RICE UNIVERSITY

The New Crowd:
Design of Subway Station with Overlaid Passenger Flow and Information Flow

by

Leming Yang

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

Master of Architecture

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HOUSTON, TEXAS
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ABSTRACT

The New Crowd:
Design of Subway Station with Overlaid Passenger Flow and Information Flow

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Leming Yang

A new prototype of subway station with overlaid passenger flow and information flow is suggested to be applied to the newly developed Line 8 in the City of Beijing, both to deal with the crowded passenger flow space and to provide a dynamically continuous city image to the passengers as a feedback of the collection of their route information.
ACKNOWLEDGEMENTS

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I am fortunate to have studied in a department with professors and students working in a close environment. I want to thank Lysle Oliveros for providing comments on my thesis. I thank Kathleen H. Roberts for the coordination on the thesis procedures.

My parents have always encouraged me and guided me to independence and hard working. I am grateful to them for their generosity.
CONTENTS

ABSTRACT .................................................................................................................. II

ACKNOWLEDGEMENTS ............................................................................................... III

LIST OF FIGURES ......................................................................................................... V

LIST OF TABLES ............................................................................................................. VII

CHAPTER 1  INTRODUCTION ...................................................................................... 1

CHAPTER 2  SUBWAY DEVELOPMENT AND CITY EVOLUTION ................................. 3

  2.1 1970s: When the Subway Started in Beijing .......................................................... 3

  2.2 City Expansion and Subway Development ............................................................. 5

CHAPTER 3  SUBWAY AND THE CROWDS ................................................................. 11

  3.1 The Formation of Subway Crowds ...................................................................... 11

  3.2 Crowd Scare and Crowd Effect .......................................................................... 14

  3.3 The Crowd ‘Benefit’ in Subway System ............................................................... 15

  3.4 City Illegibility and ‘City Image Comprehending Database’ .......................... 17

CHAPTER 4  SUBWAY STATION DESIGN ................................................................ 21

  4.1 Prototype Design .................................................................................................. 21

  4.2 Variations and Adaptations ................................................................................ 31

CHAPTER 5  CONCLUSIONS AND FUTURE DIRECTIONS .................................... 33

BIBLIOGRAPHY .......................................................................................................... 34
LIST OF FIGURES

Figure 2.1: Map of Beijing in Ming dynasty ............................................. 4
Figure 2.2: Capital constructing rules illustrated in the Rites of Zhou .................. 4
Figure 2.3: Illustration of modern city expansion ........................................ 5
Figure 2.4: Illustration of Beijing subway expansion ..................................... 6
Figure 2.5: Illustration of recent Beijing subway development ........................ 7
Figure 2.6: Photo of a crowding subway station in Beijing .............................. 11
Figure 2.7: Photos of crowds entering subway stations in Beijing .................... 12
Figure 2.8: A year-round calendar of events affecting subway ridership .......... 12
Figure 2.9: Illustration of distribution of city function along Line 8 .................... 13
Figure 2.10: Surrounding city environment around Line 8: Transportation routes, connection or fragmentation? ................................................................. 16
Figure 2.11: Illustration of trips around Line 8 ............................................. 16
Figure 2.12: Illustration of how subway trips could form a ‘City Image Comprehending Database’ ................................................................. 17
Figure 2.13: Illustration of trip information that could be collected from passengers .... 19
Figure 2.14: The site of Line 8 and the information along the line ........................ 20
Figure 2.15: Station prototype design ....................................................... 21
Figure 2.16: Station prototype sections ...................................................... 22
Figure 2.17: Station prototype model ......................................................... 22
Figure 2.18: Station prototype plans ......................................................... 23
Figure 2.19: The overlaying of passenger and information flow ...................... 24
Figure 2.20: Illustration of information flow of Seaside Station .......................................25
Figure 2.21: Screen displaying of business centre and shopping centre attraction.................26
Figure 2.22: Screen displaying of festival ceremony attraction..............................................27
Figure 2.23: Screen displaying of landscape park attraction................................................28
Figure 2.24: Screen displaying of museum attraction..........................................................29
Figure 2.25: Screen displaying of attractions in a city scale .................................................30
Figure 2.26: Variations of prototype .......................................................................................31
Figure 2.27: Adaptations of station prototype and its variations ..............................................32
LIST OF TABLES

