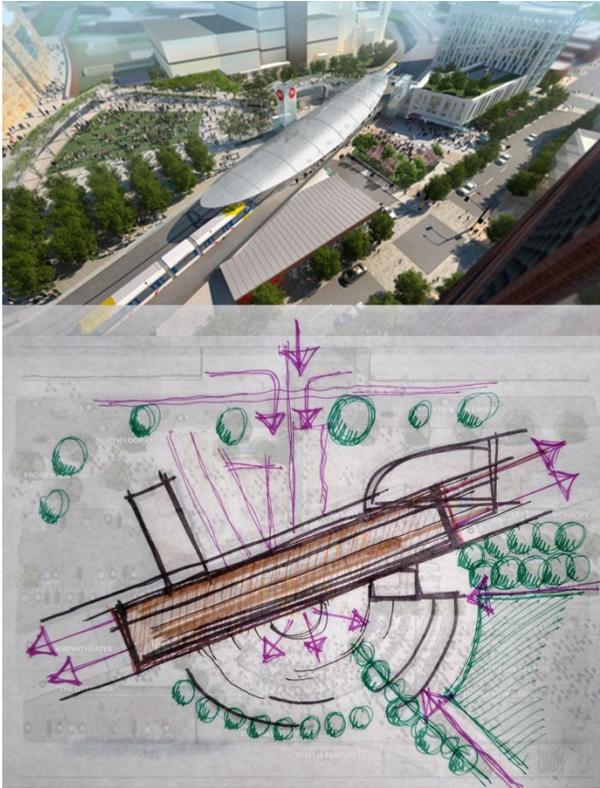
AMPHI-THEATER
STYLE COURTYARD

SHELTERED OUTDOOR
MEETING SPACES

OFFICE CULTURE

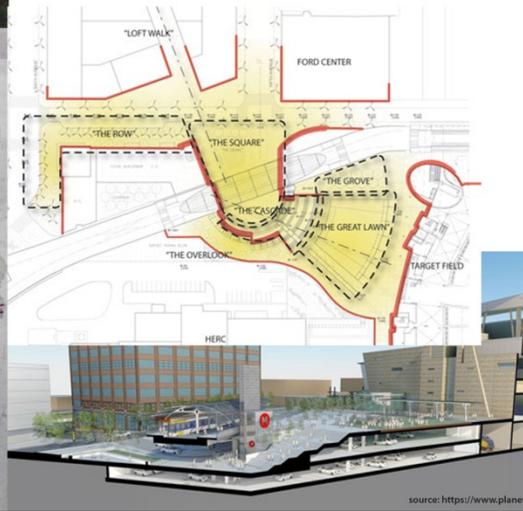
CONTROLLED ACCESS

https://www.architectmagazine.com/design/facebook-reveals-frank-gehry-designed-hq-expansion_o



The Interchange, Minneapolis

What we're calling "Open Transit Design" is a new way to explain the concepts underlying some fairly long-established principles in station design that are re-emerging in an era of unprecedented interest in city living. Just as the name suggests Open Transit is an inclusive design point of view that incorporates a wider array of spaces and modes to create an iconic place.



- WIDER ARRAY OF SPACES
- MODES TO CREATE ICONIC SPACES
- OCCUPANCY HOUR
- INTEGRATION OF DIFFERENT TRANSIT MODELS
- INTEGRATION OF CULTURE



Shopping mall
Pedestrian
Slow modes of transportation

Ground level

Driveway
Pickup spot

Underground

Utility

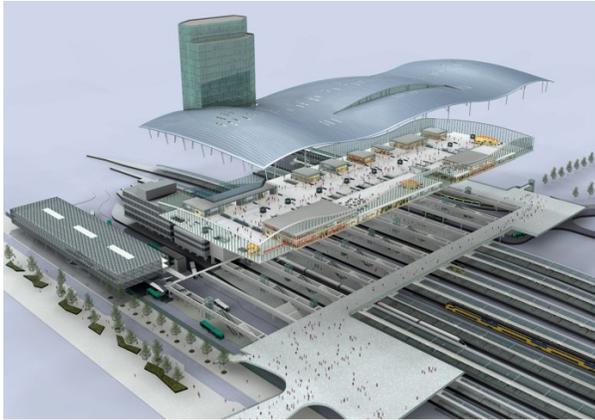
Streets Ahead Exhibition London, UK

Dedicated cycle and pedestrian lane
Reclaimed green space
Space-saving parking



BUILDING ADAPTATION

USER RESPONSES



Utrecht New Central Station, Netherland

Utrecht is the fourth largest city of the Netherlands, with a population of more than a quarter of a million. Utrecht's central location in the Netherlands makes it an attractive city to live in and a favourite enterprise location. The European high speed train network also integrates Utrecht to Frankfurt, one of the most important cities of finance and banking in Europe, and it is expected to be connected to Barcelona and Turin via Lille.

Considering this scenario the Utrecht Station, located in the center of the city and surrounded by various types of land uses, has an important role to develop within Europe as a hub of interconnections. As mentioned above, the railway track, at the moment, acts as a barrier and divides the city into two separate sections with specific land uses:

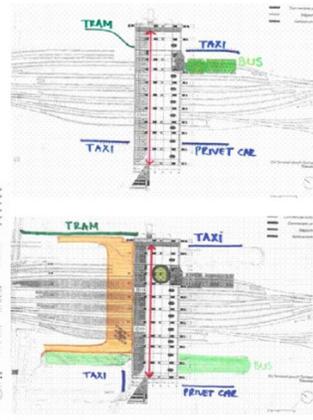
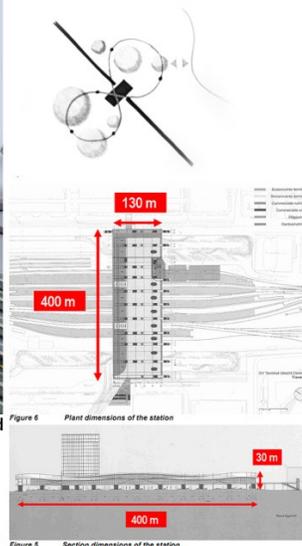
- a) On the east side of the railway - residential developments, cultural and religious facilities, and commercial uses;
- b) On the west side of the railway - predominantly office buildings

New Public Transport Terminal
Public space and accommodations
Re/development of properties

City versus station
Bus passengers
Station as a shopping centre
Passages through the station

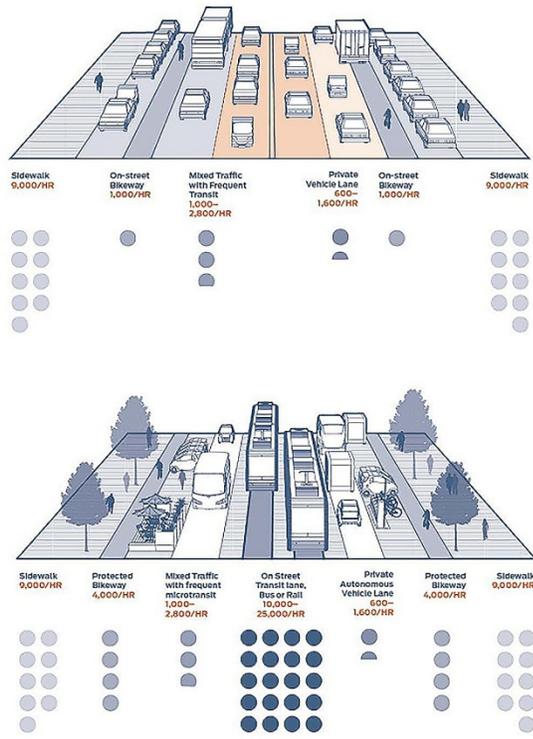
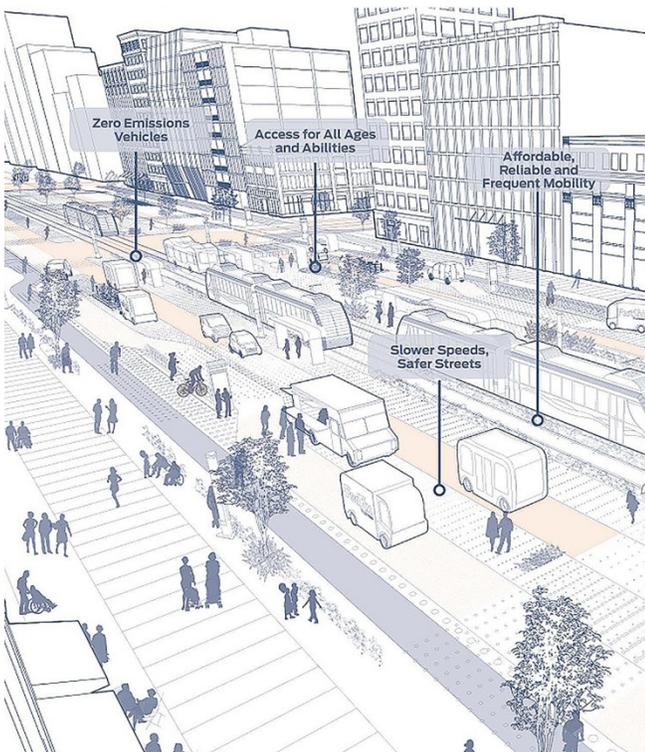
Higher accessibility
Transfer connections
Retail
broader group of users

Barrier instead of a connector
Unpleasant environment
Dead ends
Disadvantage at night

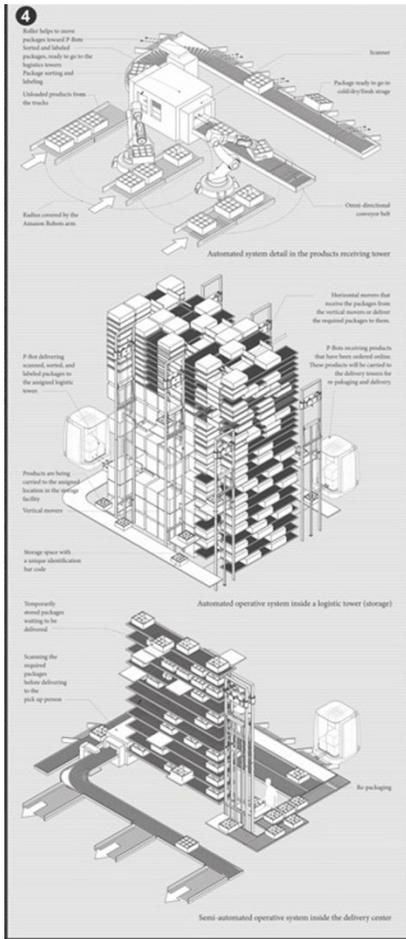


- CITY VS STATION
- STATION AS A SHOPPING CENTRE
- BROADER GROUP OF USERS
- LACKING SUFFICIENT OCCUPANCY/USAGES
- OFF-PEEK TIME DISADVANTAGES
- BUILDING ORIENTATION
- MULTIMODAL HUB

https://www.archdaily.com/801731/utrecht-central-station-bentheim-crouwel-architects?ad_medium=gallery



- AUTONOMOUS
- VEHICLE SPEED
- PEDESTRIAN
- ROAD SHARING



PLATFORM OF MOTION

The Platform of Motion is a speculative design for Amazon distribution center at Brooklyn (3rd st 3rd ave), NY, USA. This is an architectural experimentation of looking at the future of amazon's logistics center as an urban interface right at the moment when Amazon has the initiative to buy the Whole Foods Market and is planning to step in the online grocery services. To keep pace with the demands of "quick online deliveries", physical spaces of existing logistics centers are being re-designed. These are ensuring more speed by reducing probable slowness in the entire system. Logistics centers are being fully automated, less human, more robots, more efficiency. Hence, when this super-fast automated version of logistic center merges with the "super slow" grocery stores, and the commercial objective is to reduce the allocated time per individual order placed online, we are definitely going to lose "slow human moments" in the overall system.

