Sustainable Urban Forms for Chinese Typical New Towns

By

Sunhwa Son

M. S. in Architecture
Ewha Womans University, 2006

B. S. in Architecture
Ewha Womans University, 2002

SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN ARCHITECTURAL STUDIES
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SEPTEMBER 2008

© 2008 Sunhwa Son. All rights reserved.

The author hereby grants to MIT permission to reproduce and to distribute publicly paper and electronic copies of this thesis document in whole or in part in any medium now known or hereafter created.

Signature of Author: ________________________________

Department of Architecture
August 5, 2008

Certified by: ________________________________

Alexander D’Hooghe
Assistant Professor of Architecture
Thesis Supervisor

Accepted by: ________________________________

Julian Beinart
Professor of Architecture
Chair of the Department Committee on Graduate Students
Sustainable Urban Forms for Chinese Typical New Towns

Thesis Supervisor: Alexander D’Hooghe  
Assistant Professor of Architecture

Thesis reader: Julian Beinart  
Professor of Architecture
ABSTRACT

The phenomena of exploding world urban population and sharply decreasing global arable lands are illustrated in contemporary China in a dramatically amplified form. Construction of many new towns in rural areas has been accelerated due to vigorous economic growth and immigration of people to urban areas. Many such new towns deal with their sustainability as a fundamental goal. However, these new towns are not demonstrating whether their urban forms are effectively responding to the principles of sustainability, going beyond plausible visual images. This study, through the application of sustainability principles to the examination of plans in new towns, proposes alternative urban forms for typical Chinese towns constructed in the countryside. Reviewing practices relevant to sustainability, the study draws out the consensus urban models and principles for sustainable development. The paper also investigates how new town plans differ from both historic capital cities and the work units of the Maoist period, classifying them into four types based on featured visual elements. Last, this thesis proposes linear networking compact cities as a model for typical micro-scale towns. Constructing linear urban blocks along an integrated efficient infrastructure, the maximum natural landscape is preserved intact. This study attempts to inspire further studies and attention to desirable sustainable urban forms for Chinese new towns.
Acknowledgements

I would like to express my sincere gratitude to all MIT professors of architecture and friends who have all the while inspired me with further interests and enthusiasm.

Many thanks to Professor Alexander D’Hooghe for his helpful guidance and knowledgeable perspectives in shaping and improving my thesis.

I am grateful to Professors John De Monchaux and Julian Beinart for expanding my knowledge and insight, as well as for their kind encouragement.

Specially thanks to Robert A. Irwin for his continuous help and valuable comments.

I dedicate this thesis to my mother for her unconditional love and support.
Contents

Abstract 3
Acknowledgement 4

1. Introduction 8
   1.1 Rapid Economic Growth and Urbanization in China 8
   1.2 Typical New Town Development and Sustainability 10
   1.3 Thesis Goals and Organization 13

2. Review of Theories and Practices Relevant to Sustainability 14
   2.1 Feng Shui Theory 14
   2.2 Sustainable Urban Design in the Tropics 16
   2.3 Ideal Cities: The Garden City Concept 18
   2.4 Ideal Cities: The Urban Village Concept 21
   2.5 The New Urbanism Movement 22
   2.6 The Compact City Concept 24
   2.7 Conclusion 26

3. Review of Chinese Urban Forms 28
   3.1 Past Capital Cities 28
   3.2 Work Units of the Maoist Period 32
   3.3 Typology of Chinese New Towns 35
      3.3.1 Copies of Western Historic Identity 35
      3.3.2 Garden-centered Grid Cities 40
      3.3.3 Water-based Cities 43
      3.3.4. Compactly-Developed Cities 46
   3.4 Conclusion 49

4. Reconsideration of Linear Group Forms 51
   4.1 Case Study 1: Tel Aviv City Center (1962) 51
   4.2 Case Study 2: Spatial Retaining Bars (1989) 57
   4.3 Conclusion 61
5. Micro-scale Networking Cities for Typical Chinese Towns 63
5.1 Clear Edge :: Urbanity and Nature 63
5.2 Integrated Infrastructure :: Efficient Transportation 65
5.3 Compactness :: The Building Unit as a Mixed-use Block 67
5.4 Expansion of Settlements :: Networking Cities 68