Table 2.1: The ridership, train num. and length of Beijing subway ........................................8

Table 2.2: Comparison of area, population, subway length, subway and bus ridership among
global cities ..........................................................................................................................9

Table 2.3: Comparison of transportation modes’ rate among continents ...............................10

Table 2.4: Comparison of transportation time among continents .........................................11
Chapter 1

Introduction

The term ‘Beijing Subway’ refers to a rapid transit rail network that serves the urban and suburban of Beijing district. Containing 8 lines, over 200 km of tracks and 123 stations currently in operation and average ridership per day for 3.4 million, the Beijing Subway is the busiest rapid transit system in mainland China.

Because of the increasing crowded situations in the system, the existing network is considered not adequately meet the city’s mass transit needs and is undergoing rapid expansion. According to the existing plan, the system will be containing 19 lines and 561 km of tracks in operation by 2015, compared to 200 km today and 23.6 km in 1971.

Along with the convenience the transportation infrastructure brings to the citizens, are the more and heavier crowds appearing in the stations. Big ridership increase has been approving that the larger coverage of the subway system over the city has been working more as a crowd-absorbent rather than a crowd-catharsis at this stage. By the first season of 2008, the average daily ridership in each station is 40,000 compared to 1,500 in 1971.

‘The New Crowd’ focuses on the crowds formed in the subway system. As a concept widely studied in social and psychological field, the Crowd has been described in both negative and positive ways (as ‘the crowd scare’ and ‘the crowd effect’). Deriving the concept of ‘space generated crowd’ from the concept of ‘capital generated crowd’ which has been studied in the field of business, the thesis raises the question: if the capital generated crowd in turn brings ‘benefits’ to the capital, how could the ‘space generated crowd’ in the subway stations benefit the city space?

We look for answer in passengers. As a unit in the passenger flow, every individual has an
idea of his/her trip route and destination, whether vague or clear. And they only have this information of his/her own. When this limitation of information is projected to the expanding and increasingly more complex urban space, it becomes both a result and cause of the fragmentation of the city space.

A new subway ticket and map searching system is expected to provide a dynamically continuous city image to all the passengers as a feedback of the collections of their route information. Also the digital circulation is helpful to arrange the passenger flow under crowding situations as the digital and passenger circulations are always interact with each other.
Chapter 2

Subway Development and City Evolution

2.1 1970s: When the Subway Started in Beijing

The Beijing subway was proposed in September 1953 by the city's planning committee and experts from the Soviet Union. The Moscow Metro functioning as both an asset for civil defense and civilian transportation system is studied as a sample and Beijing Subway was at the beginning planned for both civilian and military use.

Construction began on July 1, 1965. The line delivered 8.28 million rides in 1971 but remained under trial operation for a decade. In September, 1981, the initial line with 19 stations and 27.6 km from Fushouling in the Western Hills to the Beijing Railway Station was finally opened to full public use. Extensions were done in the following two decades but a larger scale development has taken place since 2001 when the city won the bid to host the 2008 Summer Olympic Games and accelerated plans to expand the subway. According to the press, from 2002 and 2008, the city planned to invest ¥63.8 billion (US$7.69 billion) in subway projects.

As a city transportation infrastructure, the subway construction is always corresponding to the city development. An interesting example is that during the time the initial part of subway was planned under the city wall (the 2nd Rind Road today,) there was a most controversial point on the demolition of the Beijing's historic inner city wall to make way for the subway. In the end, in a few places the city wall gates have been protected by slightly altering the course of the subway.

The city wall, which gained its shape in around 1400s, was still representing the profile of Beijing in 1970s'. Beijing started its history as a most significant city (the capital) in China
during the Mongolian Empire, when the Kublai Khan hired a Han planning expert to build his amazing capital, who followed the rules of capital construction in a classic Chinese rite document called the Rites of Zhou. The shape of the city wall today was mostly set though a little modified in the following dynasty Ming.

