THE ROLE OF TRANSIT-ORIENTED DEVELOPMENT IN URBAN PLANNING OF CITIES IN CHINA

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To My Family

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BRT	Bus Rapid Transit
DOT	Development-OrientedTransit
HUST	Huazhong University of Science and Technology
TOD	Transit-Oriented Development

Abstract of Thesis Presented to the Graduate School
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Transit-Oriented Development (TOD) is a term first used by the American planner Peter Calthorpe in 1993. To address the urban sprawl caused by too much car use and the disappearanceof community centers, Transit-oriented development proposed integrating land use on a regional scale and encouraging public transit use. It became the theoretical foundation of the movement known broadly as New Urbanism.

TOD principles have also been introduced to China in order to address the urban development problems there over the past several years. But both the current conditions and backgroundsare different in Chinese and American cities. The urban development issues in China cannot be addressed by simply copying the principle directly from America. This thesis will compare the current conditions and backgrounds in China and America.It aims to find howthe TOD principles proposed by Calthorpemay work in the urban planning of China.

CHAPTER 1
INTRODUCTION

The Transit-Oriented Development theory was proposed by Peter Calthorpe in his book *The Next American Metropolis: Ecology, Community, and The American Dream*, in order to address the issues of urban sprawl with low density and separate land use caused by excessive automobile use. This theory has become the theoretical foundation of New Urbanism.

Chinese cities are in a stage of rapid development. A great number of problems have emerged, such as traffic congestion, environment pollution, the low quality of lives, and lose of neighborhood, in this urban development process. In order to face these problems, the question how to plan cities more sustainablyhas become the major topic in Chinese academic circles. The Transit-Oriented Development theory hasearned widespread respect by many scholars and the government since it was introduced in China in 2000. However, there are a number of differences between China and America.It is important to research the TOD systematically with the consideration of Chinese background.

When the TOD theory is used to guide urban planning in China, the development of public transit is a primary concern while the relationships between mixed land use and these public transit systems are often ignored. In addition, massive road construction and single use, closed residential communities are becoming the main body of Chinese city construction. All these go against the mixed land use and open form communities linked by public transit corridors as outlined in TOD.Without a mix of land uses, the public transit system cannot solve the traffic problems and is just a wasted investment in civic infrastructure construction. Additionally, it is contradictory to

encourage people use public transit on one hand and to encourage car use by building wider roads on the other hand. Such a development model will only lead to a vicious cycle of urban development.

This thesis reviews the issues of American urban development and TOD as proposed by Peter Calthorpe in his book*The Next American Metropolis: Ecology, Community, and The American Dream.*It compares the different issues that China and America cities face,and analyzes specific forms in which commercial, residence and public landsare organized according to the TOD community model. The question s of whether or not these methods are appropriate for development of cities in China and how they may be shaped to better address the issues of China have also been discussed this analysis.

The thesis not only reviewed the TOD studies by the Chinese scholars in past, comparing the current situation between China and America, but it also proposed new principles by combining other theories outside of TOD. The literature review and analyses of Chinese cities are the main contents of the thesis. The principalChinese cities that are studied in the thesis include Beijing, Wuhan andShenyang.Building on theseanalyses, this thesis outlines several issues that should be addressed in the development of Chinese cities.

CHAPTER 2
LITERATURE REVIEW

Literature Review in America

City BeautifulMovement and Park Movement

With the most developed science and technology, America has gone beyond other countries in many fields. While, urban sprawl and suburbanization problems have become more and more significant, achieving a more sustainable development pattern is a current challenge. The reasons behind these issues are various and the methods to address these problems are also different. Through the influence of European planning and landscape trends, and the thinking about the influenceof the native environment, American urban planning supported relevant design concepts to address these issues in different historical periods.

At the end of 19th century and the beginning of 20th century, the “City Beautiful Movement” affected urban planning as the dominant trend and motivating force in America(S.Lewis). The City Beautiful Movement rose and spread first in Europe, with thegoal of addressing the loss of the urban center caused by the emerging suburban trend. The movement emphasized respect of the natural landscape and the importance of rebuilding the relationship between the urban and natural environment. The movement spread rapidly in America after the “Plan of Chicago” was developedby Daniel Burnham in 1909. Even though the plan was not realized for various economic reasons, it influenced the urban planning by recovering visual order in the city, harmonious beauty, and the baroque design concept.

Another movement that intended to address the relationship issues between nature and urban is “*Garden Cities of To-Morrow*”(Howard, 1946). The concept was

presented by Robert Owen in 1820, but increased in popularityafter 1898 when a Howard's book was published offering, among other things,principles for improving the traffic congestion situation in London, Frederick Law Olmsted Sr., the father of American landscape, was a leader of "The Parks Movement" in United States. One of his representative works is Central Park on Manhattan Island in New York City. He was also the master-mind behind the Boston Park System. The objectives of his works could be summarized as:

> First Olmsted urged a comprehensive approach; that is, the plan should always be seen as part of the large whole, taking into consideration the entire surrounding city, town, and its probable future growth. Second, he advised laying out streets in accordance with natural topography. Last, Olmsted was intensely concerned with providing a comfortable environment for residents, recommending lot and street layouts that favored the pedestrian and the provision of substantial open space to soften the urban edge." And "He believed every large city should have a variety of public grounds, including but not limited to, a large "country park", all integrated systematically into the greater city or town(S.Lewis).

In the United States, the City Beautiful Movement intended to achieve new cities with something approaching a cultural parity with the great urban centers of older European cities with a Baroque style design.Olmsted and his "Park Movement" were also influenced by the Idyllic style and Beautiful picture style from Great Britain. It is not hard to see thatthe history of city planning and landscape design in United States was significantly influenced by European culture. These movements, as the history of the development of city, left many precious heritages to urban construction stage. Although the City Beautiful Movement and Parks Movement have their historical limitations from the perspective of today, it is undeniable that these movements advanced urban planning and landscape design, and revealed the human desire for the harmonious coexistence with the natural environment.

Effect of Car Use on American Life

In 1993,with the increasing car use and traditional neighborhood community disappearing, American urban planner Peter Calthorpe put forward the transit-oriented development,or TOD concept. He hoped that through a combination of new land use patterns and public transportation, Americans would be encouraged to travel on a "Transit + Walk" form of transportation, reduce car use, and return to traditional neighborhood community life. This would solve the problems of large cities, suburbs and ecology in America.

Since the Second World War, family units had moved to the suburbs and urban centers had become places that just supported more jobs in America. Along with the development of the car industry and the spread of American highways, traffic did not limit the urban spread to the suburbs with low density. On the contrary, more people enjoy the convenience brought by the modern life style. But problems caused by a great deal of car use cannot be ignored.

> For example, fuel consumption is largely a result of sprawling land use patterns that compel use of the car. The U.S. transportation sector burned 19 percent more fuel in 1989 than in 1973. In the last twenty years, while the California population increased by 40 percent, the vehicle miles traveled have increased by 100 percent. We are driving more and we (and the environment) are enjoying it less. But the form of our communities gives us few viable alternatives(Calthorpe, 1993).

At the same time, few people realized that it is the increasing car use that causes people's living habits to change, andled to the disappearance of community centersandneighborhoods. As Calthorpedescribes:“The car is now the defining technology of our built environment. It sets the forms of our cities and town, dictating the scale of streets, the relationship between buildings, the need for vast parking areas, and

the speed at which we experience our environment.” In addition, the use of the car also suggested more travel, and this is primary cause of the urban traffic problem.

There isnot only the problem of traffic and energy consumption, but also the problemwithlife style and social interactionaspects emerge under the increasingdependence on car use. Peter Calthorpeshowed that: “there is a growing sense of frustration and placelessness in our suburban landscape; a homogeneous quality which overlays the unique nature of each place with chain-store architecture, scale less office parks, and monotonous subdivisions. These qualities are easily blurred by speed we move and the isolation we feel in our cars and in our dwellings.”

Generation of Transit-Oriented Development

Peter Calthorpe put forward, in the face of growing car use and the disappearance of city centers that it has brought, that we should make clear what the city and community should be as we attempt to restore them.

> The traditional American town had walkable streets that led to close and useful destinations. The streets were narrow, with sidewalks, and tree-lined. They were fronted by porches, balconies, and entries rather than garage doors and driveways. They allowed through traffic but slowed it with frequent intersections and frugal dimensions. There were no collector streets, complete with soundwalls, and cul-de-sacs. Privacy was maintained through layers of space rather than barriers. security was provided by eyes on the street rather than gates and patrols(Calthorpe, 1993).

At the same time, the community public green space was also be replaced by private land gradually, even though these green space and open space worked as meeting place and occupied the central location of the community. So,“rather than isolated and residual spaces, the commons should be brought back to the center of our communities and re-integrated into daily commercial life. Public spaces should provide the fundamental order of our communities and set the limits to our private domain. Our

public buildings should be proudly located to add quality, identity, and focus to the fabric of our everyday world”(Calthorpe, 1993).

And then we should discuss how to complete the "traditional American street" dream by reducing the car use. Compared with cars use, "bus + walk" way is easier to achieve this dream, and make the urban planning has new direction. In Calthorpe’s opinion, “to walk or take transit is a public act which makes the street a safer component of community; to drive is a private act which turns the street into a utility. The former leads in many ways to richer public domain, the latter to the world we come to know, if not love. The loss of variety in these modes is both the symbol and the reality of a loss of balance between our private and public lives.”

Three general principles compose Calthorpe thoughts as the basis: “first, that the region structure of growth should be guided by the expansion of transit and a more compact urban form; second, that our ubiquitous single-use zoning should be replaced with standards for mixed-use, walkable neighborhoods; and third, that our urban design policies should create an architecture oriented toward the public domain and human dimension rather than the private domain and auto scale.” The specific method to guideurban planning is the Transit-Oriented Development (Figure 2-1).