6. Conclusion 69

Notes 72
List of Figures and Illustration Credits 74
Bibliography 80
Biographical Note 82
Sustainable Urban Forms for Chinese Typical New Towns
1. Introduction

1.1 Rapid Economic Growth and Urbanization in China

China is one of today's most vigorously developing countries, looming ever larger in the global economy. Since its open policy and economic reform of 1978, China has been attempting to transform itself, originally an agriculture-oriented socialist country, into a modern industrial one with a market economy. Such fast economic growth and modernization have induced rapid urbanization at the same time, attracting many people and much investment into urban areas. The dramatic increase of the urbanization level reflects this fast growth; it changed from eighteen percent in 1978 to forty-three percent in 2007, and is expected to reach seventy percent of the Chinese population in a few decades (Figure 1). This growth of urban population originates from migration of rural peasants who seek employment and economic benefits, and it accelerates the economic growth by offering a cheap labor force and increasing consumption.

Fig. 1. Trajectory of Chinese urbanization level: Urbanization is sharply increasing and it is expected soon to reach up to seventy percent of the national population. (Source: author, based on multiple data sources (Song and Ding, 2007, 5))
The number of cities has also increased sharply, from 223 in 1980 to 660 in 2002, and most of them have been unevenly distributed in the east coast and the northeast regions due to their geographical advantages. As manufacturing and industrial facilities continue to expand and need additional land, and the problems of the existing over-populated cities increase, the pressure on new urban development also increases, both in the surroundings of existing cities and of suburbs. Considering construction of new towns as an engine to revitalize local economies and to improve living conditions, each municipal government has competitively initiated new urban development projects. In the past few years, many new town developments have been planned at the same time in a similar way, which is that most of them are located in suburban areas around the existing settlements on a small scale, through international design competitions or by invitation of selected architects, being different from “mega,” “major” cities, or “metropolises,” in terms of function and scale. Rapid proliferating of small towns in a short period of time is one of the noteworthy aspects of China’s contemporary urbanization.

Fig. 2 Economic development level measured by per capita GDP in provinces (2004): Chinese economic growth and population have been concentrated on the east coast area including Beijing and Shanghai. This concentration of wealth has been increasing the demand for and speedy construction of new urban areas. (Source: Song and Ding, 2007, 8)
1.2 Typical New Town Development and Sustainability

The winning proposals for such typical Chinese towns have in common concepts and urban templates, especially in terms of eco-friendly and sustainable development. Indeed, sustainable development has become a general agenda and popular “placebo” goal that is used as a slogan everywhere nowadays, due to the crises in both environmental pollution and exhaustion of natural resources. However, the term “sustainability” has a very ambiguous and comprehensive meaning: sustainable development includes “promoting economic progress and improving the quality of life” as well as securing long-term harmony with nature and “saving natural resources” for now and the future.\(^3\) Although debates over the ideal models of sustainable cities are still going on, most commentators agree that sustainable development ought to be a critical goal in the urban environment.

In China, the issue of sustainability is becoming more imperative because an insufficiency of energy resources is becoming a serious constraint on further development. Moreover, increasing demands for a better quality of life conflict in urban areas with congestion and environmental pollution caused by hasty construction of buildings and industrial facilities. That is why many new towns emphasize saving natural resources and maintaining an eco-friendly environment in their design themes.

However, looking into proposed plans, most new towns set out their sustainability concept with ecological images rather than with physical provisions based on sound reasons. Each plan deals with natural features, such as parks, forests, rivers, lakes, or combinations of them, as a main element in the urban structure. Such a preference for an ecologically harmonious city is closely related to the traditional Chinese culture. For a long time Chinese culture has understood
humankind as a part of nature, as well as upheld criteria that respect
the natural order and landscape. Although the term “sustainable
development” has become common everywhere, plans for new
Chinese towns, which are under the influence of legacies of historic
built forms and philosophies and the current socio-economic context,
need different approaches to be understood from those that Western
planning has applied.