Figure 2.1: Map of Beijing in Ming dynasty

Figure 2.2: Capital constructing rules illustrated in the Rites of Zhou
2.2 City Expansion and Subway Development

Following the economic reform, the urban area of Beijing has expanded greatly since 1980s'. Formerly confined by the 2nd Ring Road and the 3rd Ring Road, the urban area of Beijing is now challenging the limits of even the recently constructed 5th Ring Road and 6th Ring Road. Many areas that were formerly farmland has now been developed into residential or commercial districts. Transportation has never been as important as it is now for the cities well-operation.

Figure 2.3: Illustration of Beijing City expansion since 1970s
The Beijing Subway becomes the busiest in mainland China and the second longest after the Shanghai Metro. New ridership records have been set every short period. The existing network is considered not adequately to meet the city's mass transit needs and is undergoing rapid expansion. Three new lines were opened on July 19, 2008 ahead of the 2008 Olympic Games. Existing plans call for the entire network to double in size to 420 km by 2012 and a goal of 19 lines and 561 km of tracks in operation to be fulfilled by 2015.

Figure 2.4: Illustration of Beijing subway expansion
Figure 2.5: Illustration of recent Beijing subway development
Table 2.1: The ridership, train num. and length of Beijing subway
According to the comparison with other global metropolitans including New York City, London, Tokyo and Shanghai, we can see that under the condition of compatible city area and population, Chinese city Beijing and Shanghai have a less popular rail transportation system compared to their bus transportation which is compatible with or more popular than other global cities. Tokyo set up a good example in rail transportation. Not only does it have a strong subway system but it also has a further-reaching suburban rail network.

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Table 2.2: Comparison of area, population, subway length, subway and bus ridership among cities
The comparison chart below shows in average the time citizen spend on their daily commuter, in general in Asia people spend more time on traffic than people in N. America and Europe. And the statistic on Japan implied that it is possible that the traveling time could increase in more developed area with higher density.

Therefore, besides home and office, a third space becomes important in people’s daily life, that is, the space of transportation. Thanks to the emphasis on further development and adoption of public transportation, the subway system would play increasingly significant role for citizens.

Table 2.3: Comparison on transportation modes by continents

Table 2.4: Comparison on transportation time by continents
Chapter 3

Subway and the Crowds

3.1 The Formation of Subway Crowds

Along with the convenience the transportation infrastructure brings to the citizens, however, are the more and heavier crowds appearing in the stations.

We could define the subway crowds as space generated. Its appearance is based on the spatial (static) and timely (dynamic) distribution of the city functions.

The subway brings new jams on the way solving the traffic problem. The subway enters the stage of Crowd Scare.

Figure 2.6: Photo of a crowding subway station in Beijing
Figure 2.7: photos of crowds entering subway stations in Beijing

Figure 2.8: A year-round calendar of events affecting subway ridership
Figure 2.9: Illustration of distribution of city function along Line 8
3.2 Crowd Scare and Crowd Effect

A crowd is a group of people. As a concept widely studied in Social and psychological field, the crowd has been described in both negative and positive ways.

In the twenties and thirties, as part of the result of the industrial revolution, the market and the labors started rapid congregation in modern cities. Images of vast crowds at once filled the newsreel screens. A fear of the masses appeared and became a common conversation. The crowd was accused for "menacing the 'values of civilization'" as people took 'the growing habit of behaving as crowds.'

Other writers and artists took a contrary vision, one that appreciated the vitality of the crowd and recognized its ability to pursue positive goals. 'As one watches each of those passengers, riding with some inscrutable purpose of his own (or an even more inscrutable lack of purpose) toward duty or liberation, he may be touched with anger and contempt toward individuals; but he must admit the majesty of the spectacle in the mass.'