<https://lakareacts.com/winners/platform-of-motion/>

HUMAN OCCUPANCY VS MACHINE OCCUPANCY

ROBOTICS

BUILDING AS A MACHINE

BEYOND CONVENTIONALITY

AUTONOMOUS

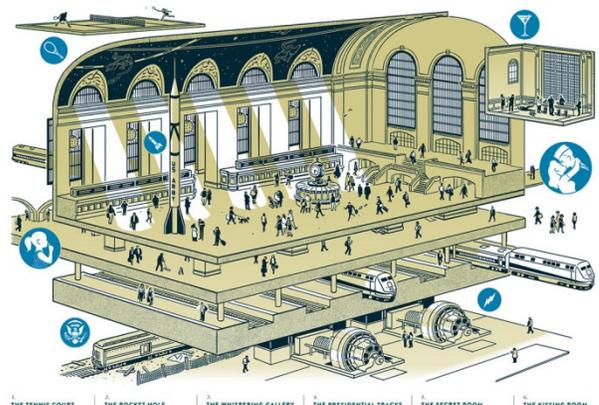
MODULARITY

BUILDING ADAPTATION

MOIBILITY

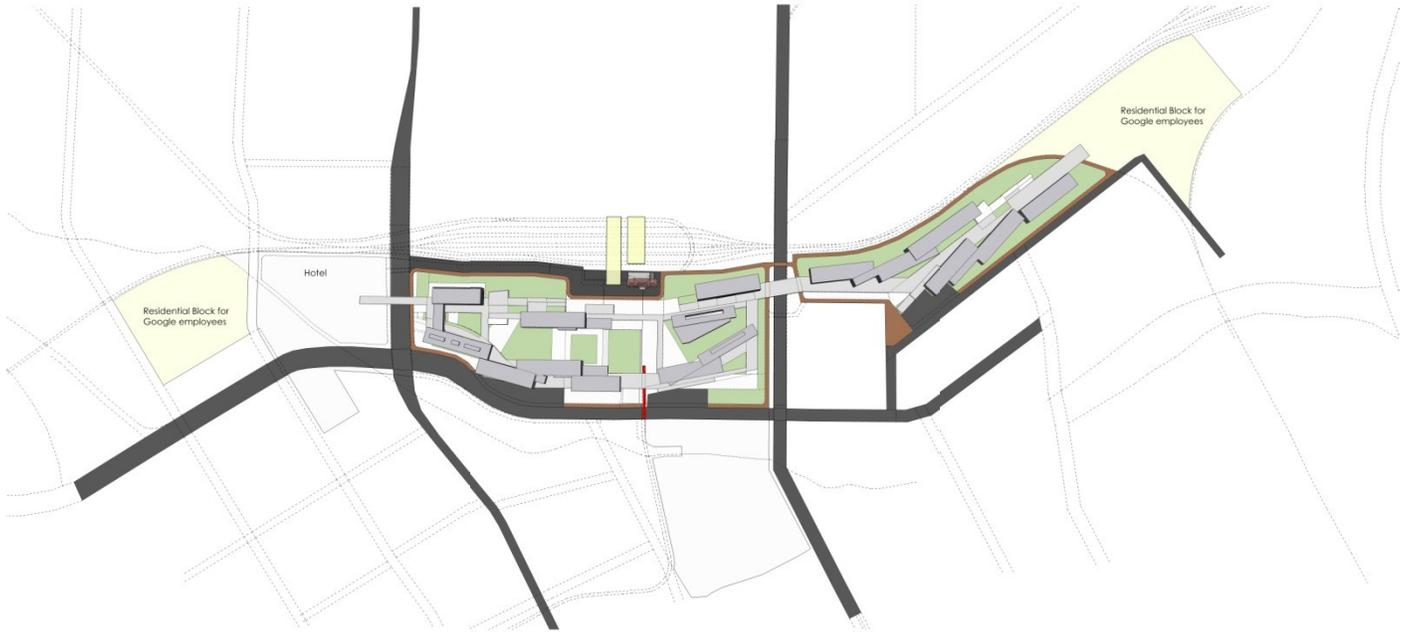


Grand Central Terminal in midtown Manhattan, which opened almost 100 years ago, enjoys far more visitors drawn to its shopping, dining, and cultural events, than actual transit users. There are more than 750,000 people that pass below its vaulted astronomical ceiling every day. When the building was first designed, however, New York did not realize it was laying the foundation for the development of today's most modern transit stations and public places.

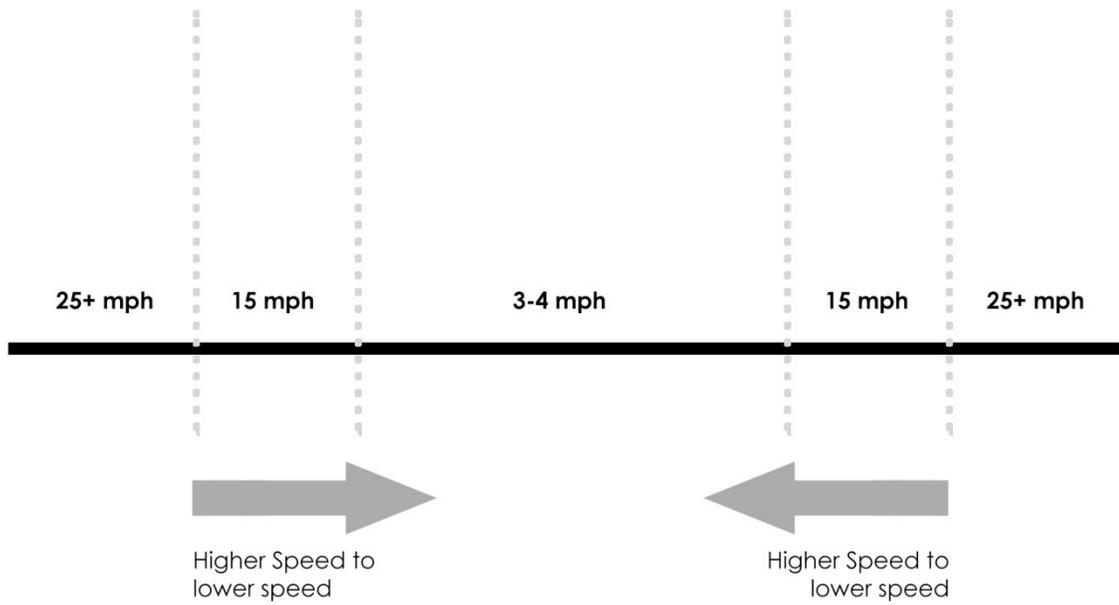


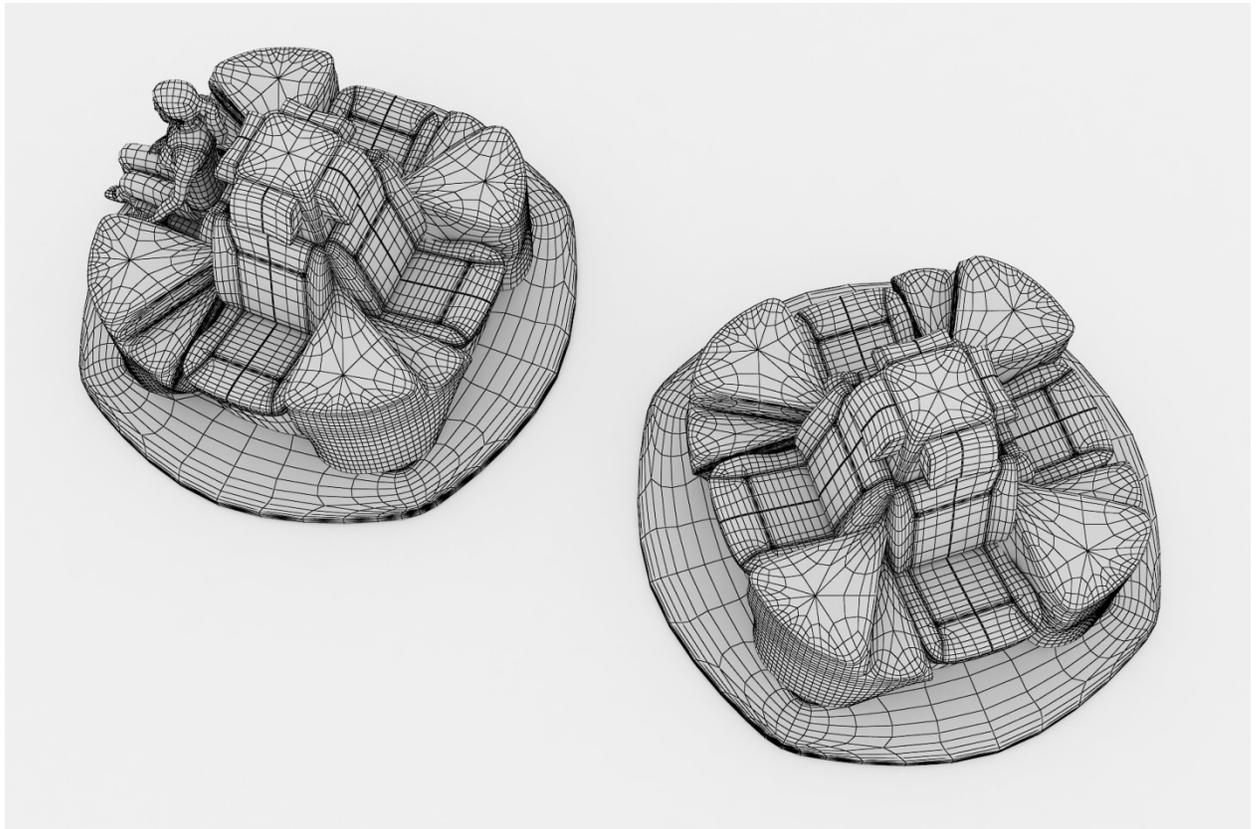
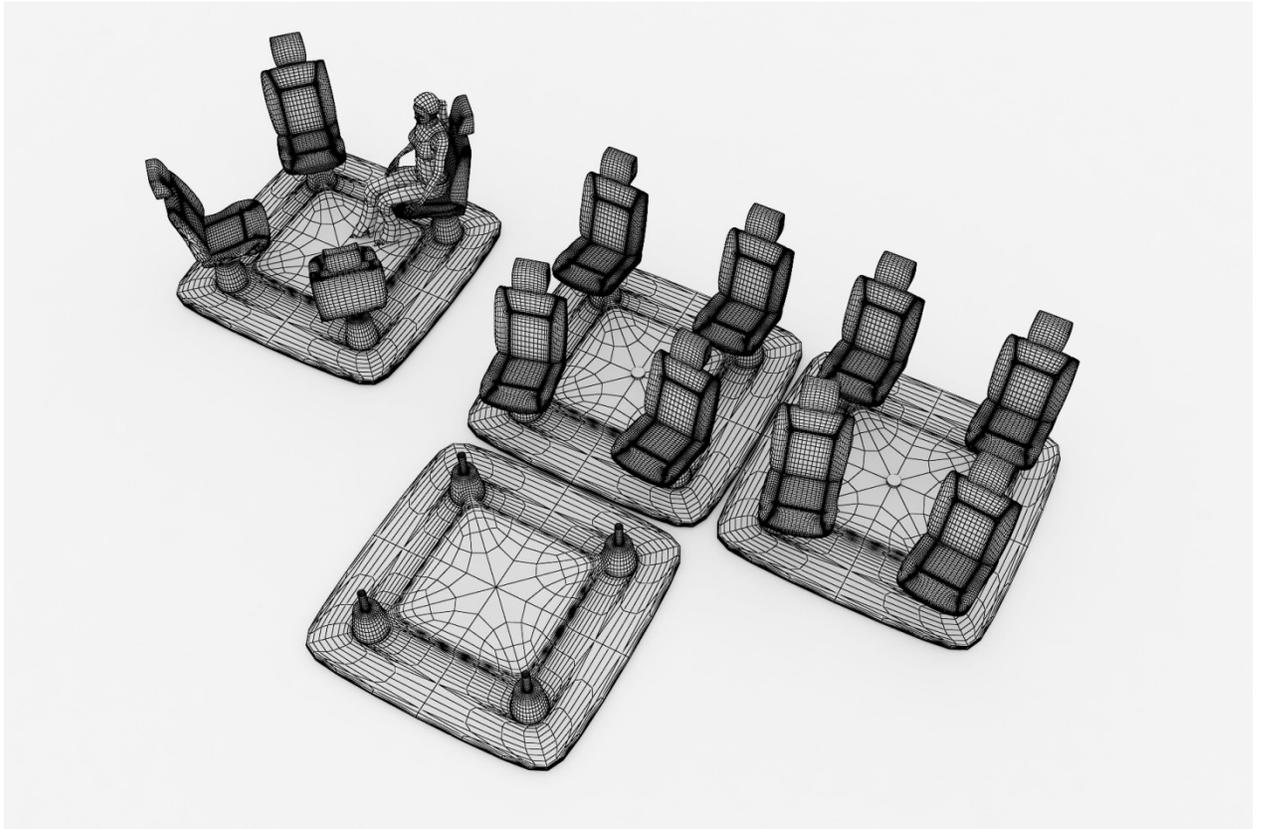
source: <https://www.nytimes.com/2013/01/20/myregion/the-birth-of-grand-central-terminal-100-years-later.html>
https://www.archdaily.com/286857/which-grand-central-vision-is-the-best-for-new-york?ad_medium-gallery