Fig. 3 The change of global ecological footprint: Whereas in 1961 only half of the planet earth was enough to
support world population, the human demands exceeded the capacity of the earth over the past forty years.
China’s fast growing resource consumption is accelerating the global demand on the earth’s ecology.
(Source: http://bp3.blogger.com/_0v_EZJS12mQ/RyYNUXWCpql/AAAAAAAADk/reWewBosxtg/s1600-h/
world_1961_sm-eco+footprint.jpg)
Fig. 4 Global trends: each datum indicates that we are standing at an important moment to modify our way of life and development patterns with exploding world population and urban settlement areas as well as rapid change in technology. China is creating a steeper slope for each datum. (Source: MVRDV, 2005, 24-27)
1.3 Thesis Goals and Organization

Given global concerns and crises in contemporary urban settlement, Chinese rapid urbanization on a large scale all throughout the country has great interest and meaning for future sustainable development. This study examines whether these Chinese new towns are sustainable, and then proposes alternative sustainable urban forms for typical Chinese new towns.

In Chapter Two, the study offers a literature review of practices and ideas that are relevant to sustainability. Considering different perspectives and approaches to sustainable development, we understand better how they have been formed and have contributed to developing sustainable models. Accordingly, the study clarifies the current consensus on the fundamental principles for sustainability.

Chapter Three investigates Chinese urban forms proposed in different periods of time, concentrating on formal principles and their sustainability. It deals mainly with three urban forms: the capital cities of ancient times, the work units of the Maoist period, and the typical new towns of the urbanization boom. Many new town plans can be classified into several types. Analyzing their strategies and structures in a particular local context and situation, this paper questions whether the featured elements for the sustainability concept are indeed effective and responsive to the criteria discussed in the previous literature review. This chapter also states which aspects of historical urban forms, maintained within a long history, are pertinent to sustainable development.

Chapter Four briefly introduces a case study of the linear group form as a potential sustainable urban form. By describing two proposals that were designed in different contexts, but with similar linear forms
incorporating compact mixed uses, the study draws out possible built forms responsive to the principles of sustainability.

Finally, as a result of previous review and analysis, this thesis proposes as a model a sustainable urban form for typical Chinese new towns constructed in the countryside. Thus, this analysis of suburbanized urbanization, critical review of new towns, and proposal of an alternative urban form can stimulate further studies of and attention to future urban possibilities.

2. Review of Theories and Practices Relevant to Sustainability

2.1 Feng Shui Theory

The Feng Shui theory, which originated in the Zhou dynasty (1100-771 BCE), has been debated as “mysterious superficial geomancy” or provable “rational principles,” but Feng Shui has been considered a reflection of the ancient Chinese view of the environment and ecology. Its fundamental principles are still relevant nowadays, as Tam et al. (1998) point out, villages or houses known as having a good location according to Feng Shui usually have a profitable advantage in real estate markets in China. Feng Shui (which literally means “winds and water” in English) was used to “determine ideal locations and orientations for cities, palaces, houses, or graves” in order to prevent natural disasters and ultimately to promote inhabitants’ health, wealth, and good luck. As seen in Figure 5, each direction has its own color and material that are connected with particular kinds of wealth, happiness, and good luck respectively.

The ancient Chinese believed that harmony with the natural landscape and following the cosmic spirit “Chi,” which vitalizes everything
on the earth, are the critical conditions for attaining people’s inner peace and happiness. According to Feng Shui, the ideal location for a habitation is “to face south or south-east, gaining benefits from maximum sunlight, and to be surrounded by mountains, and with water to the south of the site” (Figure 6). As Tam et al. claim, the ideal habitat place as determined by Feng Shui is indeed an appropriate place to stand against the monsoon climate in the Northern Hemisphere. Mountains surrounding the site block cold winds from the north, and a southern orientation also helps energy efficiency for heating houses during the winter. Moreover, the mysterious concept “Chi” has been recently recognized to be similar to the earth’s magnetic field. That is, living in accordance with “Chi” and following its flow strengthens the human body and spirit, harmonizing with the cosmic energy on the earth. It is also necessary to heed the flows of water and air as significant factors in the topography of habitat.

Fig. 5 Chinese Feng Shui Bagua Symbol: Each direction having its own color and material stands for a different kind of wealth, happiness, and good luck. (Source: http://www.fengshuifusion.com/images/bagua-feng-shui-colors.gif)

Fig. 6 The Notion of Ideal Site in Feng Shui: The ideal habitat site is surrounded by mountains and facing waters in the south. (Source: Awotona, 1999, 272)
For new town development, Feng Shui can give a hint as to where to place an ideal axis and location as well as how to balance the natural world and dwelling spaces. That is the greatest contribution by Feng Shui to a sustainable way of life. However, Feng Shui can impede logical and efficient use of natural resources and arrangement of road networks or land use patterns because of its transcendental concepts.

