

What space destined for development does infrastructure provide by the underground areas of New York and how can public activities and culture in the underground infrastructural space be related to the upper ground?

As one of the prosperous cities in the world, New York City has a famous label of congestion. The unbalanced demographic distribution between working and residential zones lead to the typical congestion of office-commuting while the capacity of transit space is also limited for land scarcity.

With the rapid development of society, the government has begun to adopt tax collection and a roadway-narrowing redesign to artificially reduce the entry of cars. Even the new generation has proposed the ambition to rebuild the structure of streets with shared cars entering. How will the traditional traffic model and spatial multiplexing of infrastructure in Manhattan change dramatically and how to deal with the typical congestion? What spaces open for development does infrastructure provided by the underground areas of New York. From the vision of mobility in the underground infrastructural system, this article will explore the typical transport system and congestion of New York City in a dynamic way and the fantastic urban anatomy beyond the surface of the skyscrapers and grids.

For the whole article, it is divided into several parts with the research of urban context, research question, site context and program. And the main focused objects are the underground transit infrastructure and the connection between upper and underground space, deriving the ambition for the program of a public hybrid building shared from underground to upper ground.

**PART 1. URBAN CONTEXT I
THE TRANSPORTATION SYSTEM OF NEW YORK**

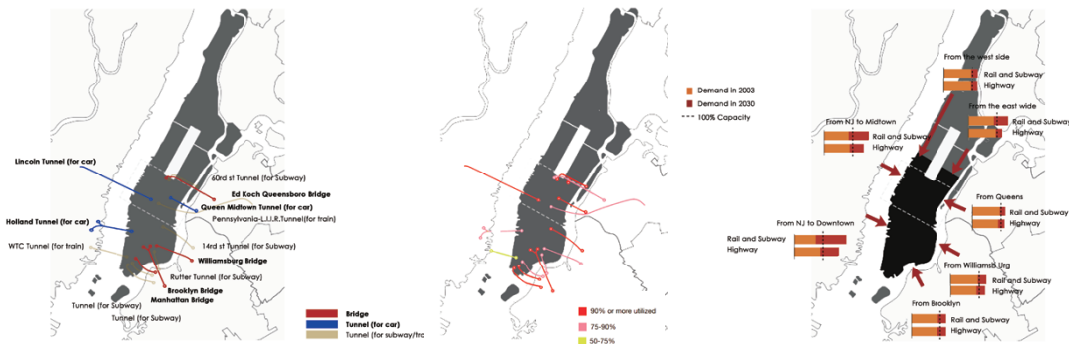


Fig.01 Accessibility with Capacity of Manhattan

1.1 DIFFERENT LAYERS : VERTICAL AND HORIZONTAL MOVEMENT SYSTEM

In New York City, congestion is the typical label. Even in different historical period and by different transportation modes, it has always existed. In the beginning, it just happened on one horizontal level by the pedestrian and carriages on the road. With more and more congestion happening in one layer, more horizontal levels were added and then gradually transit begins to develop vertically as the connection of different layers of horizontal movement. With development, eventually, New York's mass mobility system has evolved into the Vertical and horizontal movements, in other words, "horizontal dominant with the vertical connection". Horizontal dominant means the overlapping of different layers of horizontal movement while vertical connection consists of two aspects: one is the connection of different modes of transportation and the other is connecting the transportation modes to buildings like through the train to the office by the elevator.

In fact, in a complex urban system, the mix of transportation systems on the horizontal and vertical axes seems to be the standard configuration. With the development of the city, the expansion of the population, the involvement of new modes of transportation and the changes in people's lifestyles, the overlaps of different layers between horizontal and vertical transportation systems have become more complicated while the most congestion happening in the intersection has become more and more intense. Not only in New York, but also in other big cities in the world. The higher the city level, the more complicated the transportation hierarchy and overlaps. It is necessary to have a deep understanding of

the generation and operation of the transportation system.