In summary, the principles of Transit-Oriented Development are to

- Organize growth on a regional level to be compact and transit-supportive;
- Place commercial, housing, jobs, parks, and civic uses within walking distance of transit stops;
- Create pedestrian-friendly street networks which directly connect local destinations;
- Provide a mix of housing types, densities, and costs;
- Preserve sensitive habitat, riparian zones, and high quality open spaces;

- Make public spaces the focus of building orientation and neighborhood activity; and
- Encourage infill and redevelopment along transit corridors within existing neighborhoods(Calthorpe, 1993).

Many architects and urban designers thought about how to rebuild human-scale communities based on qualities of “village life” when faced with excessive automobile use in metropolisesduring the last century(Fulton, 1996). In addition to transit-oriented development and New Urbanism principles, a number of other principles have been proposed to address the issues of urban development. One such concept is “Green Urbanism,” as proposed by Timothy Beatley. Green Urbanism shares many of the tenets of New Urbanism.It proposes to plan and design cities, villages, and communities with similar methods and principles of sustainable design and development. It also intends to restore traditional neighborhood forms and reduce car use. It differed from New Urbanism, however, in that it claims that what “we need today are cities that reflect a different new urbanism, a new urbanism that is dramatically more ecological in design and functioning and that has ecological limits at its core”(Beatley, 2000).Beatley agrees to address transit, working, and living requirements on a regional scale, however he emphasizes the primary goal of Green Urbanism is “to greatly reduce the ecological footprint of cities, to live within the limit of local and regional ecosystems, and to acknowledge that in a host of ways the decisions in one city affect the quality of environment and life in other places, as well as the overall health of the planet”(Beatley, 2000).

Brief Summary

It is not hard to see that the aims of TOD mode proposed by Calthorpe would reduce car use with public traffic guidance development as the means; restore

walkable-friendly neighborhoods as traditional form with higher qualities of lives in both communities and cities; reorganize the organic relationship among transportation, community and human being by meet the residence's requirements of life and recreation with prosperous community commerce and multipurpose travel. So that the disorder sprawl of urban could be avoided and the sustainable development could be encouraged.

Literature Review in China

China's Urban Transportation Development Trend

Since it was proposed theTOD concept, has been appliedwidely in the United States. This concept began to appear in China's academic journals from 2000. In the recent decade, municipal administration, transportation, urban planning and some other academic ranges expounded and analyzed TOD and have promoted the use of this principle to address the issues in Chinese urban development. Among these, many articles and books discuss the TOD methods and the development direction in Chinese cities which will be discussed in this section.

Differing from America, China has a large number of people and a small amount of land to use, the density of population is high. Consequently, public transportation has played an irreplaceable role in the decades of urban planning cycle since the country was founded. The introduction of TOD concept injected strong invigorating for domestic public transport development, including a rail transportation and Bus Rapid Transit system (BRT). At present, about 20 domestic cities are currently in a railway construction process, working to solve the urban traffic problems through the development of public transport.

Facing the growing use of private cars, Chinese cities have realized that in the near future, even at present, some urban traffic systems are crumbling. Although the inventory of private cars in China is not as much as in the United States, and the dependence on existing public transportation of most large and medium-sized cities in china is beyond the United States, the impact of private cars use on Chinese urban traffic still cannot be ignored. The pace of road infrastructure construction cannot keep pace with the growth demand caused by the increasing motor vehicles. In additional, the construction of road facilities will encourage more people choose car travel, which means the constantly expanding road facilities will reach saturation soon and road congestion will become a normal situation(Jiang & Han, 2009).

If the measure to address city traffic congestion is making the roads wider or constructing new roads to develop the emerging towns or villages, the results would be a further stimulation of the use of private cars, a rise in travel and the arrival of cars more powerful; cannot produce effective use in the node along the road land, while a new and wide road will be needed for development after the development of land in narrow range so that the investment of public infrastructure construction will be higher; cannot gather bus passengers will result in the feasibility of economy fall when the high capacity rapid public transportation would be constructed(Jin, 2006).

In 2006, Fengjun Li, the chief engineer of ministry of construction subway and light rail research center, said: In the large cities, development strategy of rapid rail and rapid bus transit oriented city should be set; in large and medium-sized cities, development strategy of rapid bus and general public transit oriented city should be set; in the large cities, the investment strategy of road and bridge oriented urban infrastructure

construction should be turned towards the investment strategy of public transit oriented urban infrastructure construction as soon as possible; in large and medium-sized cities, the investment strategy of road oriented urban infrastructure construction should be turned towards both the road and public transit oriented urban infrastructure construction step by step(Li F. , 2006).

Development of TOD in China

By May 2006, more than 100 articles discussing TOD had been published in Chinese academic journals. Some of the opinions in these paper deem the TOD as having little significance on Chinese urban development because the numerous differences among Chinese and American cities; however, more scholars believe TOD is a good concept and should be adjusted to conform to China's urban development strategy. Thus, the scholars who support TOD have begun to research guidelines that suit China’s situation under the original guidelines proposed by Calthorpe. Such as Jiang, Y., and Han, S.

The current traffic problems in China cities areon the one hand the traffic system itself, and on the other hand is the functionallyunreasonable layout of the cities. There are many new investment and development zones, industrial estates and single function communities. This fragmented land use makes residents’ lives inconvenient and, at the same time, rapidly increases the daily travel requirements of residents, which puts the urban traffic system under higher pressure(Jiang & Han, 2009).Addressing traffic problems with a single traffic method is not enough, due to the complexity of the traffic problemirrationality of the transit system itself, and the master plan and land use of the city. From the city master plan to community development, and then to regional land

use and landscape environment, the reasons go throughmacro,medium and micro scales.

Calthorpe divided TOD communities into two levels, urban TOD and neighborhood TOD, in order to solve development problems at different levels. Although scholars in China often ignore the differences between these two levels, the funny thing is they go to their bowed to discuss the favorite aspect.

Some scholars such as Lu, H., and Zhao, J.have dictated that planning of rail transportation development must be combined close with the urban planning on a macroscopic level, with urban design and zoning planning on a medium level, and with land use planning on a micro level.

On macro level: in the overall urban planning stage, when we make urban development goals, clear urban development axis and distribute population and the industry layout properly, at the same time, we should also plan a reasonable urban rail network layout and line direction, in order to lead the city to expand orderly.

On a medium level, the relationship between region and urban should be considerate adequately. First, the node on rail line, according to the urban planning and land use status, must be located at a site near a high strength and high density development area. Second, regards to the rail line direction and nodes layout, a comprehensive planning for residential, commercial office, business and other land types along the rail line is required, so that the various types of construction land scale could be balanced and both dense and open spaces of the community could be arranged reasonable.

On a micro level, determining the plot of land property and development intensity according to the geographical location is critical (Jiang & Han, 2009) and the distance from the transit station (Lu & Zhao, 2008).

Also some scholars such as M. Zhang and J. Liu,have proposed a TOD suitable for China's urban include five aspects characteristics:

- Differential Density: Emphasizing it is differential density but not density itself makes TOD density principles apply to different cities or different regions of a city;
- Dockized District: Emphasized to reduce mental distance through the improvement of walking environment, and expand the scope of the influence of public transit;
- Deluxe Design: Emphasize the high standard and detail design of TOD. Design should not be limited to the environment; it should also include the platform, entrances, schedules, vehicles and traffic site equipment of transfer connecting;
- Diverse Destination: Concept of balance between employment and living is the key, and the balance should be kept in every commute community along the transit corridor;
- Distributed Dividends: government should bring back all or part of the economic benefits because of public investment and the low price ascension, and redistribute them(Ming & Jing, 2007).

Rather than exploring how to solve the problems of heavy traffic in cities through public transport alone, these improvements point out the issues thatshould be noted when we construct or rebuild the TOD communities in China more specifically. It seems to be closer to the original concepts of Peter Calthorpe.

Brief Summary

Through the TOD principles proposed by Calthorpe, it is not difficult to find that: TOD is used to address the urban development issues in America;the final objective is to propose an impact community form and provide high quality lives in communities and cities. Reducing car use is one method to achieve this objective, because the disorder of urban sprawl and dispersive construction are caused by the masses of car use in a

large extent. Calthorpe attaches great importance to the interpretation of space form, and integrate space and land use with building, community, area, city and other different layers, in order to achieve the goal of changing people's travel habits.

While, when the TOD concept was proven to becompatibly implemented in China, to the main approach has focused addressing traffic congestion with public transportation and less on developing strategies to improve the environment quality and change the people's travel habits. Additionally, scholars turned their attentionto the developed regions or cities, and what can be done to alleviate traffic pressure with public transit system. In another word, Transit-Oriented Development (TOD) haschanged into Development-Oriented Transit(DOT) in China.. How to address traffic problems as the objective of TOD in developments of Chinese cities became a focus for research. But the TOD principles are not the fundamental ways to solvetraffic problems.

Three issues emerge as critical for study:

- The discussion of facing to Chinese city development, whether the traffic problem can be solved through TOD is necessary;
- The comparisons between USA and China under all TOD guidelines are necessary;
- Seeking a way of region planning for healthy and sustainable life style under the Chinese background is necessary;

This article will talk about these three issues, rethink china's TOD development research, discuss region planning with an emphasis humanlifestyle instead of the traffic problems were caused by the completed areas.