Review 1



Master plan development

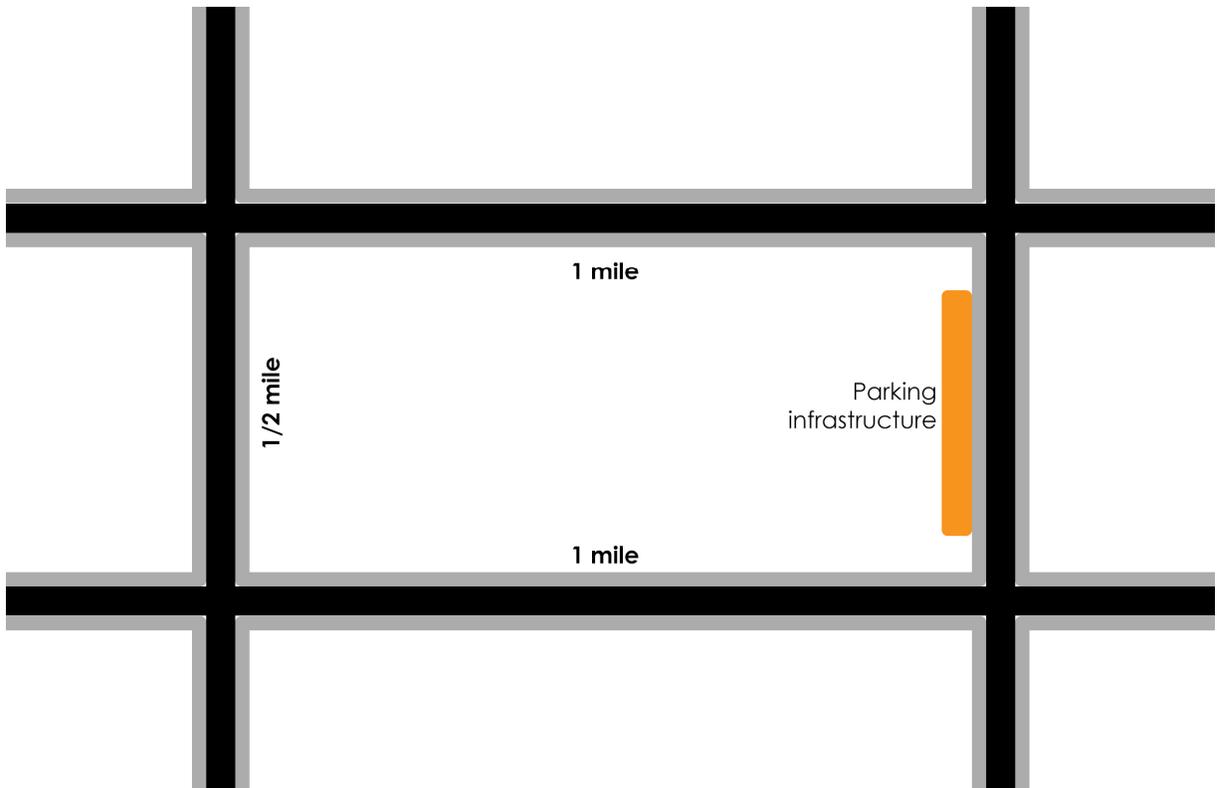




Autonomous vehicle development

Types of AV

Operation space	Protection	Speed
Outdoor	Covered	15 mph
Outdoor	Semi-covered	15 mph
Outdoor(Tileable)	Open	4 mph
Indoor	Open	4 mph
Indoor-Outdoor	Covered	4 mph
Indoor-Outdoor	Open	4 mph



Autonomous vehicle development

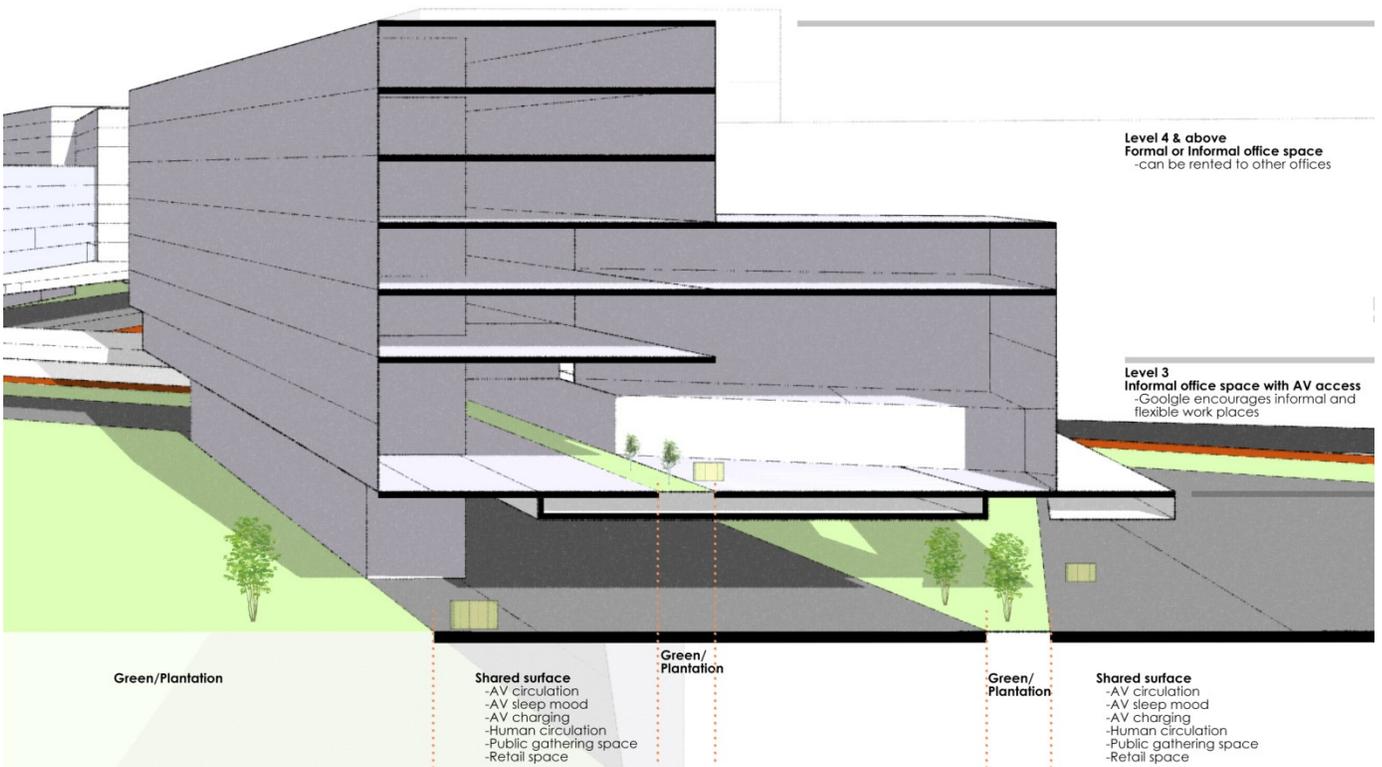
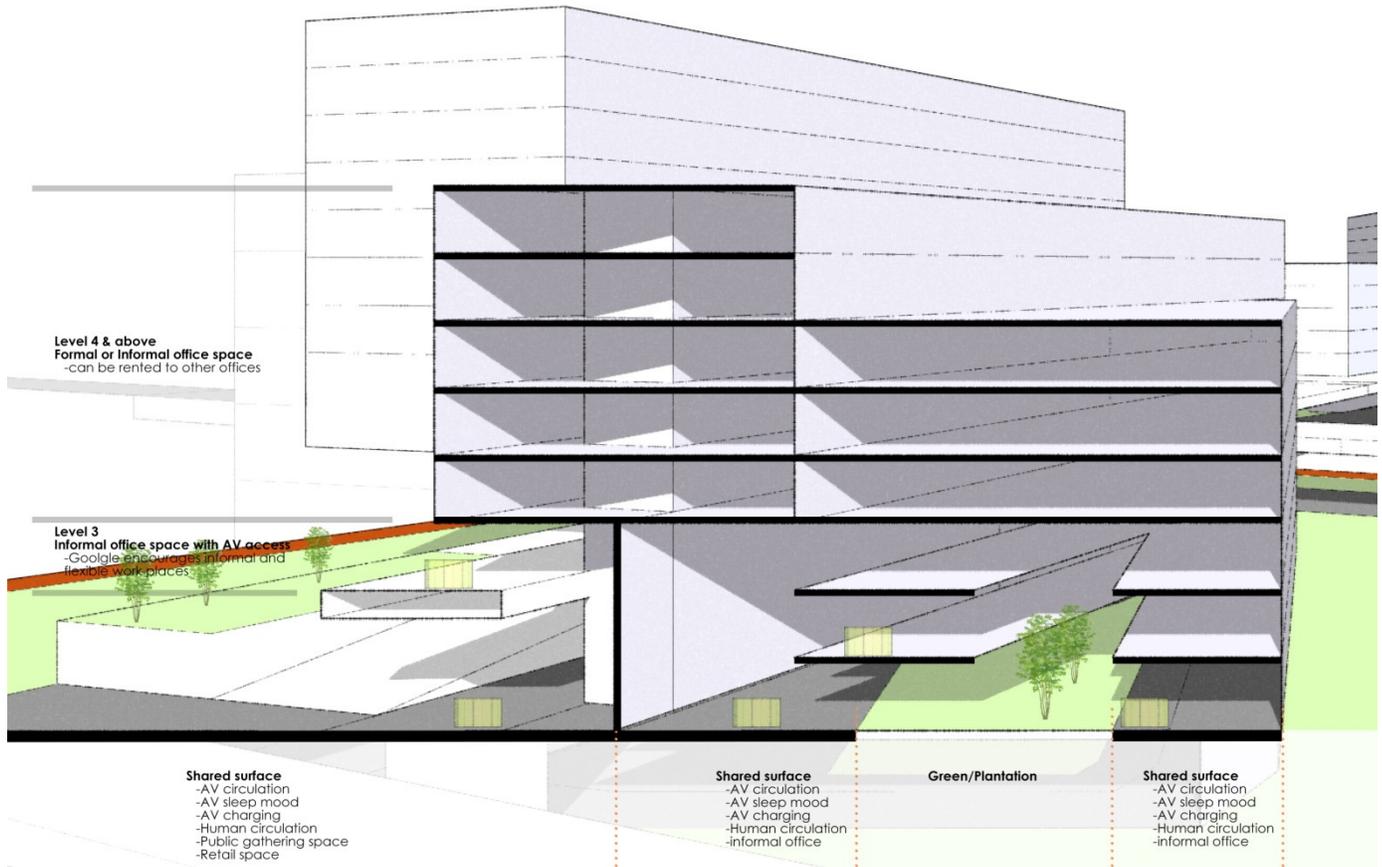