1.2 TYPICAL CONGESTION: UNBALANCED CAPACITY

Urban traffic congestion is a common question in many metropolises and increasing with alarming rapidity. It is defined as a condition that the overall volume of vehicular traffic in certain areas continues to grow faster than the overall capacity of the transportation system. In other words, the unbalanced speed between the growth rate of volume of vehicular traffic and the capacity of the transportation system is the key point in congestion. As a result, understanding the evolution process and the overall capacity of the transportation system is the first step for understanding the question of congestion.

The unbalanced of the population distribution in New York City, where most of the people working in Manhattan but not living here, has resulted in a typical official commuting and there is always the most congestion happening in the passages where people travelling into and out of Manhattan (Fig.01) and these are the key sites to alleviate congestion. Nevertheless, the traffic capacity of the bridge and tunnel of passages is limited and according to the data from research, the needed traffic capacity of commuting into the Manhattan in 2030 will be much higher than the maximum capacity that can be afforded at present. As a result, the unbalanced speed between the growth rate of volume of vehicular traffic and the capacity of the transportation system will advance the proposal of new transit forms and explore the potential of underground space for more capacity. From the perspective of future urban development, it seems that the change from certain local horizontal and vertical traffic system to traffic loop (Fig.02) and the development of infrastructural underground space is a possible way to solve the typical congestion in Manhattan.

**PART 2. URBAN CONTEXT II
THE UNDERGROUND INFRASTRUCTURAL WORLD**
Return to New York City, which has a complex transportation

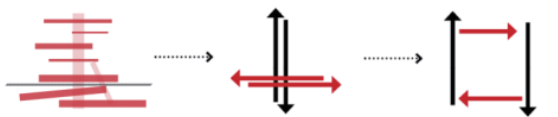


Fig.02 The change of transport system: from horizontal and vertical intersection to the loop

system, the most representative transportation is the subway system and the underground infrastructure system. According to the New York Times, the average commute time to and from New York is 57.92 minutes, with using more than two commuting methods. Most of this conversion takes place in the underground space represented by subways and trains. The research of urban context will zoom in the underground infrastructure space from the whole vertical and horizontal movement system of New York City.

The research will be divided into two aspects: one is how to understand the forming of infrastructural space and future trends by rearranging the generation and operation of the transportation system in New York, basing on longitudinal time study; another part will focus on the character of underground infrastructural space based on public cognition.

2.1 LONGITUDINAL TIME STUDY: MODERN INFRASTRUCTURAL HISTORY IN NEW YORK

There are mainly four processes of the rationalization of underground infrastructural space in New York City: infrastructure grid - urban subways and stations - intercity railway hubs - underground pedestrian network. The underground world in New York is gradually superimposed by these four levels.

Firstly, around the 1870s, five main systems, such as water supplied network, sewer, were gradually improved and infrastructure laid. And from the 1900s, following the infrastructure of the previous generation, the subway tracks and stations started construction. The original intention of form was "Arcade railway", which combined with the basements of the two sides of the existing building to arrange underground arcades system and created a double-street layer above ground and underground. With these two levels of access, the business value of commercial buildings on both sides of the subway greatly improved; Then, with more and more intersection of ground transportation and underground subway lines, the higher-level infrastructure, railway hub was built on a complete MRT network node. For example, after the completed and connected of the subway and the railway in the central station site, Central Terminal, was established to connect the systems and the ground.

At the 1930s, the underground pedestrian network appeared, which was an inevitable demand arising from the connection and collision of various urban transportation

modes and became the medium between Unicom's large-capacity transportation facilities and various specific transportation city functions. However, in New York, most of the underground pedestrian network was formed by expanding the existing public subway platform mezzanine. In the social context of private land, it was difficult to conduct a unified intervention in private land. If the surrounding owners took the initiative to bear the construction costs, the trails could be privately constructed and maintained. It was only possible to implement such underground pedestrian systems in large complexes, like Rockefeller Center, with huge underground shopping centre, underground pedestrian passage, sinking square, contacted 14 blocks nearby.