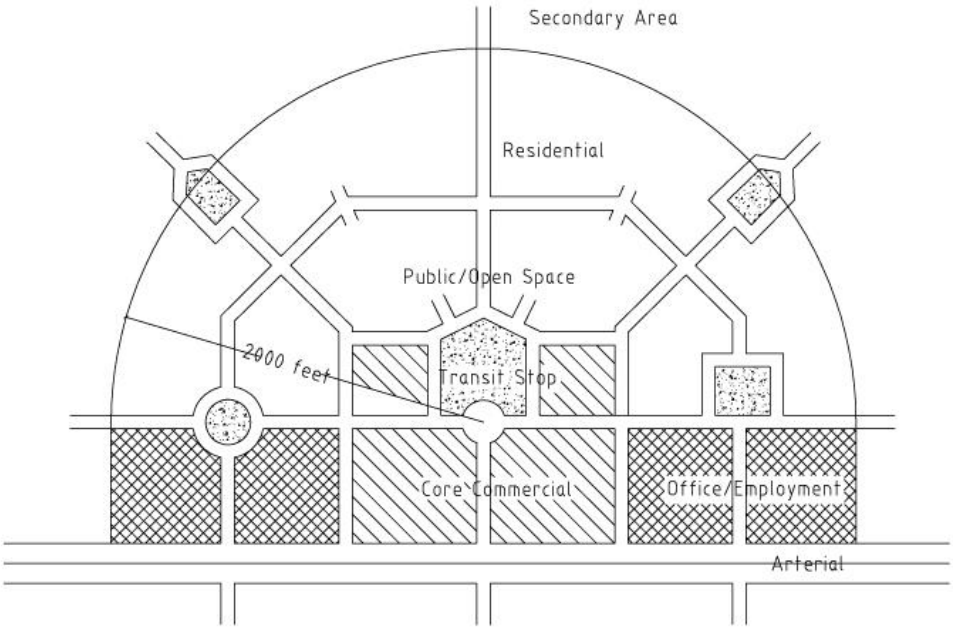

Figure2-1. Transit-Oriented Development community model (Source: Zhang, Y., after Calthorpe, P. 1993. *The Next American Metropolis: Ecology, Community, and the American Dream* (page 57). New York: Princeton Architectural Press.)

CHAPTER 3
METHODOLOGY

The frame work of the thesis is based on literature review, contrast and study, analysis and discussion and summary. It will analyze the specific issues in Chinese urban development according to the Transit-Oriented Development principles and plan methods, tried to research a TOD principle suitable for the development in Chinese cities.

Literature review:*The Next American Metropolis: Ecology, Community, and The American Dream*written by Peter Calthorpe, will be reviewed so that the theory and the basic framework of the core ideas could be understand.In order to study the roles of transit-oriented development in the urban planning of cities in China, a study of the original principles is necessary.

The review the literature about the studies in TOD based on Chinese situation in China, including books and academic articles. This literature review part can make the TOD development in China more clearly. According to these developing theories the author put forward the new opinions so that the introspection of TOD development in China could be proposed.

Contrast and study: The emergence background, development of TOD and the issues it intended to address can be understood by reviewing the literature. China has substantially different national conditions from America, where TOD theory has been used to solve development problems of urban. The contrastive study of urban sprawl and land use between America and China can help to make the Chinese requirements to TOD development clearer.The contrasting population densities of the United States

and China suggestthat the principles of transit-oriented design cannot be applied in the same ways to address the cities of China.

Analysis and discussion: In addition to clear guidelines, TOD principle also supplies specific plan methods and community models, so that it can guild planning in practice. These methods and models include two TOD community modes, three location types of TOD and four kinds of land use. Any of these items should be analyzed and discussed to determine whether it is suitable for use in China. The items suited for Chinese condition would be kept and the items do not suit for Chinese condition would be analyzed and a new idea would be proposed to take the place of them. This part is the main body of the article.In this part, some case studies of projects in the city of Wuhan, China will conduct. Specific projects include Techno Park, Contemporary International Garden, and Luoyu Road, which provide insight into the ways in which transit-oriented development principles have been recently used in China.

Summarize: Some new principles came out when the analysis and discussion be finished. The conclusions will form by summarizing these new principles. In addition, a contrast between TOD community proposed by Peter Calthorpe and corporate compound in plan economy era in China will be done. The last part of the thesis collected all previous results and summarized reference principles then formed the conclusion.

CHAPTER 4
CONTRAST AND STUDY

Urban Sprawl in the United States

In the United States, one of the principal issues that transit-oriented development isintended to address is low-density urban sprawl.

The total area of the United States is 9,826,675 square kilometers (3.79 million square miles), and the land area is 9,161,966 square kilometers (3.54million square miles). According to the statistics by International Monetary Fund, the population in the United Stateswillreach 310 million by 2011 (International Monetary Fund). This will yield an averagepopulation density of33.84 people per square kilometer of land area (87.57 people per square mile of land area) (Figure 4-2). The area of China is 9,596,961 square kilometers(3.71 million square miles), and the land area is 9,569,901 square kilometers (3.69 million square miles). The population in China is currently 1.34billion, yielding an average population density of 140.02 people per square kilometer of land area (363.14 people per square mile of land area) (Figure 4-1).

For comparison purposes, the total surface area of the Earth is 510,064,472square kilometers (196,936,994 square miles), with a total land area of approximately 150,000,000 square kilometers (57.92 million square miles). With a global population of 7 billion, the average world population density is approximately 46.67 people per square kilometer of land area (120.86 people per square mile of land area).

The population density in the United States is lower than the world average index and it is approximately 1/4 of Chinese population density. Not only this, but another point of difference from America is that in China the mountain area occupies about 1/3

of the national land area, plateau occupies 26%, basin occupies 19%, hill occupies 10% and the plain occupies only 12%(Tan, 2006). If we see mountain, plateau, basin and hill as a mountainous area according to human's habits, the percentage that it takes in the whole land in China is approximately 2/3. The Chinese distribute on the second and the third step especially on the third step on the east coastal areas massively. This kind of distribution makes the realistic population density in the east cities much higher.

The United Stateshas the third highest population in the word, behind China and India. When compared with the countries of Asia, however, the realistic population density of the United States is not very high for a large nation land with a flat terrain. Low density urban sprawl appears under the superior natural conditions and accumulation of capital present in the United States. Urban sprawl mainly refers to the residence area sprawl in the suburbs. Because of the high regard for privatization and the private space of the land system, single-family residences have played a very important role in the United States, and this trend is more obvious in the area with more developed economy and superior natural conditions. The combined house and apartment in the center of the city are mostly for lower income people while the private houses with gardens and lawns are the first choice for the more wealthy. Large numbers of these single-family houses occupy considerable land areas (Figure 4-3).

Such large area urban sprawl with low density will not cause issues as shortage of food for the decrease of cultivated land because industry and agriculture are both highly developed in America. It will not cause travel inconvenience either because cars are essential in the lives of its residents. However, people have realized the urban sprawl in this form is not a sustainable urban development pattern. Low plot ratio leads to low

efficiency of land use, masses of car use consume more fossil fuel and brings too much emission that the air has been polluted, the issues also include the boring community function and the shortage of civic infrastructure and so on. In order to solve these issues, smart growth concept was proposed in 2000 in America. This concept mainly advocatesreducingthe urban expansion, constructing concentratedresidential areas, reducing the distance between live and work etc. The core idea is to control urban sprawl by increasing the plot ratio(Network).

The community models proposed in transit-oriented developmentsuggest that the population density should be 10families per acre so that the public transit could work efficiently when the residents travel. This also is beneficial to the development of community economy and reconstruction of the urban or community center. Both transit-oriented development and “smart growth”theories advocate for urban development to improve the efficiency of land use and improve the utilization rate of municipal infrastructure, including land.

Urban Sprawl in China

China is atan important stage in its urban development process. Attracted by an increase in job opportunities, residentsmove towards the towns from the villages, and move towards the city from the towns. These movements lead to the dramatic increases in urban population and the continued expansion of the city in scale. A development mode, the city as the center developed first, and then it drives the towns and then the villages formed.

In the United States, urban sprawl tends to produce low density development patterns. In China, however, high density urban spread is created with city as the center. This has been referred to as a "booth pie" (Min, 2005)mode of spreading.

Traffic is the main problem under this mode. Because of the trust in "ringplus radiation" shaped traffic planning modes, the concept of the "ring" always appear in China's urban planning and development process. The center of the city is the center of the ring, and it is also the place with highest land price and most population. Cities developed with the rings as the center and spread outside circle by circle. Then the "booth pie" mode was formed. Beijing is not the only city in China influenced by this mode, some other metropolis such as Wuhan and Shenyang are defining their urban centers by these rings (Figure 4-4).

The ring roads emphasized the single center of the city. Large civic infrastructures are in the center of the city usually, such as the government, hospitals, commercial centers and banks. The city center becomes attract point of travel in regional scale even in larger scale. Because this center supplies more convenient civic infrastructure and job opportunities to people, the residents gather to such center. In the area far from the center, the land price is much lower and it has less civic infrastructures, so this area becomes a second attract point to the people live in further area. Because the different ratios of attraction and land use, the traffic generates naturally. It just like the air will flow from high pressure area to low pressure area and the wind generates naturally. The urban size continues to expand for the increasing people gather to the center and it forms the urban sprawl.

Land Use

The unbalance development of cities and the urban sprawl issues are all caused by the unreasonable land use.The conception of land use function zoning idea in urban was proposed in*Athens Charter* at first. According to the assertion in *Athens Charter*, the land in city was been divided into four uses as living, working, recreation and

circulation(Corbusier, 1973). The urban land should be divided based on these four functions and each function should be set in the specific land. In the subsequent *Charter of Machu Picchu*, the contact between people and people in the behavior got attention again and became a main element except the functions in urban planning. According to *Charter of Machu Picchu*, a city was treated as a dynamic system. It required urban planners and policy makers must see a city as a structure system in the process of continuous development and change, and denied the stiff, cold and monotonous life breath brought by the function partition(Charter of Machu Picchu, 1977). However, the position of function division concept has never been moved in urban planning and architectural design field. Urban planning remains industrial land, commercial land, residence land etc. even in nowadays.

The function division land is remarkable especially in United States. Central business district, city center, residential area was divided strictly and the corridors to link these lands together are the main street or even higher level roads as interstates. The activities as living, working and recreation are divided in land but connect by circulation. The circulation ignored other activities caused by these three behaviors. It means travel was a single purpose trip in the cars. Because compare to recreation, working seems more important and concentration, it occupies the urban center and other traffic convenience area with some public service places so that the working requirements of residents could be meted; the residence land for living and the recreation land to meet humans' spiritual needs spread towards the suburban. Only few residences appear in the central business district and the prices of these residences are very high.