Fig. Study sections

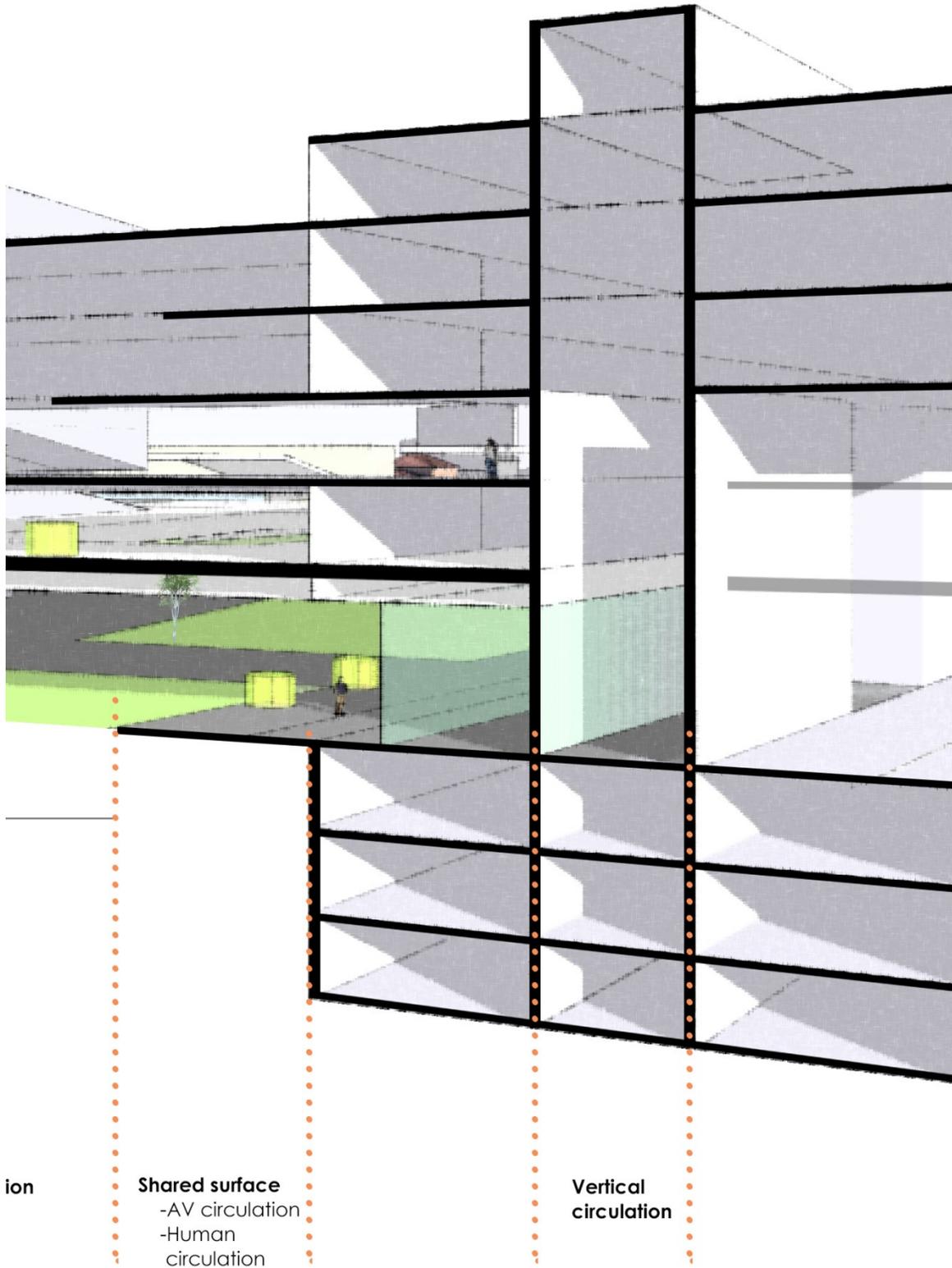


Fig. Study sections

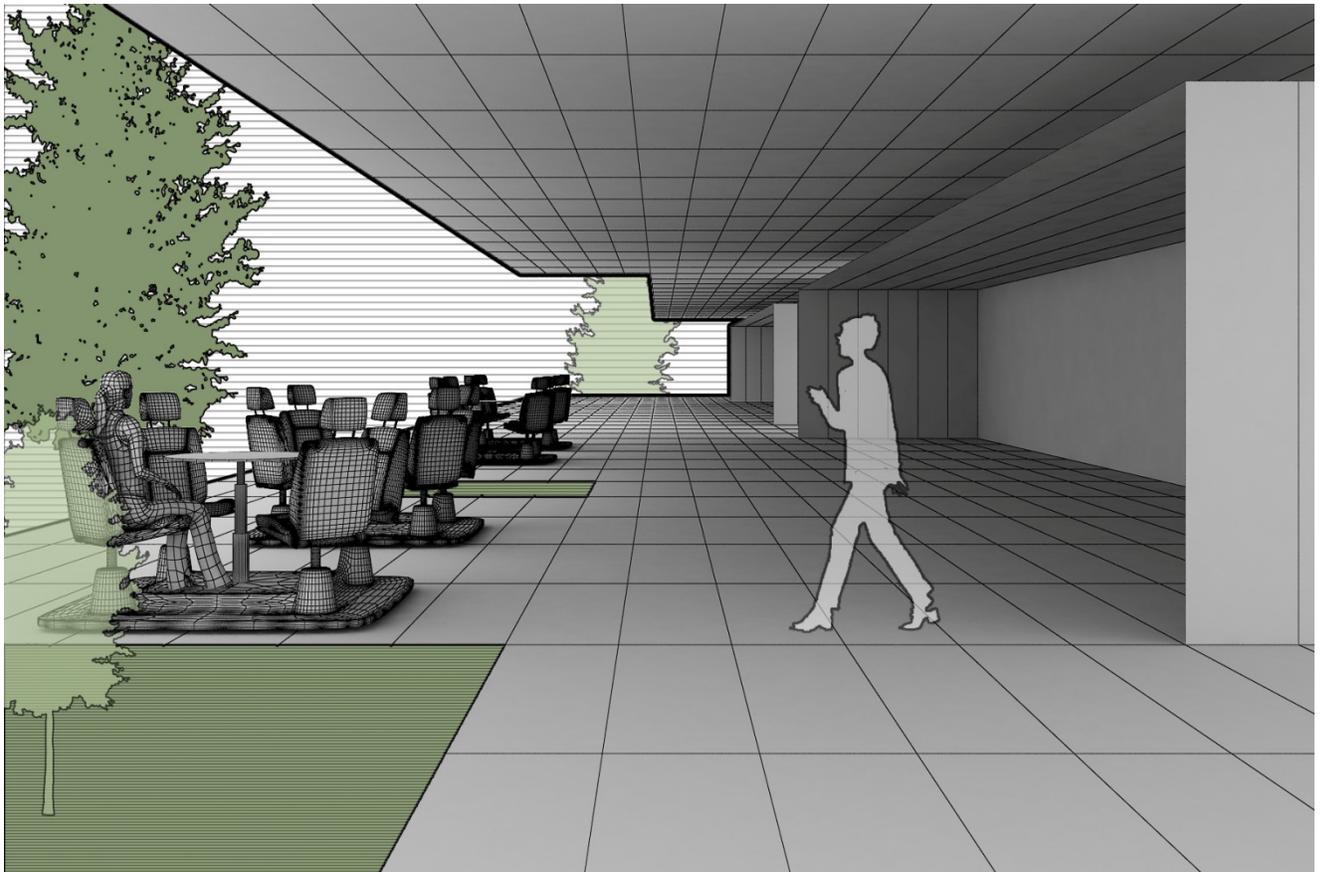


Fig. Preliminary perspective

Review 2



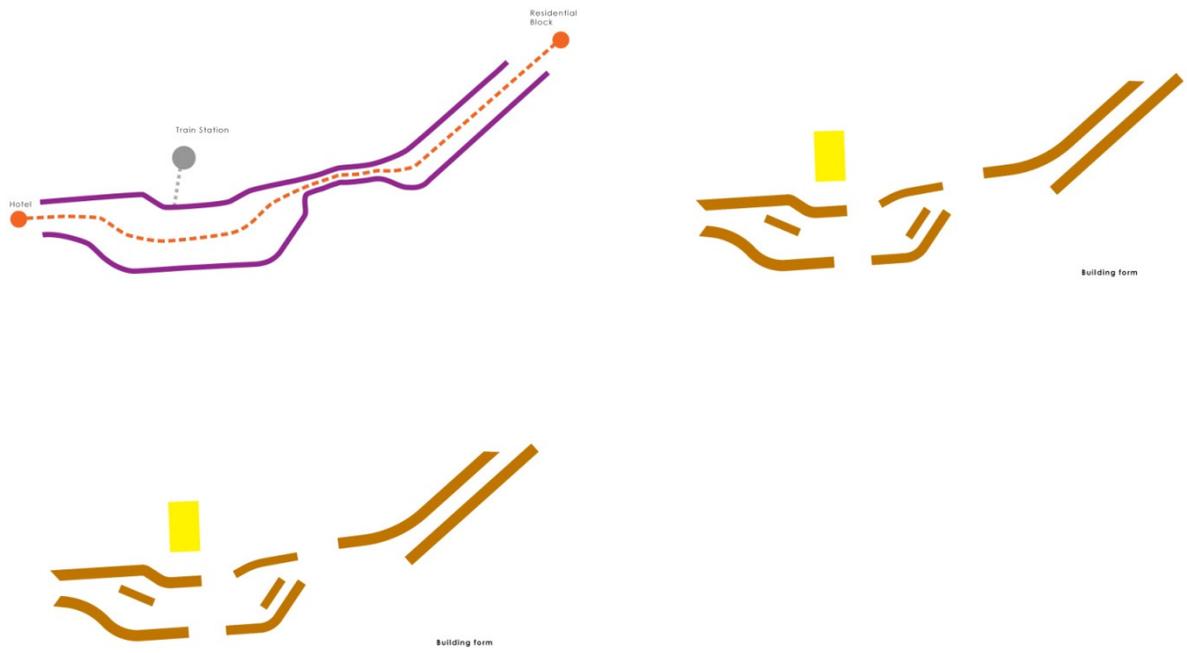


Fig. Master plan development



Fig. 1st floor plan

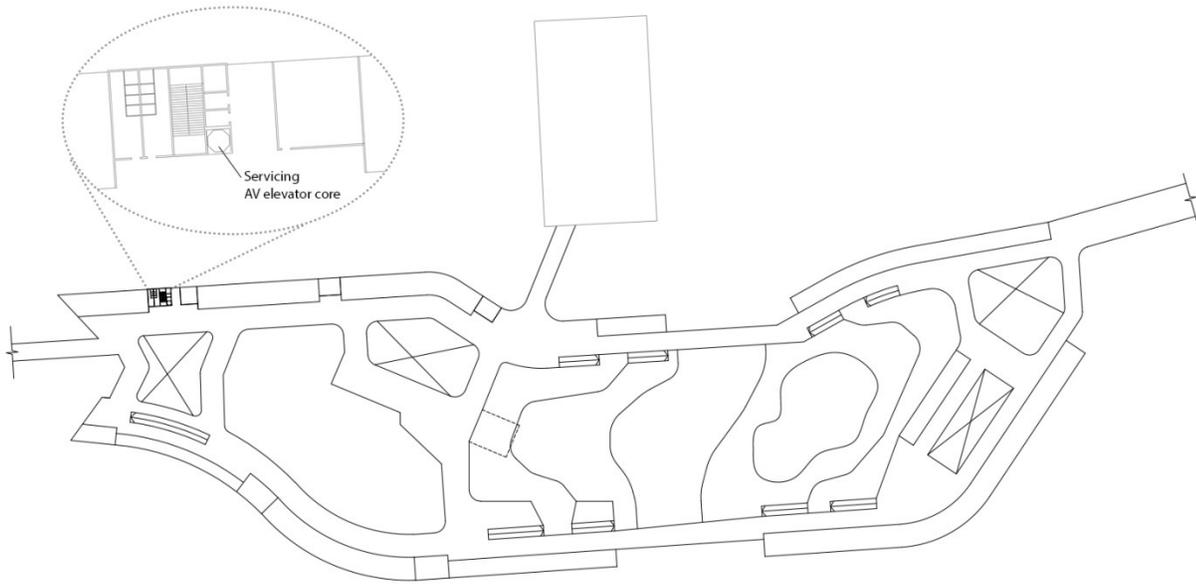
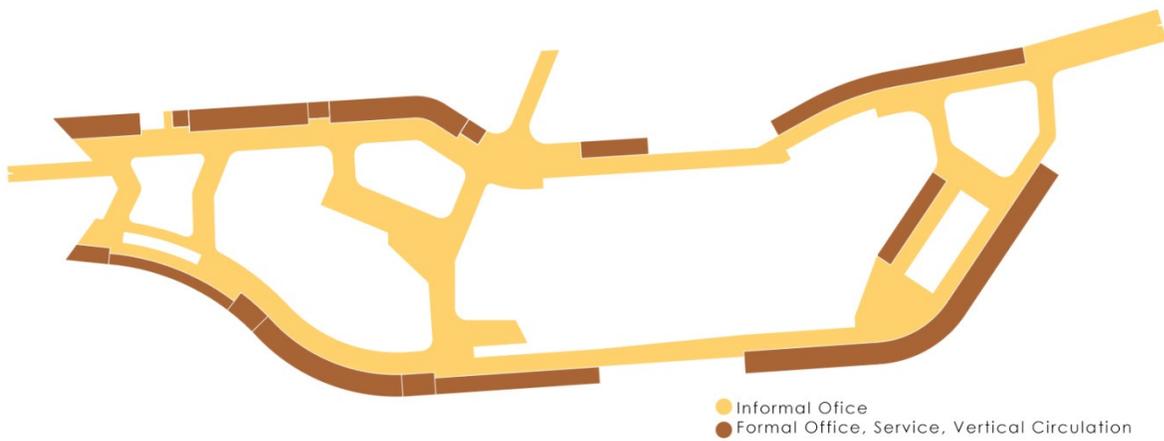