2.2 Sustainable Urban Design in the Tropics

Urban design guidelines proposed in the 1980s for warm and humid cities provide a more practical basis and more detailed ideas than Feng Shui to achieve a sustainable environment. Due to their unique climate conditions, tropical cities consider the regulation of sunlight and air ventilation as the most critical elements to reduce discomfort and energy consumption, and they find the solutions through introducing natural features into urban areas on a large scale.

![Diagram](image)

*Fig. 7 Examples of vegetation belts in urban areas: Greenbelts placed in an east-west way block the cold wind in winter as well as uncomfortable setting sunlight from the west. (Source: Schiller and Evans, 1998, 173-177)*
For example, planting vegetation is basic to providing shade and covering the ground to reduce heating from the land. Waterways and pools are also used to modify urban temperatures. This approach also stresses “openness to encourage breezes,” both at a town scale, with “permeable urban structures and parks,” and at an architectural scale, with “pocket spaces between buildings and vertical air-shafts in buildings.” The most recommended feature for tropical cities is ecological open space, which, as a pleasant amenity, is recommended to be “continuous belts of trees and waters oriented with the long axis in an east-west direction” to reduce the thermal impact of the urban center.

The ideas and visions of tropical cities are well described by Ken Yeang as follows:

The image of the Tropical City is one of a tropical urban garden. The metaphor generates the image of a city with natural sun lighting, rainfall, cool breezes, and the close presence of nature in all aspects of the city life. It is a vision of a city in which its public, semi-public and private spaces are lit with diffused natural sunlight, having openness in the planning that permits cross-ventilation, and high ceiling heights to encourage cross wind-flow...

... The landscaping and buildings are not regarded as separate elements, but are integrated at all levels. Plantings are integrated with built structures to give the image of a garden city. Water landscape features are used in conjunction with the prevailing wind to provide cool breezes in interiors and communal areas.

As stated above, general guidelines for warm and humid cities include making comfortable and attractive spaces, and having rational energy use and environmentally sensitive design using the natural environment. However, even though vegetation has good cooling effects,
these cities depend too much on visible green features. Street and road patterns are oriented to encourage the natural air movement accompanying rows of trees but not for the efficiency of transport networking. Moreover, building configurations and density regulations are designed to allow breezes and shade but not for the high density and intensive development that are required to reduce travel distances and to increase efficient land use. The specific climate and topographies of tropical cities limit their appropriateness for urban structures and practices in other parts of the world.

2.3 Ideal Cities: The Garden City Concept

Another idea to integrate the natural landscape and urban settlement is found in the Garden City concept proposed by Ebenezer Howard in 1898. This concept, originating from concerns about the existing cities’ congestion and sustainability, suggests the most important formative idea of modern town planning. Based on a diagrammatic 2.3-kilometer circle for a desired population of 30,000, the concept inspired many suburban developments in terms of a self-sufficient, small, decentralized town that consists of several clusters and hierarchical circulation roads surrounded by a green belt to halt the town’s expansion (seen in Figures 8-10).
Even though the circular shapes in the diagrammatic drawings were not directly reflected in the new construction, the physical characteristics of the plans affected the new towns' layouts with respect to stress on surrounding agricultural lands, a central park, and public space. Indeed, many towns were constructed in England at the time as successful examples of the Garden City concept, such as Letchworth Garden City (Figure 11), begun in 1903, and Welwyn Garden City (Figure 12) in 1919. The Garden City concept also led to the first Green Belt Act in 1938 in England and became a sort of origin of new town development: that is, small towns in the countryside surrounded by agricultural areas to limit their expansion.

Because the Garden City concept proposed a model for a better quality of life in contrast to the congested existing cities, it caused the thriving phenomena of urban sprawl and suburbanization of existing cities after
World War II. However, it is necessary to reconsider its feasibility in several respects. If the Garden City reaches a population of more than 30,000, it is supposed to establish another composite of clusters moving out from the existing town and the surrounding green belt (seen in Figure 10). It is doubtful that the population can be easily controlled according to this scenario and that several different Garden Cities built at close distances can preserve their own surrounding green belts without interference from each other. Furthermore, Howard’s Garden City concept presents relatively low density, 75 persons per hectare, and separate functional zoning, such as housing, industry, and recreation. These low density and separate zoning are contrary to the recently proposed principles of sustainable development.