With the same condition in China, the price of residence is depends on the location. The reason that residences in central area are much more higher than the ones in sub area is the people live in the urban center can enjoy more civic infrastructures and get to their destinations conveniently and faster. The destinations are the companies to the white collars, the factories to the workers, the schools to the children, the shopping mall or markets to the housewives and may be hospitals or community centers to the olds. People depend on these civic infrastructures very much. Everyone hope to arrive at their destination easily and conveniently rather than get into traffic congestion in rush hour or spend hours on send the children to school and back to their work. However, these issues trouble a great number of residents and employees no exceptions even though the people live in the center affording a high price. Although the inhabitants live in these houses occupy more superior geographic conditions, not all of the residents in these places work near their homes.

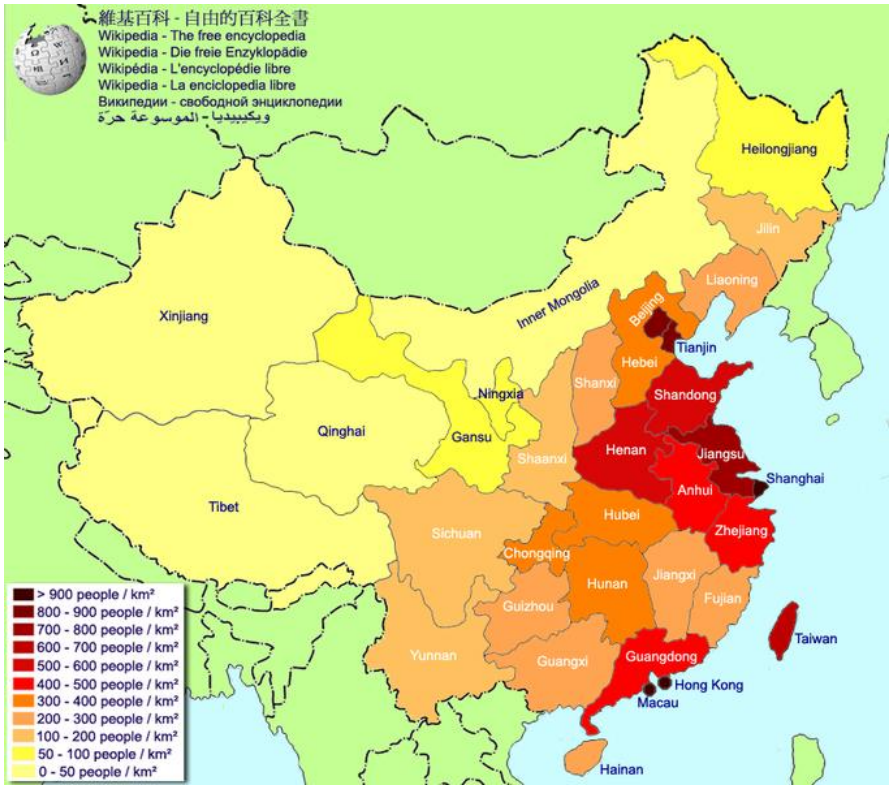

Figure 4-1. China population density (Source:http://en.wikipedia.org/wiki/File: Population_density_of_China_by_first-level_administrative_regions (English).png)

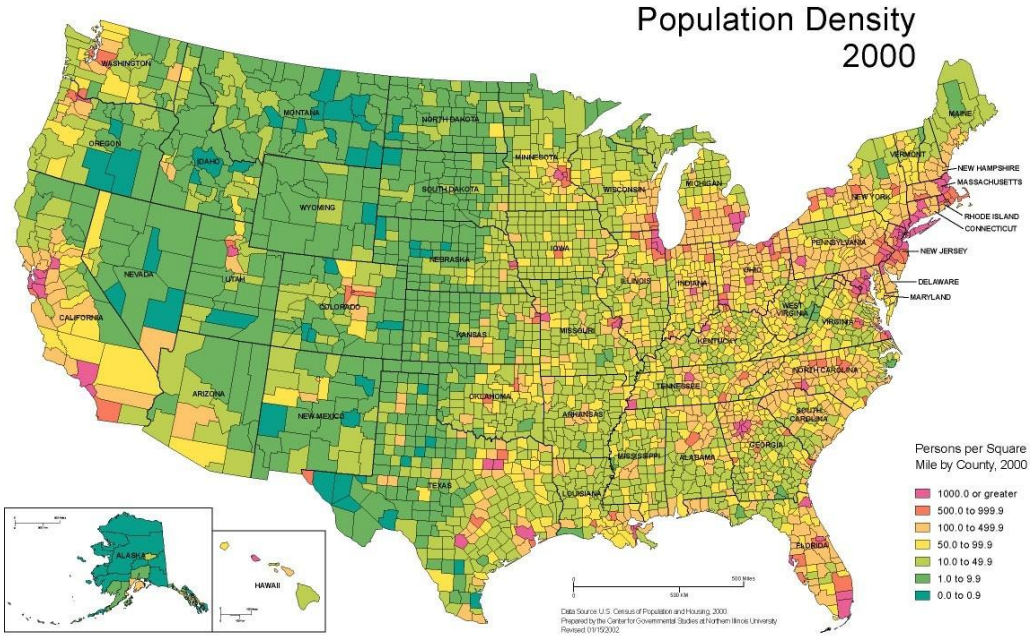

Figure 4-2.America population density (Source: http://www.theodora.com/maps/ new9/usa_population_density.jpg)

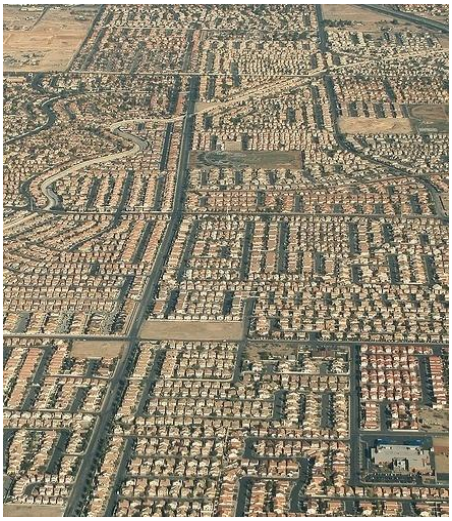

Figure 4-3.Urban sprawl in Las Vegas, Nevada (source: http://www.flickr.com/photos/38037974@N00/893633769/)

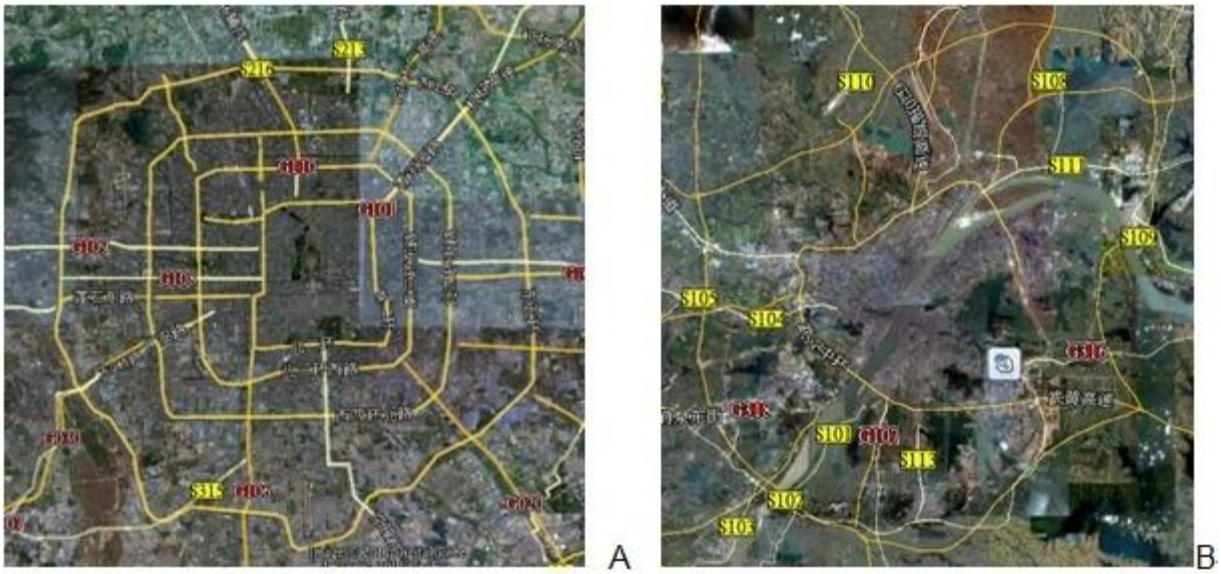

Figure 4-4. Examples ofChinese cities urban sprawl. A) Ring roads in Beijing, B) Ring roads in Wuhan (Source: Google Earth).

CHAPTER 5
ANALYSIS AND DISCUSSION

Two TOD Community Modes

Urban TOD

Urban TOD communities locate at the main public transport network line directly: such as light rail, intercity railway and bus rapid transit station. The land use in urban TOD should include high density commercial center and medium to high density residences.

Urban TOD is used to meet the working, commerce and living requirements. Because it has great value of passengers and superior traffic conditions by locating at main public transport network, it should have an admission of high plot ratio construction. Urban TOD is suitable for the development of crowded job types such as office and business, as well as medium to high density residential area. These two functions should mix together of course.

In China: in the metropolises and big cities, the land along the main public transport route has been used efficiently so it meets the develop requirement of urban TOD. However, in Chinese cities, the main public transport systems coincide with the main streets often rather than the individual public transport lanes and city trunk thought by Calthorpe. It will influence the pedestrians' environment directly and also not good for encouraging people to use public transit and reduce the car use.