There was a third way of conceiving the crowd as a status of contemporary existence. Gerald Stanley Lee in his best-selling book Crowds; A Moving Picture of Democracy describes that the crowd was created by the giant business organizations of the modern city. It consisted of all those who worked in skyscrapers, shopped in department stores, read mass-circulation newspapers, and went to the movies. Everywhere the individual finds himself surrounded by crowds. 'A crowd surrounds him as he goes to work, and a crowd surrounds him as he returns from work. Often he does his work as part of a crowd.'

The crowd principles (or Polymerization Effect) in the field of business are as below:

'The crowd principle is the first principle of production. The producer who can get the most men together and the most dollars together controls the market; after he controls the
market, instead of merely getting the most men and the most dollars, he can get all the men and all the dollars...

'The crowd principle is the first principle of distribution. The man who can get the most men to buy a particular thing from him can buy the most of it and buy it the cheapest, and therefore get more men to buy from him…'

3.3 The Crowd 'Benefit' in Subway System

If "the Crowd" we talked before as capital generated (Commercial Crowd), we could define the subway crowds as space generated. Its appearance is based on the spatial (static) and timely (dynamic) distribution of the city function.

The question is: The formation and expansion of the commercial crowds in turn provide commercial benefits (Polymerization Effect). What could the spatial crowds in this rapid transit system bring us, or bring to the city space itself?

We look for answer in the passengers. As a unit within the passenger flow, every individual has got an idea of his/her trip route and destination, whether vague or clear. And they only have this information of his/her own. The information of each passenger is limited. This limitation of information could be seen as both the cause and the result of the fragmentation of the city space. If the spatial information of the passenger could be gathered at the same time the passengers are gathered, with the overall information shown as a feedback, we can achieve the goal to rebuild the city images in a more continuous way.

Psychologically, if the images appear in the passengers’ minds, physically, if the images will go on to affect the passengers’ trips.
Figure 2.10: Surrounding city environment around Line 8: Transportation routes, connection or fragmentation?

Figure 2.11: Illustration of trips around Line 8
3.4 City Illegibility and the ‘City Image Comprehending Database’

The layout of the City of Beijing from Yuan Dynasty is according to the basic rules recorded in the Rites of Zhou. The most cited sentences are: “To build a capital, with a nine-mile length on each side (of the square), 3 doors on each side, 9 paths on each direction; To locate the (Emperor’s) Ancestral Temple on the left (West), to locate the Imperial Divine
Temple on the right (East); To place the Imperial Palace on the front, to place the commercial markets on the back…”

There were strict rules on the specification of private residential houses as well as government buildings. Plus the zoning of the city based on a class hierarchy system, the physical image of the city in terms of architecture and planning, was settled in a way statistic rather than dynamic, straightforward other than obscure, negative other than positive.

Entering the modern time, when we no longer see the previous strongly defined hierarchy system that affected the image of the city, the city construction enters an age in which the shaping force of the city image has become the rule of industrial production with a little (seen from later) idealistic utopianism. Factories are seen as most proper signs to describe the new age. Commuter travelling constitutes the biggest part of the transportation concern. At this moment, the old city zoning rules were broken; buildings with modern functions have been filled in the city after necessary reservation of some historical sites (which is accused today for not being good enough); citizens are granted the right to travel much more freely in the city although at first, these trips are a lot simpler than they are today thanks to the relatively bald combination of the city functions.
Today, when the city zoning is no longer largely depending on a class hierarchy or the idealistic utopianism; the functions of the physical system of the city are no longer bald and monotone as they were at the beginning of the industrial age; people travel freely everywhere in the city and communicate information instantly. After abandoning the predetermined rules for a static city control, we seem to enter the 'age of obscurity' in terms of comprehending the image of the city. Subway, on the other hand, is as dynamic as a contemporary city, or it is in fact part of the source of this dynamicity. This explains why the subway is considered as 'a vital part of the physical city which can easily be made to represent the urban whole'. The 'inscrutable purposes' in each passenger's mind represents each fragment of perception of the city space and we expect that the collection of such information would provide us with an instantly updated 'City Image Comprehending Database'.