Fig. 2nd floor plan



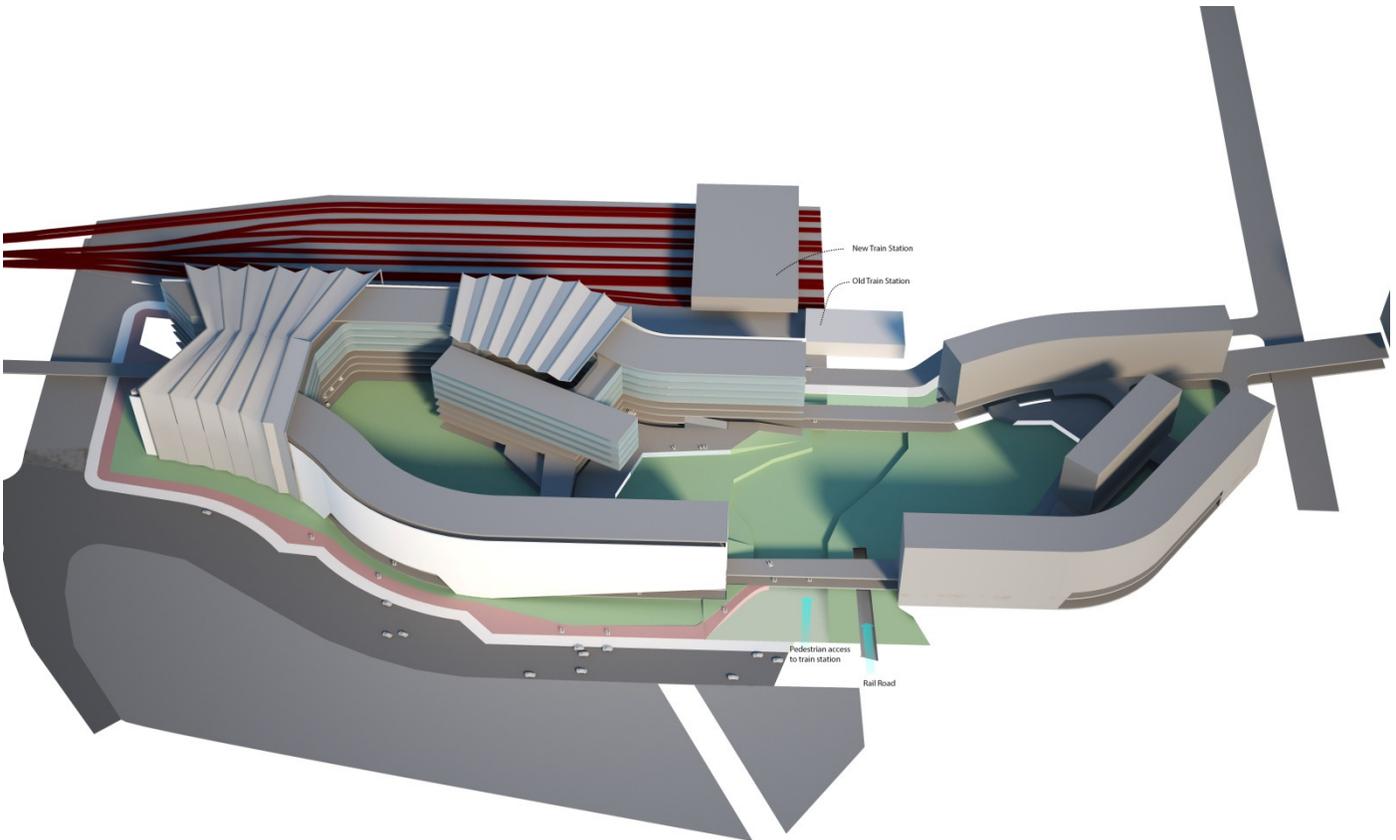
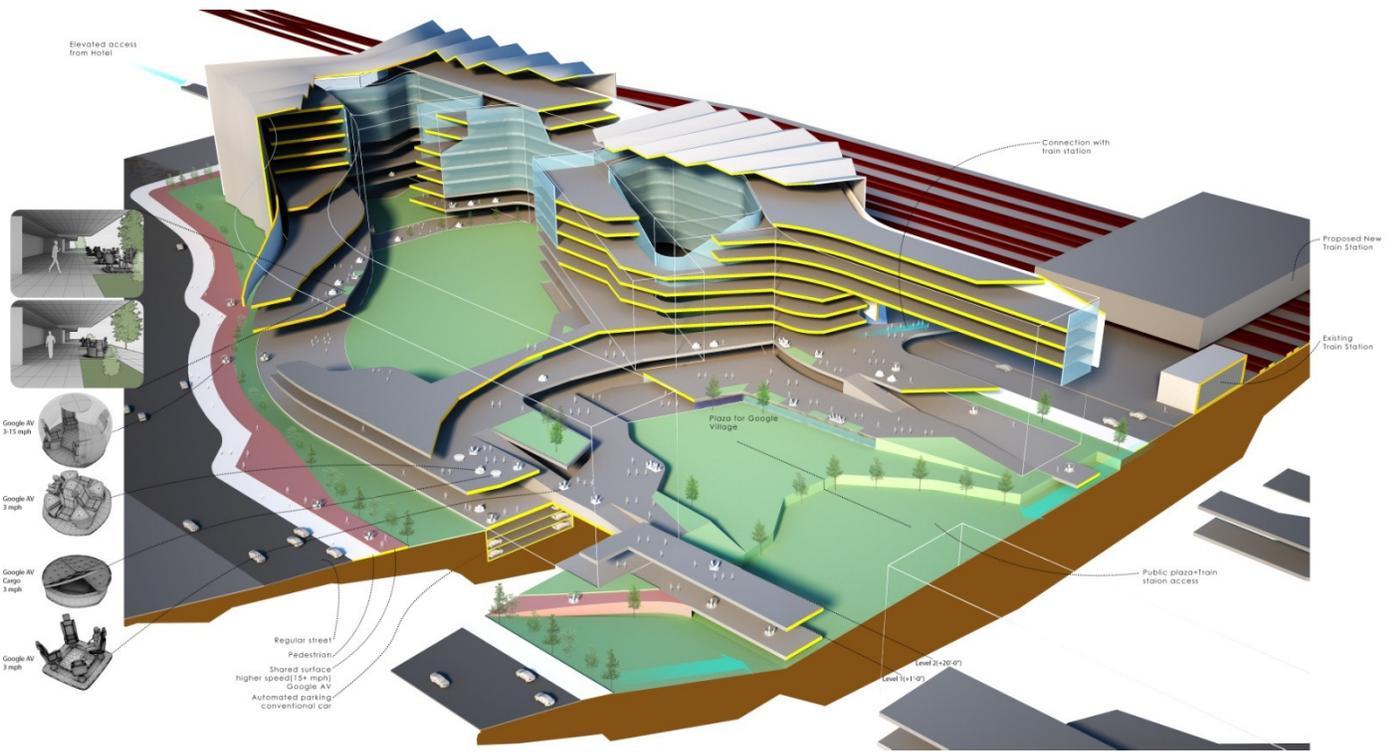