Wuchang district in Wuhan city, for example, Luoyu Road is a main road in Wuchang district which connected to Hanyang district by Yangzi River Bridge; it is also one road with the most bus routes. There are more than 20 different bus routes from Luxiang station to Jiedaokou station within this road in Wuchang. Many large enterprise,

business and communities are along this road such as Huazhong University of Science and Technology, Central China Normal University, Yamao shopping mall, Wuhan Hospital and so on. Because the Luoyu Road is the city main road and has a huge capacity of cars, the buses go with other vehicles together and the speed is influenced. The “bus + walk” environment does not be formed along the routeSo, in order to divide the bus lanes and other vehicle lanes by rapid urban trunk roads, viaducts, or rapid bus lanes, reduce the effect of cars on buses.

Neighborhood TOD

Neighborhood TOD locates on auxiliary bus line in region, the transfer time by bus from neighborhood TOD community station to a main public transit station should not be more than 10minutes (distance about 3 miles). The function contents of the community should include residences, retail, civic land and recreation.

Compare to urban TOD, the density of neighborhood TOD should be lower and the scale of block should be smaller and body friendly so that the commercial behavior could be encouraged. It requires more employment opportunities in this community as well as the requirements of living, shopping and recreation be meted so that the car use could be reduced by form micro transit circulation. Be different from communities can reflect city structure and style as urban TOD, neighborhood TOD community should attach greater importance to improve people's lives in environmental quality.

In China: in the metropolises and big cities, the public transportation route classifications are clear, the number of motor vehicles on the city's auxiliary streets is less, both these conditions provide good environment relatively to the pedestrians. But at the same time, there is not enough municipal and recreation land in these auxiliary regions what instead of that island with many multiple floors apartments.

Liangdao Street in Wuhan, for example, the residents manage small business on Zhonghua Road and Yanzhi Road nearby for living. There are several bus routes go through this region but not too many cars. Even though no specific walkable streets here, the pedestrian environment is pretty good as a result there are many customers walk here. The disadvantage in this region is the shortage of public green spaces and recreation infrastructures.So, in order to meet the residents' requirements of living and entertainmentin regional scale, municipal, shopping and entertainment land proportion in neighborhood TOD must be mixed together.

Brief Summary

The research of the TOD theory currently in China often ignores community construction and pays more attention to solve the urban transportation problem with development of public transport. Urban TOD and neighborhood TOD are the two main carriers of the TOD principles.

Urban TOD should not only meet the plenty of employment and living behavior needs but also reflect the city characteristics and constructions. Such as the region famous for technology, culture, and education should be different with the region famous for business, commerce, and finance. Even though the mixed land use policy will be encouraged to meet people's behavior needs in small region, it not means all different communities should have the same pattern and style. Neighborhood TOD community should pay more attention to people's needs, make the life environmental quality more satisfy.

Locations and Types of Transit-Oriented Development

Re-developable Site

In America, the re-developablesite refers to the regions with single land use with unreasonable planning and low construction quality such as a waste factory or old district within the urban core.

There are also re-developable sites in Chinese cities. Tanhualin community in Wuhan, for example, as the old district in the city center, played as important role in history in business and residential aspects. But the high speed urban development requirement does not allow districts with low density and small scale to remain in the central area where space is in such demand. Districts like theTanhualin communities are the redevelopment sites in China. It's worth noting that the conception “redevelop” here is different from the preservation projects in historic districts such as 798 Art Center in Beijing, the New World in Shanghai, and Moganshan Road in Hangzhou.These districts are historic so they need to be protected even as they are redeveloped to become cultural tourist destinations. Redevelopment in TOD often means to redevelop communities and districts with unreasonable land use to improve land use and provide higher densities.

Infill Site

Infill site refers to the low density or undeveloped regions crowded by the urban.

In America, there are many large and open park lots and wild land. The construction density of these regions is low and they do not need to be redeveloped. A new community is needed to infill directly. So it is called aninfill site.

In China, although few large and open park lots exist in urban, there are still some communities with low density such as urban villages. Urban villages refer to: In the

process of urbanization, after all or most of the arable land has been requisitioned, the original farmers changed into residents, they still live in the original village, and the village evolved into a residential area. The density of construction and the level of residents' lives are low in these urban villages. For some historic urban villages, they should be protected and redeveloped but for the villages with no historic value, the infill development could be considered.

What should be mentioned is because the redevelopable site and infill site are both in the urban area, the context regions' functions and constructions should be considered comprehensively when a new project is in processing in these sites. The functions of the new community should be complementarities with the existing ones.

New Growth Area

New growth areas refer to large and pristine areas, usually located in outside of the cities. Such areas are often the original urban green space or farmland. The conditions in America and China are almost the same for new growth areas. Balance development and protection to the ecological environment should be focused on when these areas are developed. Especially in order to avoid urban sprawl, the importance to limit the development within the urban developed boundary should be enhanced especially.

Many metropolises have "economic development zone" or some relative regions in China. The industrial parks and science parks are the main forms in current developed situation, but they all lack of service facilities such as residences or retails. The densities of these parks are usually low because the price of land is cheap and the area is large. In addition, the corridors link these new growth areas are roads for cars. Public transport has not become the main factor yet to share the traffic.

A science park in Wuhan, for example, was built in 2000. The land area is about 915,000square feet, the total construction area is about 646,000square feet, and the building density is 17.5%. According to this data, the plot ratio is just 0.7. In addition, the major function of the science park is office and has little service function such as commerce, residence or restaurant and no bus route. Employees can only choose private cars or commute to get to work. The science park like this is not convenient to the users and it also increases the urban traffic burden. Until to 2009, a comprehensive building with commercial and residential functions was built in order to service the employees in this corporation and the relative parks in the region.

Land Use Types in TOD Communities

TOD is a mixed model for community development. It is located in the middle of public transportation centers and commercial district with a radius of 2000 feet. TOD combines residential, retail, work and open facilities into one pedestrian-friendly space, giving residents and workers a variety of transportation options (bus, bicycle, walking or small vehicles)(Calthorpe, 1993).

Calthorpe mentioned pointed out that the "mixed community development model" includes the core business district, residential areas, public land and sub-regions. The four regions combine together to form a community with the core commercial area in the middle, residential areas surrounding that and sub-regions on the outside. Buses can be a main method of transportation by taking people into the center of the community. Residents and workers can walk to the bus stop, thus reducing the reliance on private vehicles.

Core Commercial Areas

The core commercial area is the center of the community and it is responsible for being the public transportation hub among other purposes. Depending on the size and location of the community, every core commercial area is different in its size and level of mixture. Calthorpe divided the commercial businesses into different types, including grocery stores, supermarkets, pharmacies, specialty stores and department stores. Not only are all of these services for the residents in the community, but they may also serve as supplements for neighboring communities. All of these commercial services must be close to the public transportation station in order to serve arriving and departing residents. Also, they must achieve a minimum of 0.3 floor are ratio to maximize the usage of land.

It's not hard to see that the main targets of the TOD commercial area is the residents in the community; at the same time, these businesses may provide job opportunities. Opposite of the concentrated shopping model in the U.S., community commerce emphasizes decentralized and flexible shopping. Most of the retail business is concentrated in shopping plazas, including for commodities, clothing, food, medicine and electronics. Another two types of popular shopping areas are shopping malls and outlets. These shopping areas concentrate different services into one place; they are usually located next to a major road, take up large areas of land and provide an one-stop shopping service. The shopping frequency is fairly low, usually once every week or two weeks. The main transportation method is by car, almost never using public transportation or walking. These shopping areas are closely related to the habits in American life, already becoming the main method of commerce in the U.S.

In China, not only are there “pedestrian-only shopping streets” in large cities, but there are also retail stores everywhere. These stores are usually located next to main streets and not deep into residential areas. These include grocery stores, small supermarkets, restaurants and hair salons. In comparison to the shopping areas in the U.S., although China also has these community shopping areas, they are inadequate in satisfying residents’ demand. In other words, Chinese cities use a combination of decentralized and centralized shopping areas, which has a great advantage in Calthorpe’s model over American shopping areas. However, because the commercial areas are not centralized within the communities, they are not making the residents’ lives easier. They only provide the residents with basic needs.

Making matters worse, modern city residential developments are becoming more residential while business are investing in commercial areas. This has to do with the profits for the investors, and it also has to do with local government policy. Even if these areas are next to major roads, motor vehicles will cause the surrounding areas to be unsafe for pedestrians. Therefore, establishing commercial areas within residential areas is not beneficial for the residents, but it can also raise the value for the land. If these commercial areas are located near public transportation center, they can be more convenient of the residents and bring more business opportunities.

Furthermore, these core commercial areas can bring many job opportunities. For a service-oriented economy like the U.S., they may satisfy residents’ demands for shopping and also give residents many employment opportunities. However, unlike the U.S. economy, China’s economy is still reliant on agriculture and manufacturing (Table 5-1). With recent developments, but China’s service sector has also grown significantly.

According to “China Statistical Yearbook, 2010”, the ratios among China’s three major sectors went from 70.5 : 17.3 : 12.2 in 1978 to38.1 : 27,8 : 34.1 in 2009(Yearbook, 2010) (Figure 5-1). In some cities, the service sector has taken over first place. For example in Beijing, the ratio has changed from 1.4 : 29.5 : 69.1 in 2005 to 1.08 : 26.83 : 72.09 in 2007 (Figure 5-2).

The core commercial areas not only include retail and services, but also combine other types of commercial activities. Compared to independent commercial pedestrian-only streets, these commercial areas do not need to be very large and do not have the goal of attracting as many customers as possible. Its goal is to be spread out near a public transportation center, meet the residents’ everyday needs and balance a city’s development by avoiding commerce-only areas, which can lead to traffic problems and lack of social diversity.

Residential Areas

Residential areas are another important component of a TOD community. Its building density can directly affect the population within the community. According to Calthorpe, neighborhood TOD communities need to have at least 7 households per acre with an average density of at least 10 households per acre. Urban TOD community needs to have at least 12 households per acre with an average density of at least 15 households per acre. The maximum density will be decided on a case to case basis. These recommendations are based on America’s low-density city sprawl problems. In order to encourage the mixed usage of land and provide a variety of building styles, single houses, townhouses and apartment buildings are all mixed in these numbers.