Ten years after the War II, the New York municipal government cleaned up many old communities and forced the relocation of 250,000 people to build a large number of landscape roads, parks, and public housing complexes. The pressure of the crowded was alleviated and the construction of underground space slowed down. However, after the 1960s, with the traffic congestion caused by urban expansion and car-centred inefficient transportation systems, pollution and safety hazards, there was an urgent need to continue to expand underground space.

As a result, in the 21st century, underground development has been once again put on the agenda, including the expansion of the Central Station, the development of Hudson Station, and the opening of a new tunnel under the Hudson River. Lowline Plan plans to transform the abandoned railway parking lot into an underground public garden by directing natural light to create an underground space that can grow natural plants. For New York, the vertical integration on the ground and underground is the coordination of the multilevel city base and it is clear that the future development of underground infrastructural space is a fine prospect in the rationalization of underground space in the city.

2.2 CHARACTER OF UNDERGROUND INFRASTRUCTURAL SPACE BASED ON PUBLIC COGNITION.

The underground space that connects different levels of transportation should also play its significance as urban public space. And underground culture also reflects daily life on the ground. Underground infrastructural space is always the ignored public space while extremely variable

and fluid with different types of spaces and experience. It is not only a connection between different urban space but also the place where urban life happened.

Nevertheless, the public generally has a negative impression on underground space. In the book, *Underground Infrastructures Planning, Design and Construction*, it said that: "For ordinary people, underground work or life triggers a negative (psychological) reaction... The public's negative perception of the formation of underground space includes dark and humid, airy and sunless." Especially in New York, the crime of the New York subway system in the 1980s may affect people's attitudes towards underground public places: violent conflict, crime, drugs, homeless, dirty, obsolescence. Another example, the book, *New York Underground: The Anatomy of a City*, tells about people's attitudes to abandoned underground space after the terrorist attacks of 9/11: "These attacks have had a profound impact on underground space in New York. Now the streets of the city seem to be full of threats. From these dark spaces that are uninhabited and most residents feel strange, New York seems particularly vulnerable."

Therefore, the first challenge is how to transform the underground infrastructural space into a public space that could have cultural meanings and give a positive impression to generate positive interactions. In fact, the underground space has some general advantages, such as being free from the noise and pollution of ground transportation, especially in New York, and being able to pass continuously in different climates. For example, the winter in Montreal, Canadian is super harsh. Compared with being exposed to the snow on the street, its underground pedestrian passage helps people to walk more comfortably in the city. And in London, putting the historical memory of seeking asylum into underground space gives people an understanding of the safety and comfort of the underground environment. For New York, how to make the most of the positive public concept of underground space, such as freedom, art, avant-garde, to transform these underground "flowing corridors" into new containers and connection for public life?

PART 3. RESEARCH QUESTION

Focused on the underground infrastructure and the connection in New York City, the main research question is provided as:

what space destined for development does



Fig.03 The transit system with accessibility of Midtown

infrastructure provide by the underground areas of New York and how can public activities and culture in the underground infrastructural space be related to the upper ground?

It mainly focus on how to understand the underground infrastructure of New York in a dynamic way and explore the fantastic possibility of connection between upper and underground. In order to better research this question, it can be divided into the following four sub-questions :

- What are the forms and organization of space derived along with the underground transport?
- What's the cultural intention and typical public perception for the underground space in NY?
- What is the difference between upper ground space and underground space?
- How can upper ground and underground be effectively connected as a whole?