Figure 2.13: Illustration of trip information that could be collected from passengers
Figure 2.14: The site of Line 8 and the information along the line
Chapter 4

Subway Station Design

4.1 Prototype Design

The new stations become places where the crowds congregate and the fragments resemble a mosaic; where the spatial perception of the city is shifted and a better sense of direction is achieved.

Crowds Accommodation

The first character of the space planning of the new prototype is the multi-paths design. Instead of placing several separate entrances on the corners and the sides of the streets, the new plan adopts multiple paths for vertical circulation. The paths connecting the up ground entrances and the underground platforms are arrayed and connected to each other in a parallel way.
In the traditional station planning format of Entrance – Passage – Vertical Circulation – Platform - Train doors circulation (or Entrance – Passage – Vertical Circulation – Platform - Train doors), bottle neck effect could happen at every conjunction where the breadth has a sharp decrease.

In the new prototype, as the total breadth of the multiple paths is compatible with the length of the platform length the entrances, passages, stairs becomes a different section of a whole circulation which almost always keeps the breadth of the platform length. Therefore, we propose that the parallel multiple paths would effectively avoid the bottle neck effect which is the core reason for the crowded situation.
Figure 2.18: Station prototype plans
Digital Circulation

The digital Circulation of a subway station includes traveling data input system combined with ticketing, a data processing system taking data into analysis and coming out with an overall scope of the spatial data and the locations that have data at the most density. On the back side of the multiple circulation routes are led screens that display the generated information of most popular places and destinations. By get a glimpse of the screen, a passenger will be able to absorb the information on trips in the city.

Figure 2.19: The overlaying of passenger flow and information flow of subway station
Adaptation Example: Seaside Station located on the south end of the Line 8.

In this city heart area, there are plenty of attractive destinations among which we might find some most attractive places, the national arts museum, the Longfu Temple Street in traditional style, The palace and parks around it and further the Wangfujing shopping district.
Figure 2.21: Screen displaying business centre and shopping street attraction

The screen is displaying a composition of those destinations: The shopping street, the traditional ceremony, the gallery in the museum and the Park around Palace.
Figure 2.22: Screen displaying festival ceremony attraction
Figure 2.23: Screen displaying landscape park attraction
Figure 2.24: Screen displaying museum attraction
For those people who are waiting for the train, they get images of a more general view of the city as the subway covers most part of the city as one system.
4.2 Variations and Adaptations

Variations of the prototype:

A prototype with connected parallel entrances with a total breadth compatible to the length of the train platform downwards and located on two sides of the street could have flexible variations due to the specific site characters.

Variation 1: The entrances may not always show up on both sides of the road. Variation 1 has entrances on one side and it is usually a combination of 2 types of entrances: In some part the entrances are in both sides and in other parts they are in either side.

Variation 2: Parallel entrances don't always connect to each other to get a maximum total breadth of the circulation. Instead, the dense of the entrances could be lower.

Variation 3: The total breadth of the entrances could be reduced in less busy traffic area.

Variation 4: The entrances may not stay straightly above the platform. Like the traditional tunnel-entrance station type, the parallel entrances could be at locations with a certain

Figure 2.26: Variation of Prototype
distance away from above the platform.

Figure 2.27: Adaptations of prototype and its variations
Chapter 5

Conclusions and Future Directions

The basic understanding of the operation of subway system has been acquired through the research and the direction of considering the passenger (the crowd) as a main focus during the design has been set from the beginning.

The spatial planning of the prototype and its variations are developed through the organization of passenger circulation. The adoption of the Polymerization Effect in the study of subway crowds provides an active point of view when looking at the crowds formed in the transportation system. The crowds become subjects rather than objects in the station design.

The future work could include more accurate calculation in the decisions of essential dimensions according to a further analysis of the ridership information; a more detailed proposal for the ‘City Image Comprehending Database’ and a more responsive relationship dynamically and mutually between the subway stations and their users – the crowds.


Jay Shuffield. The subway as intermediary public space. Web material.


London information: http://www.statistics.gov.uk/

New York City traffic information: http://www.mta.info/nyct/facts/ridership/index.htm