Calculated according to the average household having 1300 squarefeet, the average city-level TOD community’s minimum volume ratio is 0.44; the average

neighborhood TOD minimum volume ratio is 0.30. If these numbers are reached, public transportation in these communities will be effective.

In Chinese cities, for multiple floors apartment communities with a volume ration between 0.8 and 1.2, they are already very nice communities, while it usually reach 1.2-1.5; for the communities with multiple-high rise apartments, the volume ratio can reach 1.5-2.0; the volume ratio can reach 3.0 or even higher in a high-rise apartment community(CCDI, 2008). A multiple-high rise apartment community in Beijing, for example, the land area is 880 acre and the total binding area is about 1430 acre, the volume ratio reach 1.55.

This means that the minimum ratio will not be a problem for the public transportation system in China. In fact, the over-development may bring more pressure to public transportation and other methods of transportation. In comparison to America's mostly single-house model, Chinese cities mostly have high-rise apartment buildings. The ratio between single houses and apartment buildings in U.S. cities is around 60% : 40%; in Chinese cities, there are essentially no single houses. However, this does mean that Chinese communities have reached the standard of TOD communities.

Single-purpose residential areas have tempted personal vehicle use and have cause an imbalance in urban development. Developers are looking out for their own interests by mixing different types of residential models in one community, which can bring different types of residents in, causing negative social effects.

Additionally, in the U.S different from in China, some developers will both sell and rent residential units to consumers with different needs. At the same time, the developers will be in charge of community property management create a good

environment to attract more customers to rent their units. Residents can choose base on their work or study needs and facilitate their lives. This unit is also called "subsidiary unit." As the developers of these subsidiary units are also in charge of the management, the operating conditions can easily be controlled, forming a beneficial cycle. This is especially true for low-income residents who cannot rely on car travel, making their lives more convenient.

According to 2010 U.S. Census Data, the number of housing units reached 131,704,730, with 11.4% vacant, 56.1% owner occupied, and 23.5% renter occupied.This meansthat there were 30,950,611 units occupied by renters in the United States. In Florida, there were a total of 8,989,580 housing units, of which 1,357,426 (or 15.1%) were renter-occupied(Mazur & Wilson, 2011).

China's urban housing prices have been a topic of heated discussion. For many young people, having the right to own a house for 70 years is not easy, especially in urban areas. In the face of work-location constraints, they have to solve the housing problem, so they may also choose to rent. Unlike the United States, China has almost no residential rental real estate community and all of the homes are for sale. Rental housing is often through privately owned homes which have been sold. These buyers may have purchase the unit for investment or other purposes, directly causing home prices to increase.

Take Shenyang for example, in 2011, the average price of one square meter of residential housing reached 7,500 yuan, and to buy a 970 squarefeet of residential required 675,000 yuan (excluding transaction tax and loan interest). Calculated by using the age of 70 years, this price is equivalent to 9640 yuan per year. The

970squareftresidential unit costs a monthly rent of about 1,500 yuan, an annual rent of about 18,000 yuan, and nearly double the price to buy a house. Compared to the required one-time payment to purchase housing, rental reduces the economic pressure on the household, which means that the rental market still has huge potential. Moreover, rental is a more convenient option for students and recently-employed. Once people buy houses, it is hard to change its location, but their place of employment is not necessarily as stable as their residence. In other words, even if residents live near the place of employment at the moment of purchase, one cannot guarantee their long-term proximity. In contrast, choosing to rent is more flexible and can save a lot of expenses in terms of time and money.

Returning to the TOD residential area, dreams of creating a "pedestrian-oriented" atmosphere in China's high volume residential areas does not seem feasible, but the scale of streets and communities can still be controlled, even if the building height may be high. Using the core business district as the center, one can arrange high-density residential areas, while providing a variety of types of housing and control over the size of streets and neighborhoods. If you can provide a certain percentage for rental housing, not only can it provide housing for temporary workers in the community, but it can also encourage the developers to sustain the community's environment. All of this is to reduce the usage of private vehicles and encourage developing balanced urban centers.

Public Uses

Traditional public land, once used as a meeting place for the community center, is now gradually being replaced by the expansion of private land: including shopping malls, private clubs, and isolated communities. As part of our most basic public space, streets

have been used as parking facilities, and our private world is becoming increasingly isolated in the garage door and the behind courtyard walls.

Relative to the U.S. model of low-density cities and communities, Chinese urban development is more concentrated, with higher building densities. At the same time, public spaces are relatively smaller. The U.S. experience has confirmed that a large amount of car use will lead to a significant loss of public space, which leads to fractured neighborhoods and reduces community retail businesses. In both China and the United States, public spaces seem to have been neglected.

In the U.S., although there is much land, public spaces are often replaced by large shopping malls and large areas of parking lots. Within individual communities, public land is only built to attract tenants for the pool or gym. The caveat here is that public land includes not only public green space, but also community parks, squares, libraries, theaters, post offices and other municipal services. These buildings should be located to facilitate residents in the community. Of course, not every community should have such comprehensive facilities. Neighboring communities can complement each other's facilities improve the efficiency of land use.

In Chinese cities, there are more and more isolated residential areas. These areas are segregated by walls from the outside in order to make the community more secure and more independent. These communities may provide entertainment areas, public greens and other public spaces. However, these spaces are built upon isolated left-over land from residential buildings and they cannot form a buffer zone, let alone separating the streets from the residential buildings.

In the Contemporary International Garden community in Wuhan, China, a large community sport park becomes a point of attraction for customers and visitors (Figure 5-3).However, the sports park is on the edge of the community, occupying unbuildable land located along a high-pressure roadway corridor. As a result, only some fitness equipment and simple infrastructure are needed to compose the park. It did not activate the residents' use because it was so far from the community center.

Public spaces should be easy to reach, located near the core commercial area. The day care, library, police station and fire station should also be near the center, next to the public green. However, large parks and greens should not be in the center as that will cause a separation between the core commercial area and the residential areas. On the same note, other large facilities should also be built on the sub-regions in the outskirts of the community.

Due to urban expansions, cities lack large parks and greens; this leads to poor air quality and severely disrupts the ecosystem with the cities. This is why Central Park in New York City has been recognized and approved by urban designers around the world. Of course, only a large green park is not enough to sustain a city's ecosystem; it requires more public green spaces and community parks at every level of the city.

Secondary Areas

Secondaryareas are usually located further away from the public transportation center, located outside of the core commercial area and the public green. According to Calthorpe, there are three types of secondary areas: 1) Those areas located near the public transportation center but separated by a major road; 2) Areas located far away from the public transportation center, and separated by a major road; and 3) Areas

located away from the public transportation center, but next to the TOD community (Figure 5-4).

In the first case, since it is located close to the public transportation center, the area can be used for high-density employment area. In the second case, the area can be used for low-density single-house style housing. The area can also be used for other low-density residential housing, schools and community parks.

In other words, second areas can also be used for office and residential use, depending on its proximity to the public transportation center. Since commercial businesses in the second areas would not directly compete with the business in the core commercial area, these businesses can serve as supplements and help with the supply. The majority of the second areas are still residential.

Clearly the secondary area in the U.S. protects land for single-family homes, but for Chinese cities, it is used for much higher density of development. Although the secondary areas are away from the bus station and the building density should be reduced, it is typically not reduced to allow the existence of independent homes. Lower building density can provide a better living environment for the community. Because of the presence of single-family homes, these secondary areas within the community in the United States place even fewer restrictions on private cars. However for Chinese cities, building a more pedestrian-friendly community environment is more conducive to the development of secondary regions.

Moreover, in order to improve the traffic situation within cities, one can place more employment facilities such as city government, offices and small factories in the secondary areas, providing additional employment support for the TOD community.

For secondary area property density, Calthorpe anticipated 7 households per acre, which is a standard that Chinese communities can easily reach. The biggest problem Chinese cities face is the expansion of urban areas without taking into consideration the public transportation system. Since residents are not able to rely on walking or bicycling, a large number of private vehicles swarms into the city's center, causing today's traffic problems. Developing mixed community styles instead of isolated residential areas will not only benefit balanced developments but also reduce traffic circulation and develop more harmony and trust among neighbors.

Table 5-1. Number of employed persons at year-end by three strata of industry (Source: China Statistical Yearbook, 2010).