Fig. Three-dimensional study

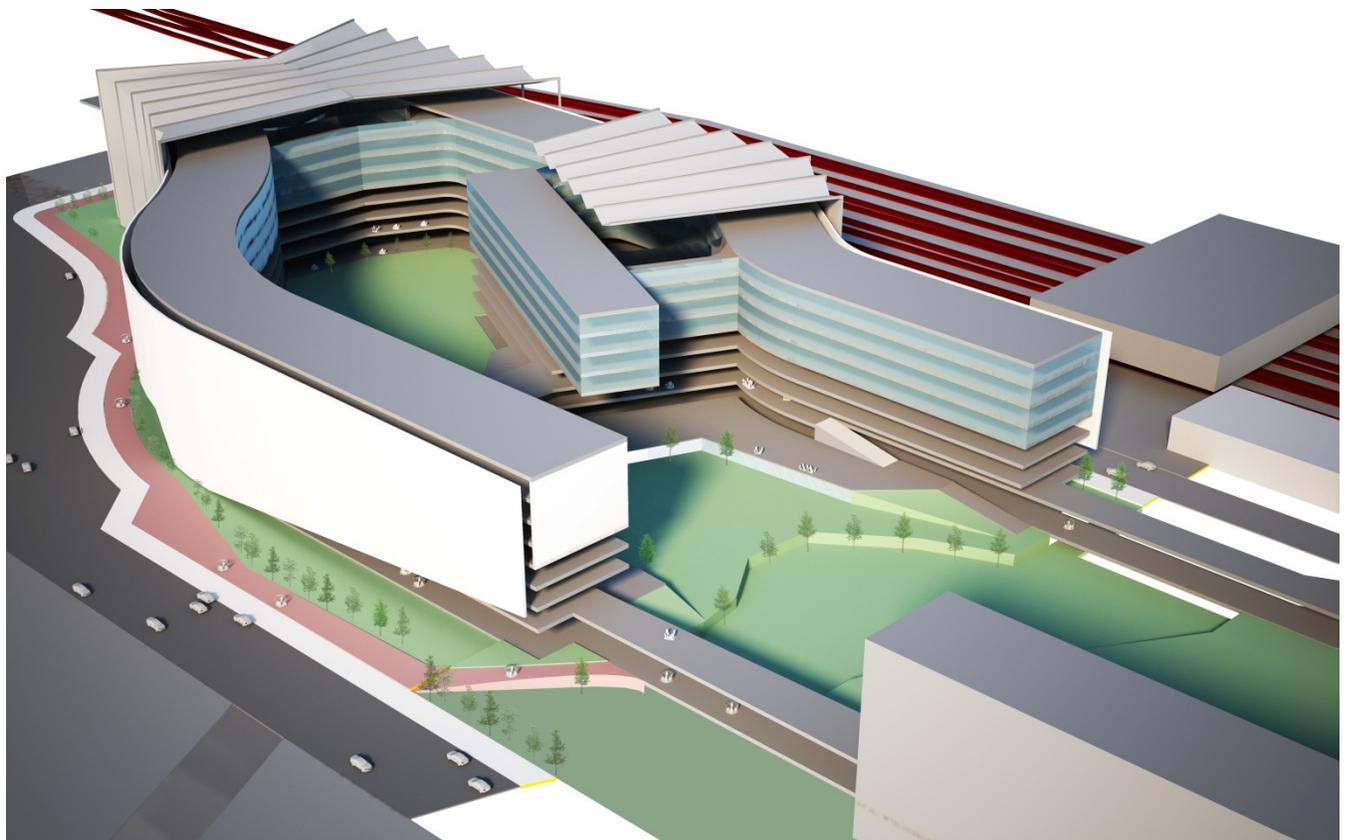
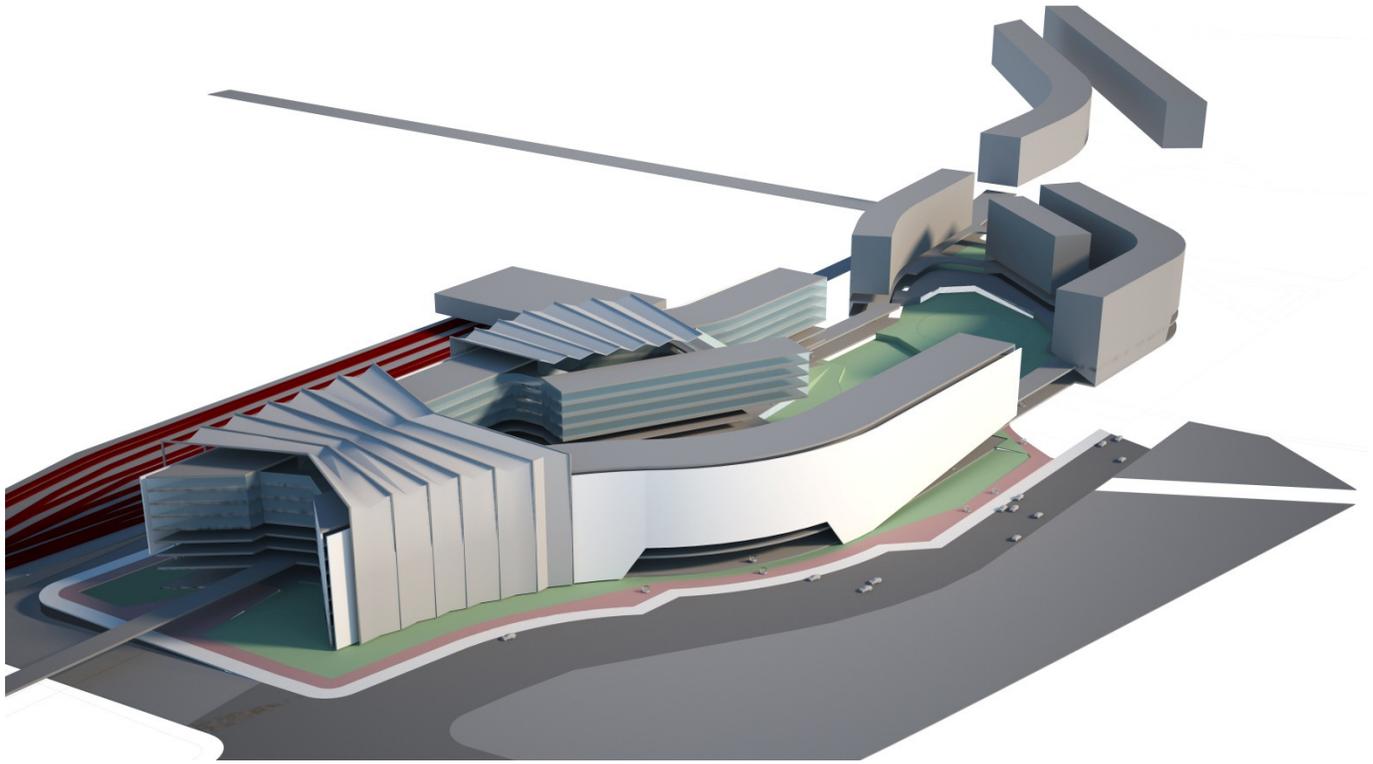
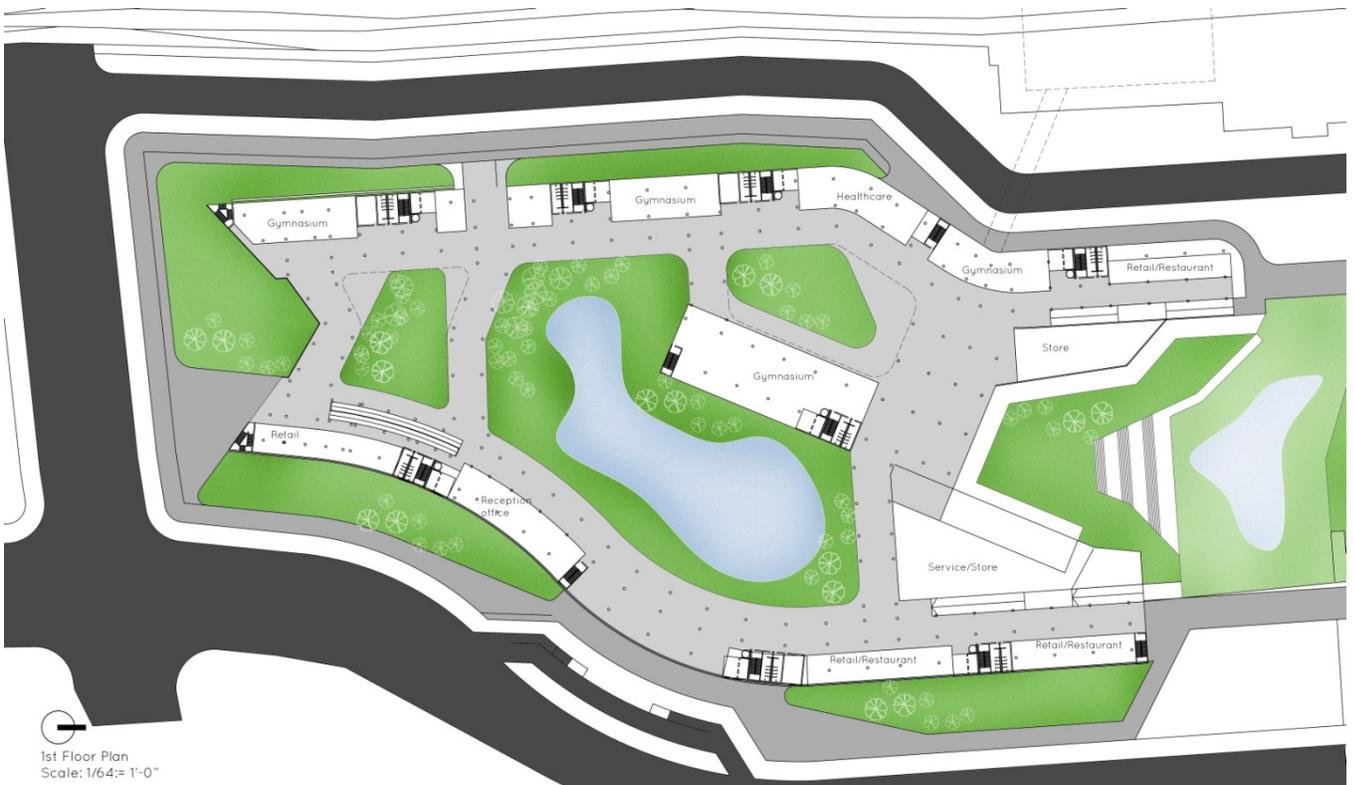
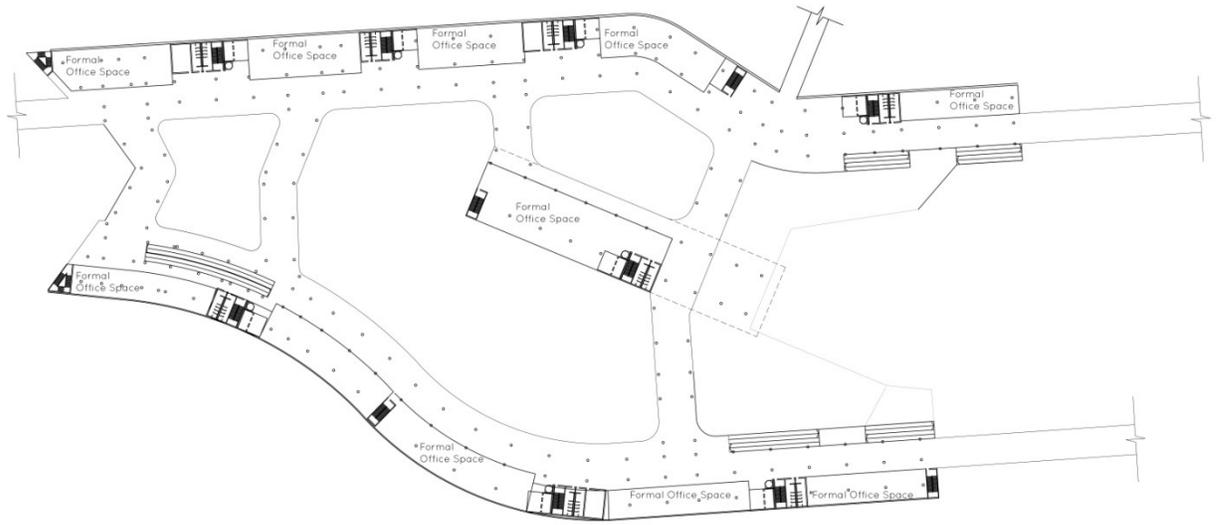


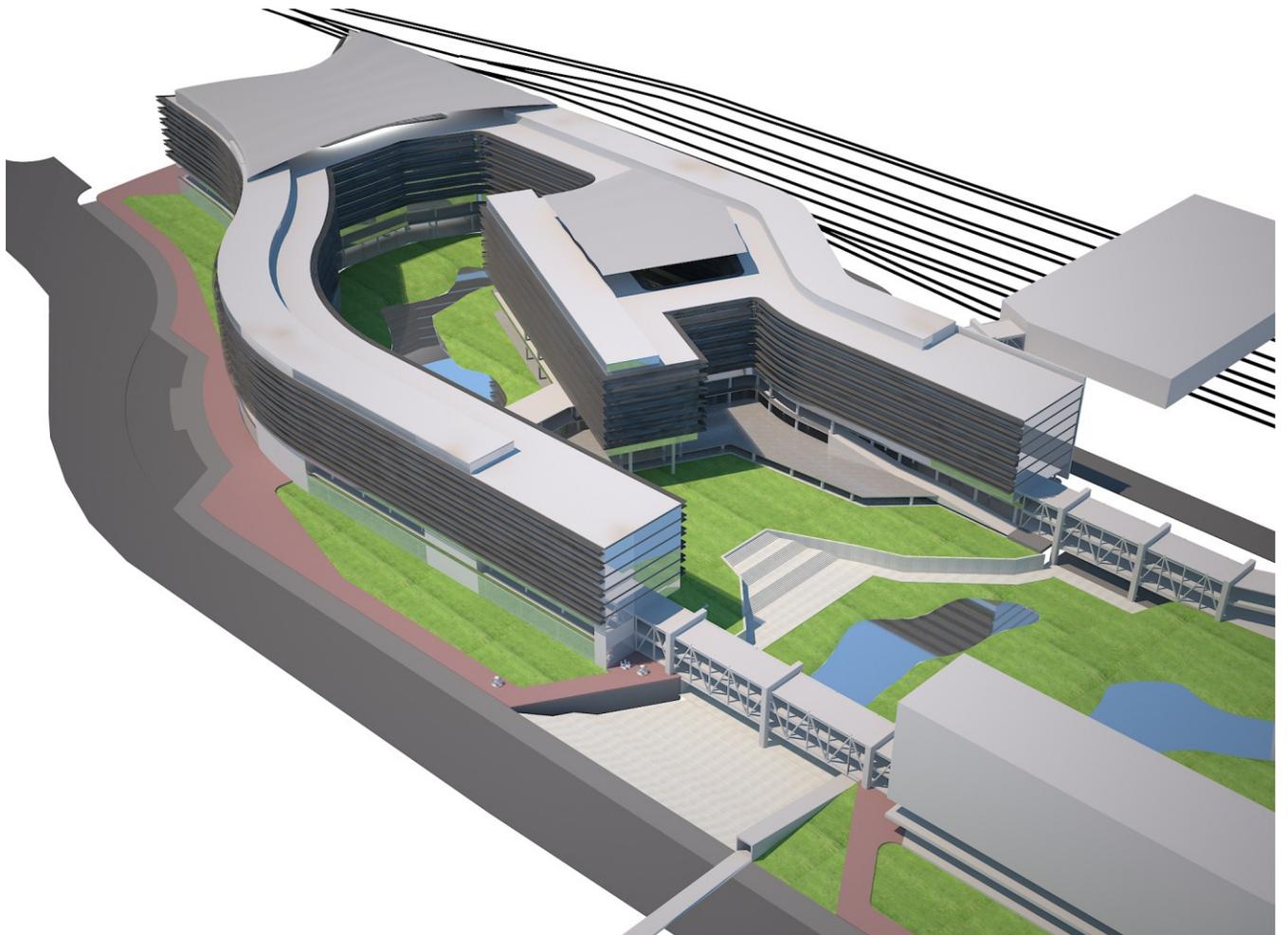
Fig. Three-dimensional study

Review 3





2nd Floor Plan
Scale: 1/64" = 1'-0"