Fig. 11 Letchworth Garden City in 1903
(Source: http://www.uky.edu/Classes/PS/776/Projects/Howard/g-city20.gif)

Fig. 12 Welwyn Garden City in 1919 (Source: http://cyberium.co.uk/parkhistory/welwyn.html)
2.4 Ideal Cities: The Urban Village Concept

In opposition to the ill effects of urban sprawl and booming modernization all over the world, the urban village group in the U.K. suggested an alternative new urbanism concept in the late 1980s that they called the Urban Village. This concept advocated human scale, mixed use, and medium density within traditional rural village structures, in contrast to the International Style of many modern cities. The Urban Village also encourages public transit, cycling, and walking, based on a walkably scaled community.

Rodwell has directed attention to the ideas of Gustavo Giovannoni (1873-1947), who found sustainability in the context of historic cities. Giovannoni characterized the historic city by its compactness, vibrant streets for pedestrian, close proximity of its many different activities in public spaces, and contextual homogeneity with small-scale buildings. He argued that such features make for the sustainable viability of cities.

Designed by Leon Krier in the late 1980s, the English town Poundbury is an example of a new village practice following traditional principles rather than modern planning (Figures 13-15). The town has been planned to extend progressively by 2025 to a 400-acre self-contained community for a population of 6,000. It exhibits traditional European urban patterns – high-density, low-rise, and mixed-use – but no zoning plan. Sharing views and interests with the New Urbanism movement, this new urban village development sought an alternative urbanism for contemporary cities. However, it dealt with more social issues, comfortable human-scaled communities with affordable housing and cultural diversity, and traditional architectural styles based on traditionalism to allow for sustainable expansion and continuous development in a modern way of life.

Fig. 13 Master plan of Poundbury designed by Leon Krier
(Source: http://www.cabe.org.uk/AssetLibrary/2943.jpg)
2.5 The New Urbanism Movement

*Americans use 8 times more energy than Europeans because 90% of American communities are not walkable (sprawl), and we have not invested in a world-class national rail network the way Europeans have been doing for many years. We have invested our wealth in roads, cars, and spraways, all of which waste huge amounts of energy, are unsustainable, and have no future.*¹²

Originating in the United States, the New Urbanism Movement presents a concern and approach similar to the new urban village concept and opposing car-dominated suburban sprawl. Critically conscious of global warming and peaking oil prices, new American urbanists found a solution in compact development with high-density, high-amenity, and mixed-use walkable communities based on a viable public transport system. Among these principles, an efficient and convenient public transport system is the most fundamental basis for sustainability, in that it reduces non-renewable energy consumption as well as vitalizes urban centers and streets.
In this respect, Curitiba, a city in Brazil, has been considered as a successful and exemplary model of transit-oriented development (seen in

![Curitiba public transport](http://upload.wikimedia.org/wikipedia/commons/1/16/Curitiba_PublicTransport.png)

![Curitiba skyline](http://en.wikipedia.org/wiki/Image:Curitiba0079.JPG)

![Curitiba Map](http://commons.wikimedia.org/wiki/curitiba.png)
Figures 16-18). The city, 430.9 square kilometers in size with a population of 1.8 million, located in southern Brazil, is well known for the high quality of its master plan and planning system. Its public transport system, integrated with the urban form and pedestrian network, has efficiently regulated urban growth patterns and environmental quality. As seen in Figures 16 and 18, the high-density skylines and busy streets precisely coincide with the transit routes of the city. Despite the highest car-ownership rate in Brazil, Curitiba has the highest ridership of public transport in the country (about 2.14 million passengers a day). 13

### 2.6 Compact City Concept

The Brundtland Commission report published in 1987 and the UNCED (United Nations Conference on Environment and Development) Agenda 21 Proposal in 1992 have a common interest in global efforts to achieve sustainable development. They suggested the Compact City as the best possible resolution for sustainable development. Preserving open space and farm lands as much as possible, they claim, is the way to protect food output for the exploding population. Also, increasing density and intensification within urban settlements is intended to maximize efficiency in resource consumption and to promote a better way of life. Indeed, compact development offers benefits for public transport and infrastructure systems as well as economic activities. For this reason, compactness has been emphasized, from neo-traditionalism like the Urban Village concept to modern twentieth-century cities, as a fundamental principle.