Year	Total Employee NO. (10 Thousand)				Percentage		
		Primary Industry	Second Industry	Tertiary Industry	Primary Industry	Second Industry	Tertiary Industry
2001	73025	36513	16284	20228	50	22.3	27.7
2002	73740	36870	15780	21090	50	21.4	28.6
2003	74432	36546	16077	21809	49.1	21.6	29.3
2004	75200	35269	16920	23011	46.9	22.5	30.6
2005	75825	33970	18084	23771	44.8	23.8	31.4
2006	76400	32561	19225	24614	42.6	25.2	32.2
2007	76990	31444	20629	24917	40.8	26.8	32.4
2008	77480	30654	21109	25717	39.6	27.2	33.2
2009	77995	29708	21684	26603	38.1	27.8	34.1

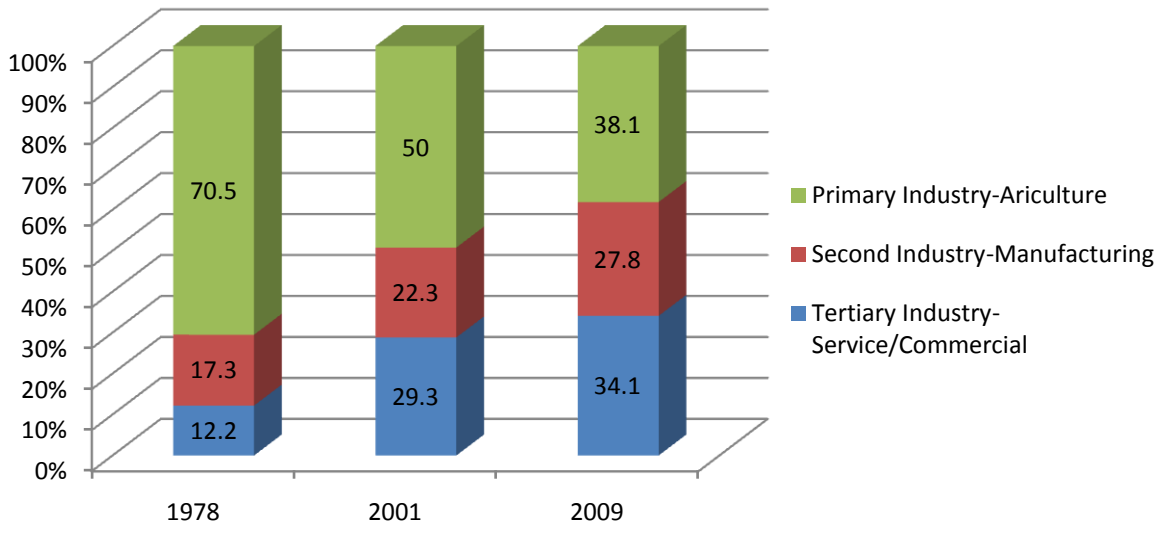

Figure 5-1. Ratios among China's three major industries in 1978, 2001 and 2009(Source: Zhang, Y)

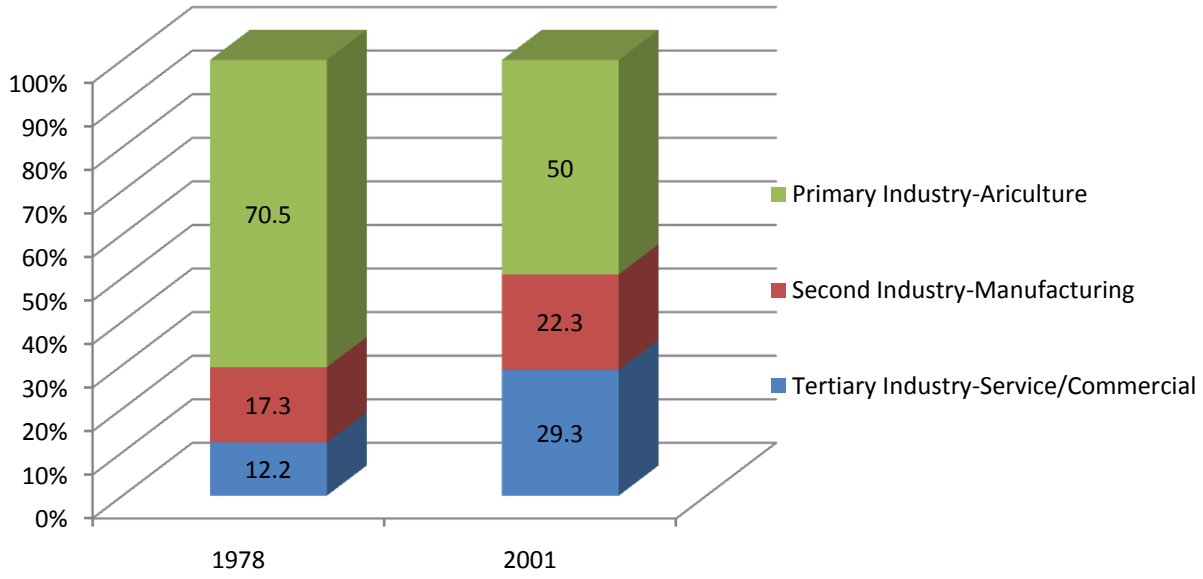

Figure 5-2. Ratios among Beijing's three major industries in 2005 and 2007(Source: Zhang, Y).

Figure 5-3. Green space under a high-pressure corridor (Source: Author annotated image from Google Earth)

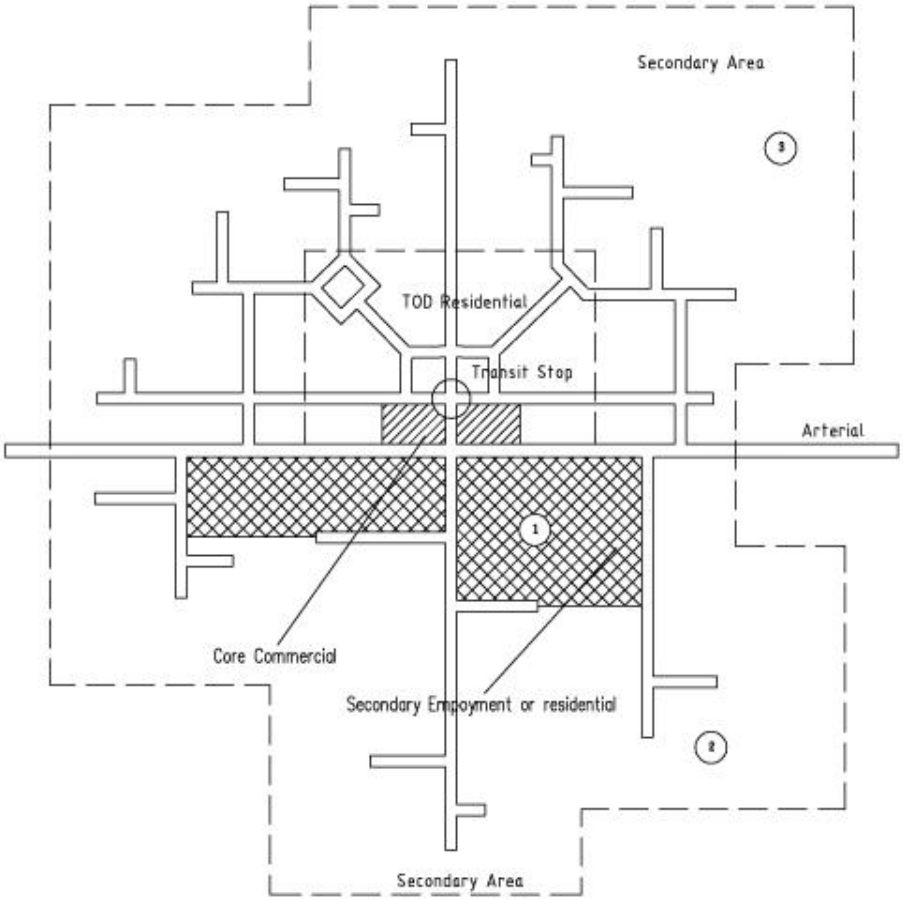

Figure 5-4.Types of second area (Source: Zhang, Y., after Calthorpe, P. 1993. *The Next American Metropolis: Ecology, Community, and the American Dream* (page 87). New York: Princeton Architectural Press.)

CHAPTER 6
RESULTS

Relationship between Land Use and Transport

Transportationevolved because of human's travel requirements and the travel requirements relate to living requirements. Ifthe living requirements of life are satisfied on a "region land scale", transportation could be reduced or even avoided(Li & Liu, 2005). The "region land scale"that we talk about is a wide concept, because different living requirements should be meted on different regions or scales.

For example, if one room can satisfy both sleeping and eating requirements, the user does not need a divided bed room and dining room; if one building can satisfy both working and living needs, the users do not need to get to their work by bus or cars; if one community can satisfy all shopping, retreatment, living and working requirements, the residents do not need to go outside of the community; if one city can satisfy commerce, business, production, working, educationrequirements, the residents can live in it without needing to makelong trips.This conceptexplains the influence on transportation of destinations and travel forms on different scales. A room is on a building scale and it can be arrived at by walking; a destination on a bigger scale as a community or even a city, will need bicycles, cars and rail transit forms to accessed; if the scale expands from city to city or country to country, the new transportation modes such as trains and planes will be required. However, the transit from used most widely on all these scales is the car, and at the same time, car use is causing increasing traffic issues.

Coming back to the four basic city functions, in other words the relationship of humans among living, working and recreation, the three aspects which influence cities' development problemsare the land use, lifestyle behaviors and traffic patterns.

However, among land, behavior and traffic, as the basic activities of the city dominos,"behavior" should be the main element in this triangle model. Land and traffic planning are all for humans' behaviors (Figure 6-1). But the behaviors are often ignored in planning because they cannot be planned directly as land and traffic patterns. This has led to a trilateral relationship into bilateral relations, the relation between land use and traffic(Zhang Y. , 2011).

Influence on Urban Planning of Land Use and Traffic

Traffic is generated because of the residents' travel requirements, while the travel requirements cannot be divided from land useand personal behavior. Different travel requirements combine different land use and the results then generate different traffic needs. The main traffic issue in China now is the heavy pressure caused by car use instead of pedestrians or bicycles. Behaviorsproduced by a good community walking environment will not make a negative impact on urban traffic;on the contrary, a good walking environment solves a part of the travel needs generated by the entertainment demand for the motor vehicles.Currently China cannot supply enough employment opportunities by the activated community commerce as the description by Calthorpe. But it depends on family structure and industrial structure the issues raised by these proposals cannot be ignored in a sustainable urban planning approach.

Behavior and Scale

Human behavior isinfluenced by the environment, which triggerstransportation events. This means the city character is a planned reflection of the behavior. The activities of humans who live in 450square feet apartments are different from those who live in 1200square feet apartments. Because the area people live in is so small that they only sleep or rest at home, the entertainment behavior is usually out of the apartment, and more public spaces will be needed(Zhang Y. , 2005). In these public spaces, public activities can occur and make a community more active. The buses are usually the first choice of the people who live in these small apartments when they want to travel. Modes such as buses and walking make the community and urban scale match a human scale as environments are more pedestrian friendly rather than the thousand meters block dimensioncreated by car use.