3.1 What are the forms and organization of space derived along with the underground transport?

The infrastructure-derived space is not only a transportation space but also the remaining underground space affected by the subway, the transition space above and below the ground and the connection space of two different modes of transportation. These spaces may become shopping malls, market, park pots, youth hotels, theatres, night clubs, warehouse, product farm (cow raising) even the home of

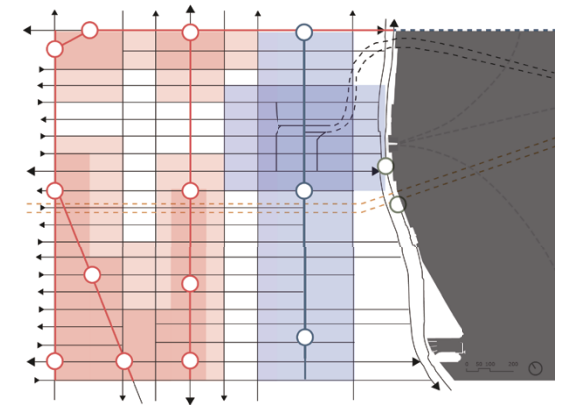


Fig.04 Transit density of Empire Village

the homeless. What are the typical subway-derived space and function in New York? What's more, the generating and usage of infrastructure-derived space is influenced by location and regional properties. The value and function of the derived space brought by the subway station crossing the commercial area and the subway station crossing the residential area are also different. How are these spaces combined and used in different areas? What underground space is needed in some special areas?

3.2 What's the cultural intention and typical public perception for the underground space in NY?

For example, in the 1960s sci-fi images of New York's future underground space propagated by the mass media had special cultural perception; in the 1980s New York's subway system was a representative of crime, poverty, and violence, and graffiti was prevalent. Until today, the underground space is still a contradiction where freedom, pioneer art, music and disorder, obsolescence, homeless survive together.

3.3 What is the difference between upper ground space and underground space?

People's perceptions of the ground and underground seem to be quite different. Upper ground means light and air while underground means darkness and violence. However, if we compare the different elements upper and under the ground, there are also some unique advantages of underground space, such as enough privacy, natural climate protection and good storage conditions. If matched with suitable functions, the underground space could have great potential to become a popular public attraction. On



Fig.05 Traffic character and Residential character in the selected site

the other hand, how to bring the sunlight, fresh air, common art to the underground space and circumvent the public's subconscious perception of underground space and form positive interactions is also a significant point.

3.4 How can upper ground and underground be effectively connected as a whole?

For Manhattan, based on the fact of limited land resources, the major possible to increase urban capacity is the development of underground space, leading to the method that how to effectively connect the upper and underground space and make it as a whole has become an important prerequisite. Most of the existing connections are commuting based connections, for example, vertical traffic spaces in some office buildings allow people to directly use elevators "from train to office door." And some specific functions are also given to the transition space according to the site context. However, when large public spaces or large traffic flows are introduced underground, this method seems to be unsuitable and effective. It seems that exploring a new form and define of connecting space between upper and underground under the context of New York is imminent.

PART 4 . SITE CONTEXT: THE PORTAL WITH MOST CONFLICT

Back to the site, Midtown of Manhattan, which has been divided into four parts, there are some obvious unbalanced in the transit system with accessibility (Fig.03). It is clear that site 2 and site 3 have the most positive traffic accessibility for the most intersection of transit grids and more transit clusters. For the site 4, which is named as

Empire Village, it has the most negative accessibility and especially lack an available transit hub which could activate the development of this zone. However, with the construction of the Second Avenue Subway line, there is a new possibility for re-organization the transport connection of Empire Village.

Based on the regional transit density and accessibility with the upcoming Second Avenue subway line and station (Fig.04), the personal site has been chosen in the most conflict area in Empire Village, where is the intersection between the entrance of the Queen Midtown tunnel and the new subway station, and could be recognized the important identity of the only portal to directly enter the Empire Village from the underground.