However, some urbanists doubt the effectiveness of compact cities. Indeed, urban decentralization over time is inevitable because continuous congestion of cities within limited territories unnecessarily causes escalation of land prices and dissatisfaction with the quality of life. 14
Moreover, Amit Oberoi argues in his MIT graduate thesis that high density has a small positive relationship with both median travel time to work and public transit modal share.15 This means that the urban density has a statistically weak correlation with transportation behavior factors because the travel behavior can also be affected by other factors such as income levels, government policies, gasoline prices, public transit systems, and so on. Even though high-density cities reduce commuting distances somehow, the city form is not connected with the distance and frequency of personal or family trips. Thus, simple high-density development is less effective than a well-functioning public transport system for reduction of traffic congestion and oil consumption.

Hong Kong exhibits the example of the compact city model with the most high-rise and high-density development in the world. Due to its exploding population and the limitation of the land area, the city adopted compaction of the urban area, leaving seventy percent of the national land green.16 However, Hong Kong has been considered as a successful and acceptable model of compact development, because it is still attractive to get people and financial resources together into the center of the city, offering economic benefits and satisfactory living conditions to the residents. Although there are some concerns about the “deterioration of the urban environment,” expansive land prices, and a poor air quality, this high-density and high-rise city has proven itself to be a sustainable form with environmental benefits and people’s satisfaction.17
2.7 Conclusion

Looking into previous and current practices relevant to the sustainability concept, we revealed common and different interests and resolutions originating in various local contexts and periods of time. The Feng Shui and tropical city guidelines included efforts to understand the natural world and utilize the climate and local topography in an ecological way, gaining benefits from them. While Feng Shui implies the idea that people ought to build a habitat accepting the natural order, the tropical city guidelines attempt to blend landscape with built forms in a physical way on a large scale. However, the Urban Village and New Urbanism movements of Western countries contain lessons drawn from both high-density traditional communities and unattractive modern suburbanization. These practices give weight to efficient public transit and a mixed-use urban core.

In sum, what is essential is to achieve economic efficiency and high environmental quality in our cities. To meet these goals, urban designers have a much greater responsibility for designing an urban form and infrastructure embodying efficient use and alternative lifestyles within a limited territory. Most people agree that the shape or size of the city is not a key issue, but “the proximity, accessibility and high density” of the city matter greatly for its sustainability. In addition to the compactness, the city should include mixed-use block, and efficient public transportation, a clear edge separate from productive landscape. However, there are still a few questions left regarding this subject. Can we define the range of ideal density, mixed use, and efficiency of transport system? Can we apply ideal urban templates and development methods, if any, to every city in the world? After all, although we can argue toward a consensus about each critical element of urban development in regards to density, land use, walking distance, public transit, road network, and planning policies, the urban form, as the result of a com-
plex layout of such elements, should be adapted to specific cultural, economic, and social contexts.

Building on this general investigation of sustainable urban development, this thesis will now examine urban templates proposed in various periods of time in China.
3. Review of Chinese Urban Forms

With a long history of city development, China has had a great number of urban settlements originating in different eras and locations. Contemporary developments overlapping with various layers of historical structures are making China more dynamic and chaotic in its urban planning. Therefore, it is worthwhile to briefly look at the historical urban templates, as a general context for understanding current urban features. Some characteristic contexts dealt with in this chapter are categorized into a) the capital city forms of ancient times, b) the Work Units of the Maoist period, and c) new towns developed in the current urbanization boom.

3.1 Past Capital Cities

Ancient Chinese cities began in the Xia period (21st century-16th century BCE) as markets and administrative centers in the agricultural society. The early city plans were rectangular with a cardinal orientation and rammed earth walls surrounding them. The canonical city plan, which was used for construction of capital cities in almost all dynasties, was established and developed in the early period of the feudal society. Written in the early years of the Warring States (475-221 BCE), "Kao Gong Ji" ("the Artificer's Record") describes this ideal city's general layout and concept. The canonical plan had a geometric grid form of a nine li (1 li = 0.5km) square with strong cardinal axiality running north and south. It was structured with nine meridional and latitudinal avenues connecting three gateways of each side of the city wall (seen in Figure 19). Such elements of the plan regarding the cardinal orientation, axiality, symmetrical grids, enclosing wall, and the number "nine" are closely related to the Chinese cosmology. That is, the city symbolizes the universe, with its ordered systems, and its imperial palace located in the center of the land. Market, workshop,
residential quarters, and temples were separately distributed around this palace.