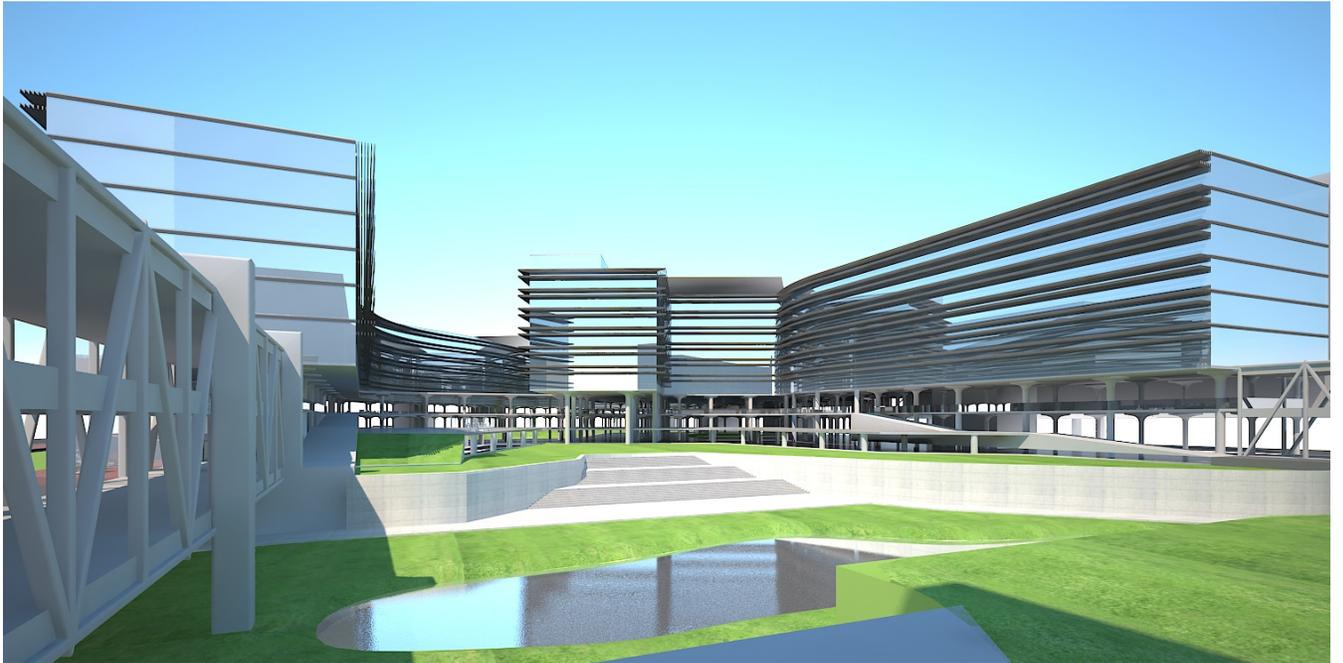
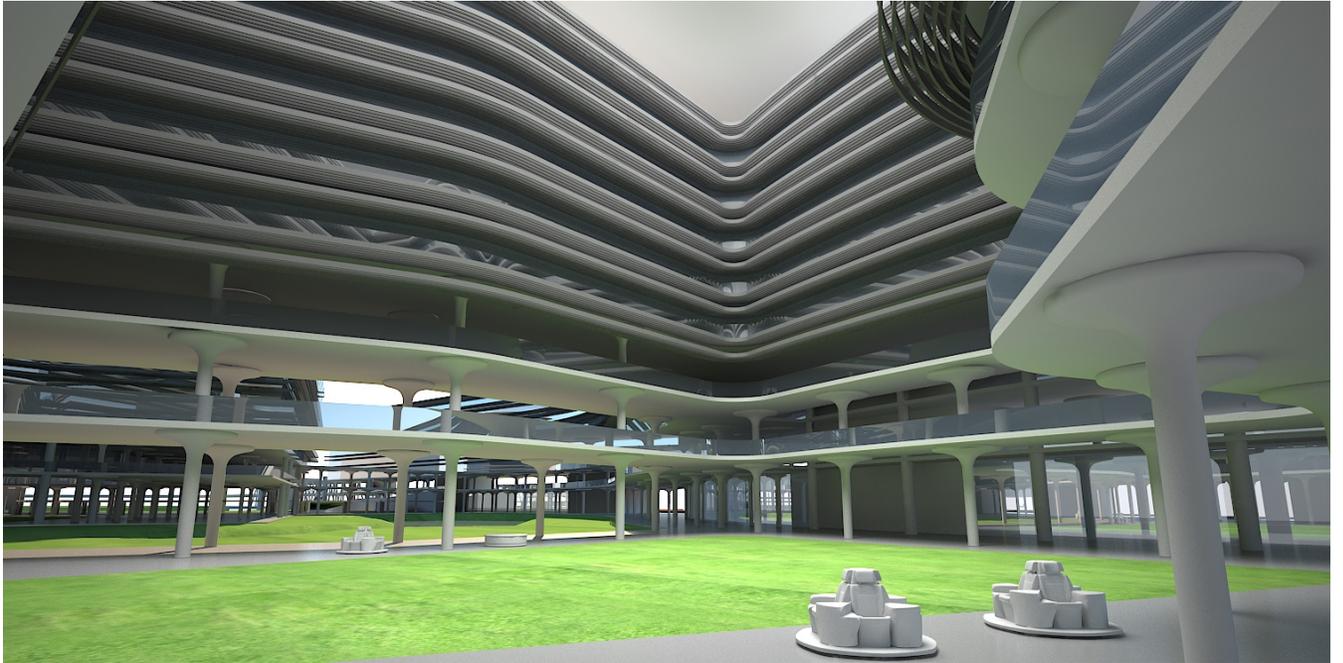


Fig. Preliminary perspective

Final Presentation

Google Transit Village: The Intersection between Autonomous Vehicle(AV) and Built Environment San Jose, CA

Md Mazharul Islam
Miami University | Department of Architecture+Interior-Design

The proposed development would create vibrant public spaces designed to encourage walking, biking, and transit use.

The Google project would create 6.5 million square feet of office space; up to 300 hotel rooms; 3,000 to 5,000 residential units; 300,000 to 500,000 square feet of commercial and active uses, which could include retail and restaurants; event center space totaling 100,000 square feet; and up to 600 rooms that would be set aside for short-term visits to the site by Google employees.*



Fig. Site analysis

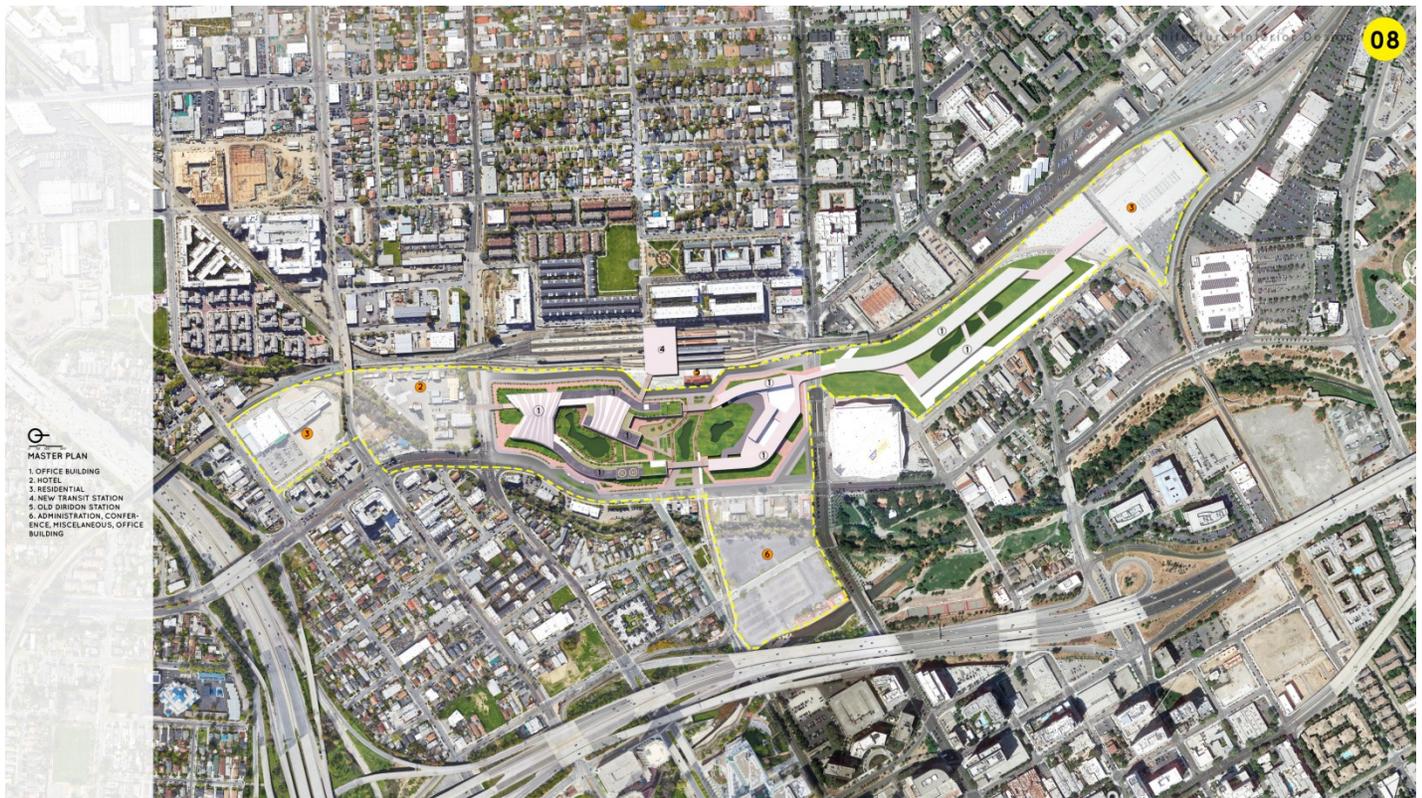
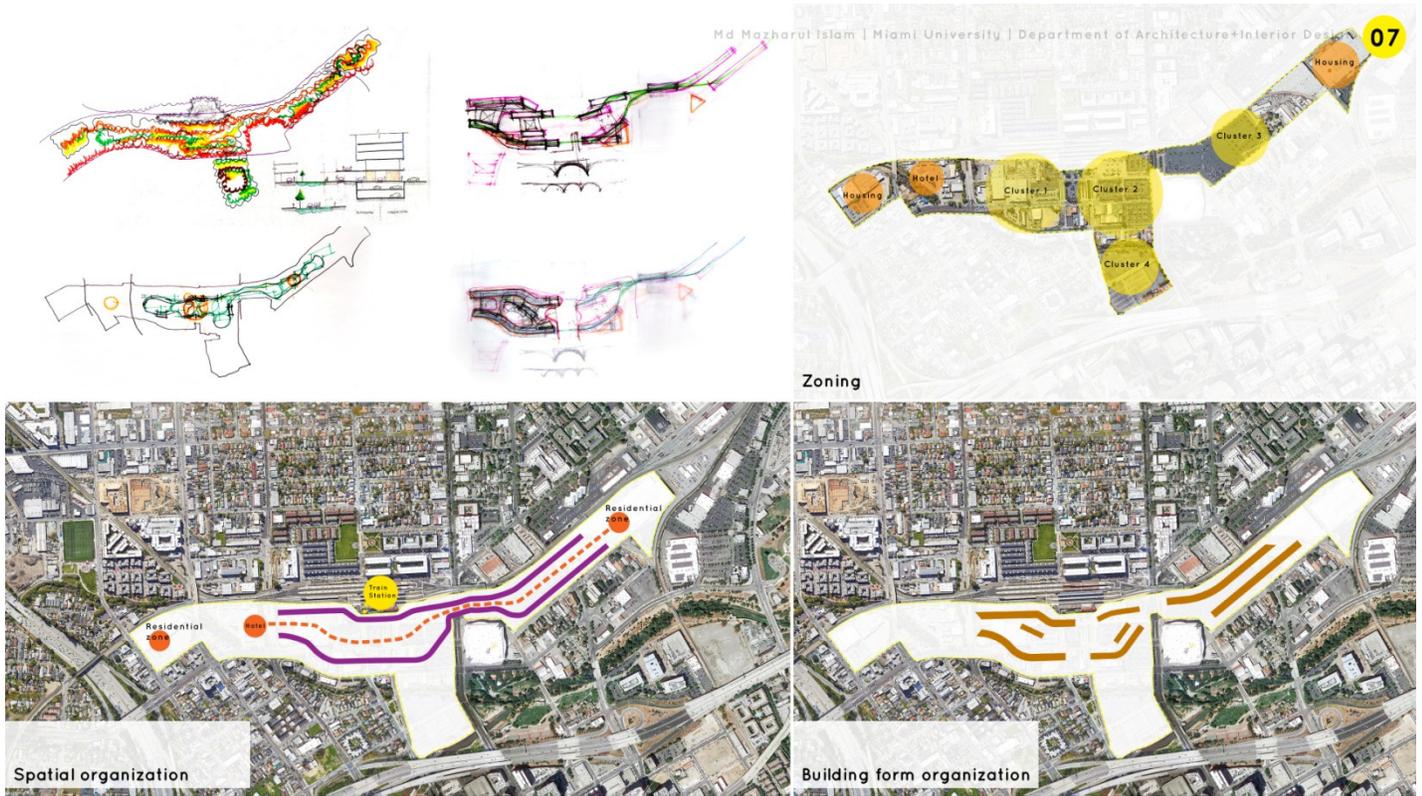