There are two main characters of traffic and residence in the selected site (Fig.05). On one hand, as the most existing congestion place in Empire Village, it always has a lot of volume of vehicle traffic and the stream of the vehicle is cut down by pedestrian. It could be worse when the pedestrian flow brought by the upcoming Second Avenue subway is seriously conflicted with vehicle flow brought by Queen tunnel in the future. At least three layers, vehicle, subway and pedestrian, of the horizontal transport system will meet here and needed to integrate efficiently in future. What' more, another serious problem is that there are many small underground parking lots in the site which are chaotic and unsafe. How to integrate them together? On the other hand, for the residential neighbourhood, the selected site is surrounded by high-rising residential buildings, which could be a nice open green view instead

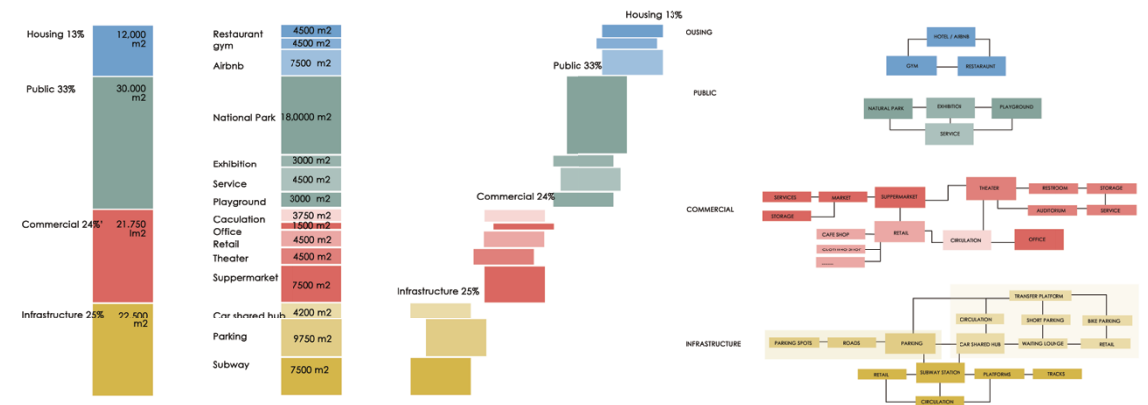


Fig.07 The ratio and structure of program

of occupied by the tracks of tunnel and wastelands. Also, there are some parks surrounding the site while some are closed and others are open for football or playground. What is more concerned is that after the interviews with some parents and children who live here, there are some basic problems and demands from residents. There are at least three kindergartens around this area, leading to lots of children come here to play with friends after school and calling for more green and safe place without the danger of car traffic.

What's more, the possibility of the development for the underground space of Second Avenue in the residential area is also an attracting point. What changes will happen in the land pattern of original space with the construction of the new subway line? And located in the residential zone where near the commercial zone of CBD and the UN, there could be a new commercial connection even circle in future with the developing of underground space in the site from the group vision.

As a result, the project has to deal with such subsistent problems and meet the demand of the residential zone. For the traffic character, the new project has to not only become the portal of Empire village where people pop up into it and enter the grid but also dealing with the future congestion with the separating of streams in three levels and integrating of parking. And for the residential character, how to return the public space occupied by tunnel to the citizen and make it becomes a new safe green shared hybrid centre under the demand of the neighbourhood is the key aim for the whole program.



Fig.06 Design strategies: 3D portal with loop

PART5. PROGRAM AND AMBITION: 3D PORTAL OF EMPIRE VILLAGE

The ambition is to create a 3D portal to enter Empire Village and the key strategies are the loop from upper to underground (Fig.06). The project will be a mixed using transport terminal for future and become a public hybrid building shared from underground to upper ground, which aims at More efficient, more multifunctional, more open to the public and greener.

The case studies mainly focus on the infrastructural buildings have the traffic loop. Interestingly, the main program of most relevant buildings are about parking, or mixed-use of parking with housing or the office building, leading to the conclusion for the future trends: the infrastructural buildings will be increasingly complex and hybrid with non-single functions and more open to the public. Secondly, the loops of the flow will be more complex and interlaced, which not only happens in the plan at the horizontal level but also could be in the section at the vertical level even integrated into the three-dimension. Besides, for the building technology, they have taken more and more high-tech and environment-friendly materials for the large open space.