Fig. 20 Evolution of Chinese capital cities (all plans drawn to the same scale) (Original source: Wu, 1986, 89-90. Referred source: Wu 1999, 5)
Fig. 21. Comparative evolution of design and size of five Chinese capitals: Luoyang, Nanjing, Xian, Beijing, and Suzhou. (Source: Golany, 2001, 90-91)
During feudal society, which includes the period from the Spring and Autumn period (770-476 BCE) through the Han (206 BCE-220 CE), Sui (581-618), and Tang (618-907), up until the Qing Dynasty (1664-1911), Chinese urban planning and principles flourished within the imperial city developments, and the synthesis of them has been implemented in the construction of Beijing since the twelfth century. As seen in Figures 20 and 21, many capital cities established by different dynasties had evolved from the early original urban form and transformed into more complex forms adapted to local topography and social changes.

Fig. 22 Evolution of Beijing’s site since the twelfth century: Zhongdu in the Jin dynasty, Dadu in the Yuan dynasty, and Beijing in the Ming and Qing dynasties (Original Source: Wu, 1986, 67. Referred source: Wu, 1999, 7)

Fig. 23 Chang An and its six main streets: “The enormous expanse of the so-called heavenly Road, measuring 150m-155m across, provided the central axis that linked the imperial complexes to the Gate of Luminous Virtue to the south, one of the four cardinal gates of the city.”21 (Source: Friedmann, 2005, 4)
Also, differences between the northern and southern regions were illustrated in urban plans. Northern cities such as Chang An and Beijing, usually located on flat plains, have developed massive and solid features on a formal square with wide straight streets for carriages (Figures 22 and 23), whereas the southern cities, such as Suzhou and Kunming, which bordered various topographies such as hills, valleys, lakes, or the sea, have developed irregular cityscapes as well as waterways for an irrigation system and main transportation mode (Figure 24). Despite such adaptations, the basic structure continued as a geometrical form based on a symmetrical layout and rectilinear grids illustrating political power within it.

3.2 Work Units of the Maoist Period

Most Chinese cities, having such a long history, began to be transformed into modern cities on a large scale under the influence of socialism in the People’s Republic regime of 1958. The government introduced the concept of work units, derived from the neighborhood units of the Soviet Union, to build self-sufficient communal spaces.22
The work units were conceived as a “total institution” including work places, housing, and social welfare spaces such as nurseries, schools, clinics, and so on, which are used exclusively by residents living in the work units (Figures 25 and 27). The government intended to reorganize the social classes using the work units, which indicate the integration of the class and living territory as a basic social unit, and this integration was presented in urban space as a gated community enclosed by walls. Duanfang Lu argues that such a self-contained integrated unit is alternative both to capitalist society and to socialism, in that this gated community can guarantee “safety, equality, social welfare, environmental sustainability, and employment” within its gated wall, reducing the need to go outside of the community for them.
John Friedmann cites Piper Rae Gaubatz’s description about the new aspects of the Maoist cities in his book as follows:

The multifunctional compounds built by Chinese work units since 1949 are walled areas somewhat reminiscent of the walled wards of the early traditional Chinese city... [T]he work-unit compound became a miniature city within its own walls, offering residents spaces for work and for play, for home life and for neighborhood life. The highly controlled environment of the work-unit compound is entered through a guarded gate... Within the gate, the architecture is utilitarian and regimented. Production facilities and residential facilities are usually housed in separate structures. Orderly rows of residential structures commonly consist of three-to five-story brick or cement buildings... Common areas between the buildings... serve as bicycle parking lots, Children’s play areas, recreation places for volley ball and other sports, and green areas. Other facilities within the walled compound vary but ideally include dining halls, provision shops, medical facilities, recreation facilities, meeting rooms, and administrative offices. Thus the work-unit compound serves as the locus for organization of many facet of life...

Neighborhood committees sometimes also functioned as work-units. By organizing small production workshops and other neighborhood labor they limited the need for long-distance mobility within the city...