“Corporate Compound” In Plan Economy Era in China

A good example for “city within a city” or Chinese TOD community is “Corporate Compound” in plan economy era. (1949-1992). In plan economy era, many party and government offices and state-owned enterprise are set in certain block or blocks. They were divided from others by walls. The resident of these compounds are the employees and their families work in the corporate. These compounds can satisfy all needs of their users with comprehensive facilities such as working, education, residence, shopping, medical treatment, recreation and diet(Qiao, 2004). The road networks belong to the compound itself and the social vehicles need permission if they want to enter the compound. These roads service the employees and their families in theirdaily lives and the motor vehicles are used for production only. The residents are living in two cities at the same time actually, a small city to meet the daily life requirements and a big city to

satisfy further desires. The requirements of users can be satisfied because the mixed land use and they do not need to go outside physically. This mode reduces the influence to the city traffic.

The TOD communities described by Calthorpe are very similar to these “Corporate Compounds”, and he emphasized TOD communities should be located at public transit stations.The planning form inside the “Corporate Compound” was used for production and it could not satisfy the increasing desires of the residents fora higher life quality level. They are also less and less able to meet the diverse work requirements in modern society. Although the forms of these compounds have been eliminated by the history gradually, but it is still has important reference value on the modern city and community development.

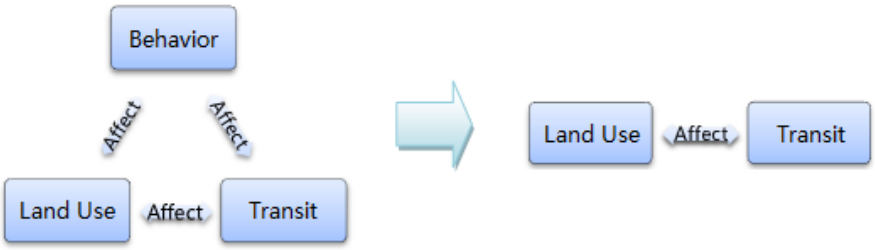

Figure 6-1. Relationship among behavior, land use and transit (Source: Zhang, Y)

CHAPTER 7
CONCLUSION

The core concepts in the future development of public transportation are to raise the quality of living, build friendlier relationships among neighbors and restore traditional community commerce in the United States. In order to reach these goals, Calthorpe offered two solutions: 1) Increase the use of public transportation and reduce the use of private cars by having pedestrian-friendly cities and neighborhoods, and 2) Increase the mixture of land use by satisfying residents' employment and living needs within their communities, thereby improving neighbors' relations and reducing the expansion of low-density city expansion. These two methods both address the issue of excessive private vehicle usage.

A TOD community is a good carrier for the future development of transportation. In this community, residents do not need to rely on small cars to go out; instead, the transportation needs are satisfied by public transportation, which are much more efficient. In this case, the routes and the density of stops of the public transportation systems directly affect the location of the community. One can clearly see that the development of public transportation is not to replace all private cars. It is used as a model for urban planning. Furthermore, this is a model for a city that has multiple centers, each based around a different TOD community.

The biggest obstacle in obtaining the desired development in public transportation in the United States is the low reliance rate on public transportation. Since most American families rely on private vehicles, the public transportation system is not used efficiently or effectively. As a result, investments into public transportation have poor returns and it is very difficult for public transportation to be the leading component in

urban development. Therefore, by placing stops at key locations within the center of a community can make it easier for the residents and improve the building density of the community.

Due to the rapid speed of growth of cities and an inherent large population, traffic problems in China have become a major concern. Since the TOD concept is designed to tackle this problem, this method of city planning has received much attention in China. Different from the United States cities, China's cities have high population and building densities; as a result, Chinese residents rely more on public transportation. However, the idea of using the concepts of public transportation development as a major component in city planning has not been adequately researched in China. In other words, Chinese cities have not used "public transportation" to lead "urban development; instead public transportation is merely seen as a tool to ameliorate the growing traffic problems.

The planning of public transit routes should be the foundation of city development. Some inefficient land use districts and communities should be rebuilt to utilize public transit routes and encourage their use by residents. New communities and projects, especially the ones in new growth sites, should utilize public transit routes as the principal mode of transportation rather than require the construction of new rapid urban trunk roads. The planning of public transit routes should proceed ahead of the development in a region or at least together with it, rather than behind it.

The fundamental problem that Chinese urban development faces is the imbalance in the construction of infrastructure. A change in the mode of transportation (from private cars to public transit) may reduce the traffic problems, but it cannot reduce the

level of need for transportation. Hoping that by simply investing in public transportation will relieve all of the traffic problems is not realistic in the long-run. By ignoring the behavior of residents and simply diving land into different purposes caused the current DOT situation in China. Without question, investment and development in public transportation is extremely important, especially for high-volume, high-speed options. Public transit needs to maintain its dominance in inner-city transportation. In terms of road construction, there should be a shift from expanding major roads into increasing the density of roads. A dense web of narrower streets will limit the use of private vehicles and encourage walking and bicycling. These will all provide the basic infrastructure needed for the development of public transportation.

Governmental agencies and planners should also make policies and strategies to encourage people to use transit forms that can improve TOD or create a pedestrian-friendly environment. These modes of movement may include public transportation and bicycle use, amongst others. For public transit, governmental agencies should consider building bus-only lanes, providing more frequent service, allowing elderly patrons and students reduced or free access, and extending the time during which patrons might travel on public transit after purchasing a ticket. In the case of bicycles, governmental agencies should consider providing an inexpensive or free rental service, the construction of bicycle- and pedestrian-only lanes, provision of more bicycle parking lots, and limiting of car use in some regions.

Furthermore, instead of encouraging a centralized location within a city of investment and commerce, there should be a widespread investment methodology that creates multiple centers in a city. Some of the tools include controlling the over-

investment in already-developed areas and favorable policy that encourage growth of under-developed areas (Figure 7-1 and Figure 7-2). These strategies may include permitting development at a higher plot ratio and subsidizing the cost of the land to incentivize development in particular areas, amongst others. These new communities should have a good mixture of land usage and complement neighboring areas that have already been developed. This way, a community that provide all of the life needs to its residents can be the most effective, reduce the need for transportation and ameliorate a city's traffic situation. Not every community needs to fit the strict model of a TOD community; the key is for every community to truly satisfy the residents' various needs.

At the same time, in order to cater to different types of residents, one should also consider the mixture of residency types. These mixed communities should also be mixed with other facilities in the city, forming open communities and not a closed neighborhood. Safety and security concerns should be addressed by friendly neighbor relations and the use of open public spaces, not by walls and gates. In terms of addressing the rising house prices in China, besides developing multi-center cities, one can also encourage small residency units for renting--an important aspect of affordability in U.S. TOD planning. With the location of residency based on employment and school locations, this is another way of improving a city's traffic problems.Legislation and financial incentives should work together to ensure anappropriate percentage of rental houses.

Lastly, the protection of ecosystems should get more attention during the urban development and community construction process. The ratio of green spaces and continuityof ecological networks cannot be destroyed. The policies and strategies for

protecting a city's natural landscapes and public green spaces must be implemented strictly to make sure that city green spaces will not be encroached on by projects driven strictly by profits.

Public participation also plays an important a role in protecting public spaces and green spaces. A more beautiful environment should be built so that the residents' sense of belonging can be restored, further encouraging them to participate in its protection.

The TOD concept stressed the building of a balanced city with pedestrian-friendly streets, improved employment opportunities and a convenient public transportation system without the pollution from private cars. The public transportation concept is not only a way to develop cities, but it is also a way to provide a higher quality of community living. In the United States and in China, even in other countries, people a healthier lifestyle and a sustainable environment are what people strive for. Urban development should not be limited to one concept; other ideas that fit the background of the TOD concept should also be used, which will allow cities to continue to develop in the right direction.

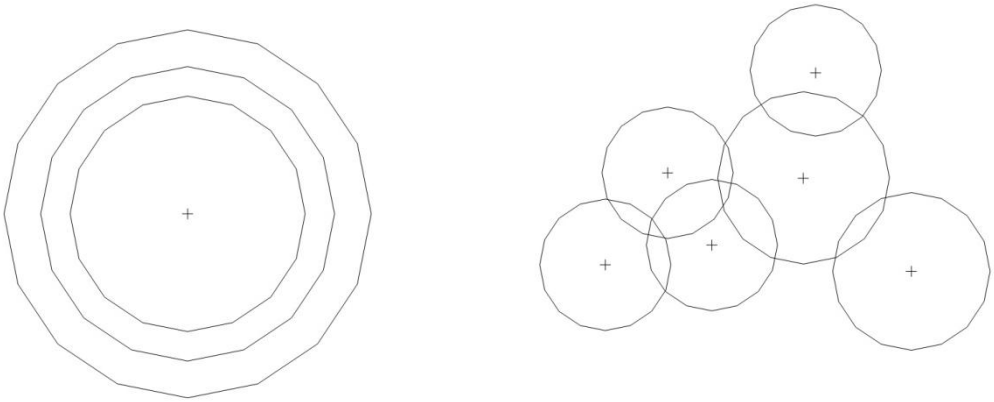

Figure 7-1. Single-center and multiple-centers-urban plans (Source: Zhang,Y.).

Figure 7-2.Single-center and multiple- centers-urban sections (Source:Zhang,Y).

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BIOGRAPHICAL SKETCH

Zhang Yibo graduated with honors from Huazhong University of Science and Technology (HUST) in 2009 with a Bachelor of Architecture. In the same year, he enrolled in the Graduate School of College of Architecture and Urban Planning, Huazhong University of Science and Technology, majoring in architecture. He then enrolled in the College Design, Construction, and Planning at the University of Florida, majoring in architecture. He graduated in December 2011 from the University of Florida with a Master of Science in architectural studies with a concentration in sustainable design. He graduated from HUST in March 2012 with a Master of Architecture. Zhang Yibo resided in Gainesville, Florida and spent most of his time studying, reading and enjoying life.