Depending on the demand of the selected site, the whole program (Fig.07), which is planned at least 90,000 square meters, even more, is divided into four functional groups. The biggest group is the public with the percentage of 33%, mainly about the public open space like a theatre, playground and gallery; then following the commercial group, 24%, and infrastructural group, 25%, which includes the vertical parking lot, shared car hub and subway station; finally is the group for temporary housing, like the hostel, with the percentage of 13%. The whole hybrid building aims to give more public shared mixed using of transport terminal and try a new connection which could effectively integrate the underground space with upper ground space to become a whole. Especially, there will be some creating space for the future function of new transportation modes, such as the shared car hub for Uber with the new bike parking.

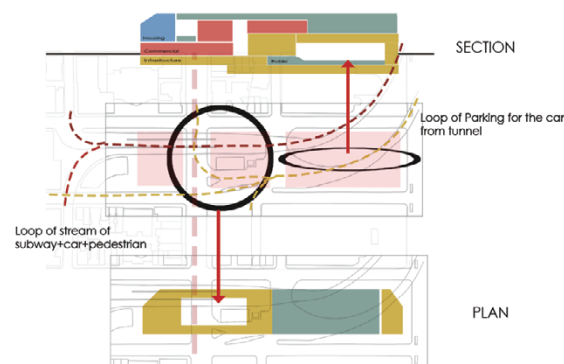


Fig.08 The Loops in site

For the arrangement of different functional groups, differentiating from the traditional way that puts every functional group layer by layer in the horizontal or vertical level, there will be a new logic to try the three-dimension loop to merge everything and make enough efficient streamlines. There are at least two basic needed different layers of loops in the selected site (Fig.08). One is the horizontal loop for the separating of the conflict from the streams of vehicle, subway and pedestrian while the other is the vertical integrating of parking for amounts of vehicles from the tunnel for the more intensive use of land.

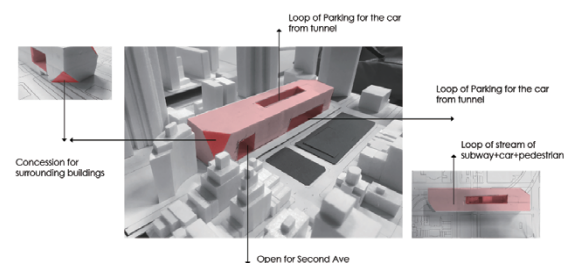


Fig.09 Massing model

For the massing model, after the trying of different forms of loops, the finalized primary one is decided as the huge integrative massing (Fig.09) that is dug various scales of holes to create different levels of loops and cut some corner for the moderating the crowded with the surrounding high-rising buildings and avoiding the pressure for the major intersections.

Besides the primary massing and preliminary framework of the program, the collage (Fig.10) has also shown the ambition that this public hybrid building from underground to the upper ground will be a 3D portal for Empire Village. Nevertheless, there are still some problems to research later, like what are the risks and potentials of mixing infrastructure with other uses? how does this building respond to future changes in mobility and how flexible will it be?

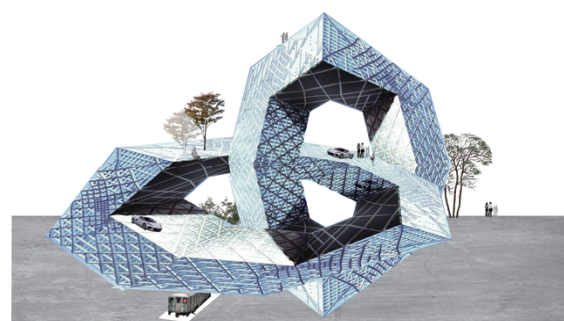


Fig.10 The collage of program

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