Fig. Master plan

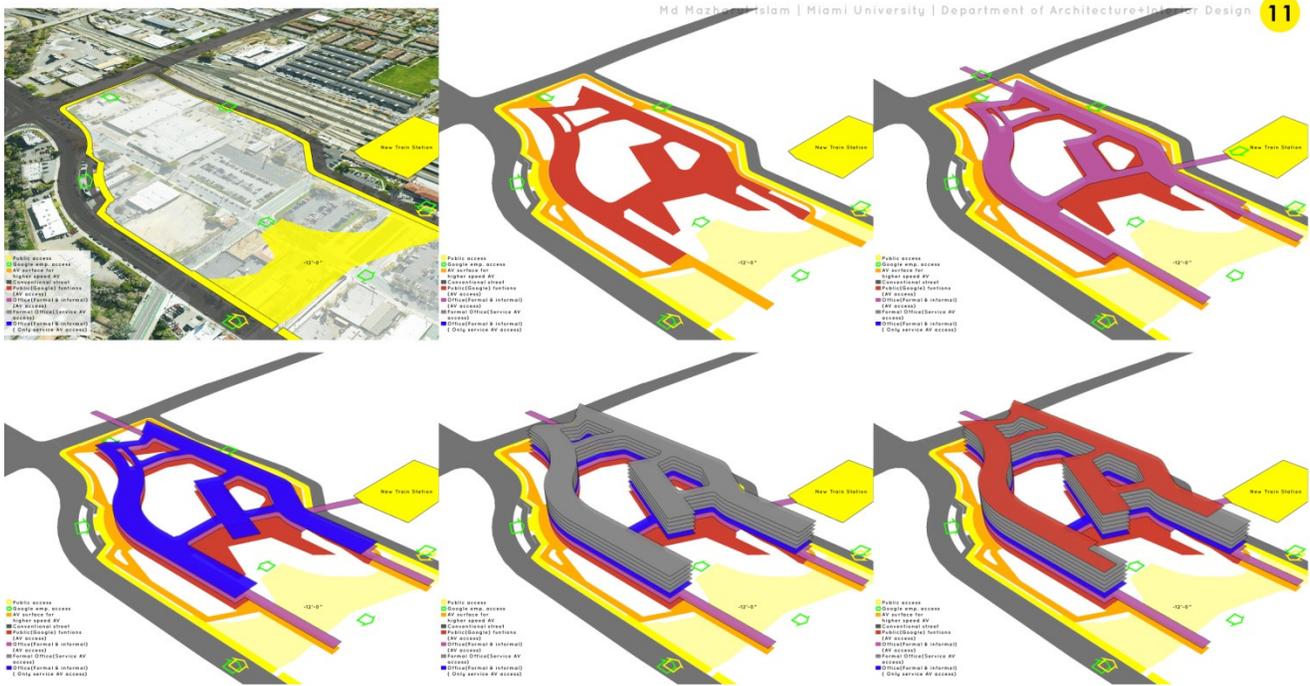


Fig. Zoning

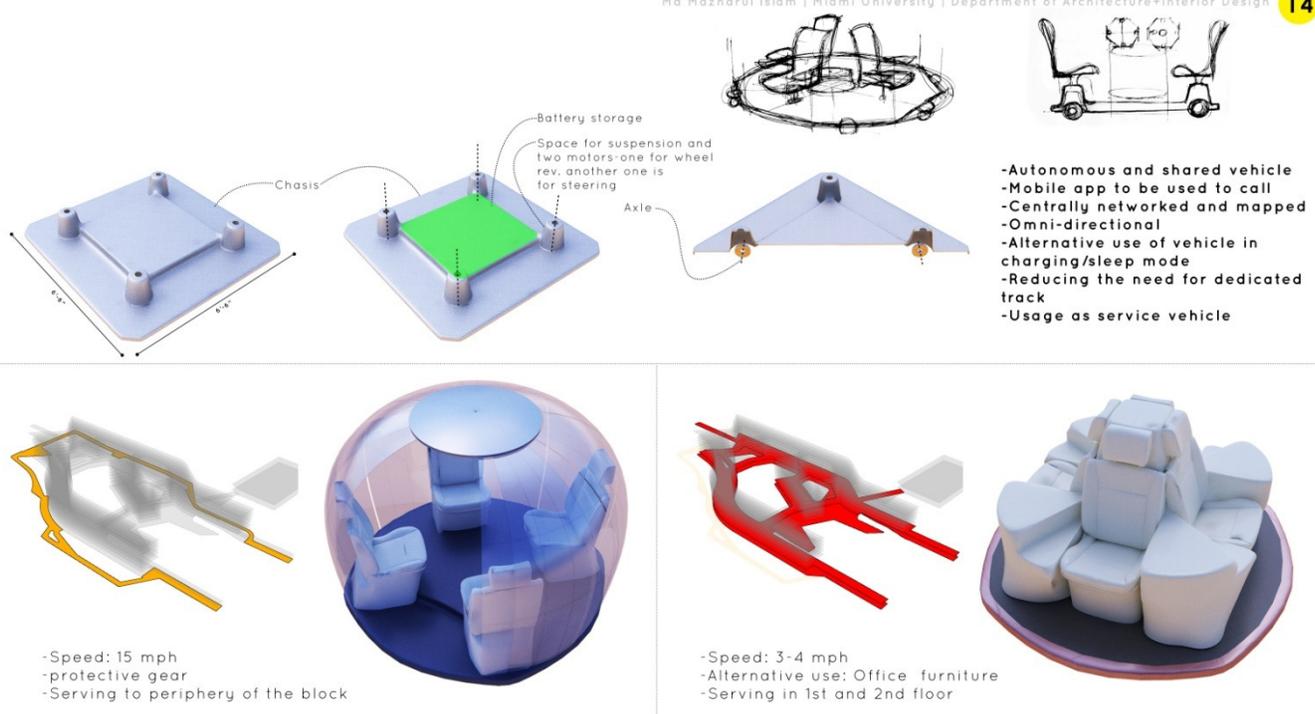
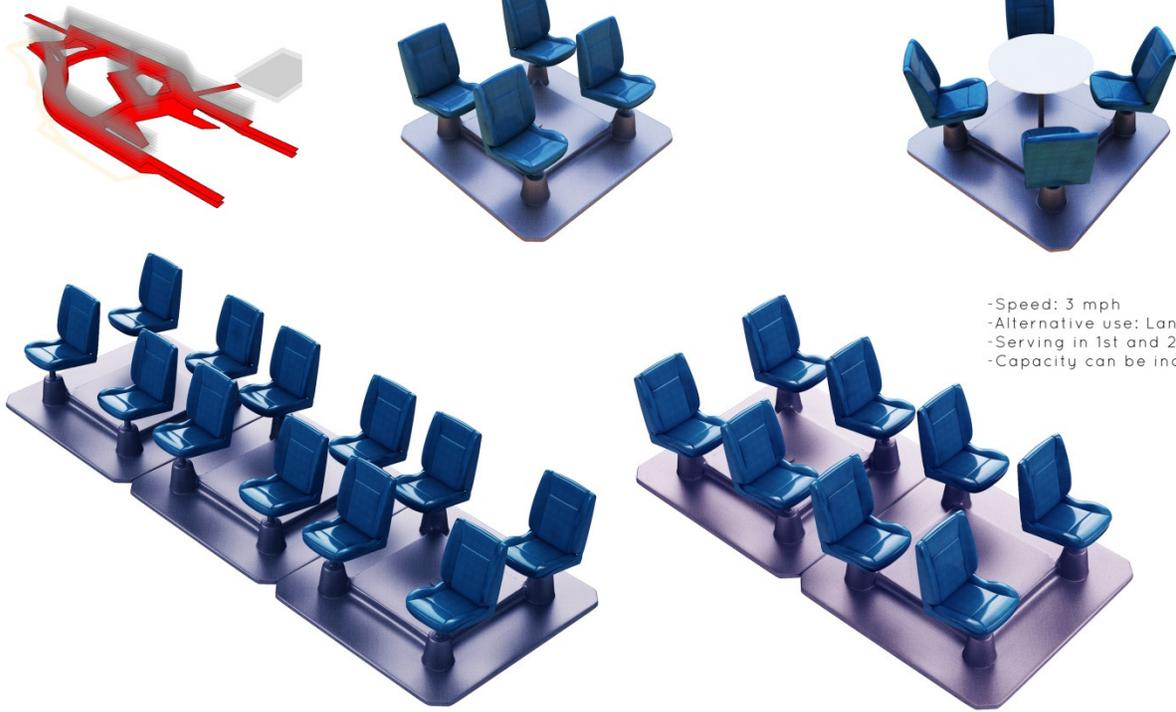
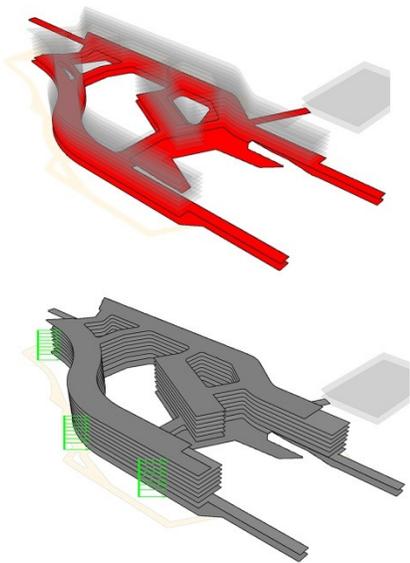


Fig. Shared AV design



- Speed: 3 mph
- Alternative use: Landscape fixture
- Serving in 1st and 2nd floor
- Capacity can be increased



Recyclable waste transport



Food delivery



Office stuff delivery

- Speed: 3 mph
- Alternative use: Office furniture
- Serving all floors
- Dedicated service AV lift