Thus ideals of social and spatial organization were creating distinctly undifferentiated social and functional landscapes... Coupled with preferences for low-cost low-rise structures, this resulted in the development of an urban environment with three prominent characteristics: generalized functional organization, low-rise standardized landscapes, and the persistence of the “walking-scale” of the city.25

Even though the work units’ concept and lifestyle have been weakened over time due to the decline of socialism, gated communities are easily seen in modern Chinese cities, especially in residential areas. These work units, featuring mixed use, proximity of communities, and shared
public facilities, have potential for a sustainable urban pattern.

3.3 Types of Chinese New Towns

This chapter classifies new town plans into four categories according to their featured visual elements and urban patterns which embody the sustainability concept. These towns, generally developed on the basis of the existing local settlements in suburbs, vary in size and shape, as well as in development method.

3.3.1 Copies of Western Historic Identity

One of the popular development methods seen in plans for new towns is to imitate approved successful templates from foreign cities, especially European cities. This method allows easily obtaining advanced Western urban planning concepts and historical urban forms which combine mixed-use patterns, well-organized townscapes with 3 to 5 story villas, and a clean environment. In addition, this method is
preferred by local governments and developers because such replicated towns make high profits by offering exotic environments and high-end residential communities both to tourists and to middle and upper-income households. The model cities for these copied town plans are varied, from European traditional cities (Figures 28 and 29), modern grid cities, and American suburban villages, to the template of the Garden City concept.

Shanghai government’s “One City Nine Towns”\(^2_6\) is a good example of this case. The government proposed a plan for developing new satellite towns to release Shanghai’s concentrated population and economic pressure, as well as to offer an international atmosphere in its suburbs.\(^2_7\) The municipal government required the entries to have urban forms similar to designated specific towns in foreign countries. Each plan replicated particular architectural styles, building facades, landscapes, vegetation, and lifestyles from the model cities. For instance, Anting new town, located in the Jiading district of Shanghai, followed a German historic town featuring a distinct town center and meandering curved streets, while Pujiang town, designed from Italian inspiration, was laid out with modern grids and mixed-use blocks.
### Table 1. Cases in Copies of Western Historic Identity

<table>
<thead>
<tr>
<th>Plans</th>
<th>Townscapes</th>
<th>New town</th>
</tr>
</thead>
</table>
| Songjiang new city     | Songjiang new city | Model :: British city  
Area :: 60 km²  
Population :: 500,000  
Density (persons/km²) :: 8333.3 |
| Anting new town        | Anting new town | Model :: German city    
Area :: 4.9 km²  
Population :: 50,000 – 80,000  
Density (persons/km²) :: 10,204-16,326.5 |
| Pujiang new town       | Pujiang new town | Model :: Italian city  
Area :: 15 km²  
Population :: 80,000 – 100,000  
Density (persons/km²) :: 5,333.3-6,666.7 |
| Luodian new town       | Luodian new town | Model :: Scandinavian city  
Area :: 6.8 km²  
Population :: 30,000 – 60,000  
Density (persons/km²) :: 4,411.8-8,823.5 |
<table>
<thead>
<tr>
<th>Model</th>
<th>Country</th>
<th>Area</th>
<th>Population</th>
<th>Density (persons/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fengjing new town</td>
<td>Canadian city</td>
<td>8 km²</td>
<td>75,000</td>
<td>9,375</td>
</tr>
<tr>
<td>Gaoqiao new town</td>
<td>Dutch city</td>
<td>9.12 km²</td>
<td>100,000</td>
<td>10,964.9</td>
</tr>
<tr>
<td>Lingang new city</td>
<td>Alexandria</td>
<td>74 km² (36 km²)</td>
<td>800,000</td>
<td>10,810.8</td>
</tr>
</tbody>
</table>

Compared to the existing major cities in China seen in Table 2, these new towns are very small but extremely high-density environments. In general, Chinese cities tend to have a big scale with a great number of people, contrary to the Western cities do. However, new towns have been developed in the countryside within a walkable distance. That is, the towns can be defined as a micro-scale compact settlement with low-rise buildings.
Table 2. Central city population densities, Chinese cities and other major cities

<table>
<thead>
<tr>
<th>City</th>
<th>Density (central city) (person/km²)</th>
<th>Area (central city) (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>5,377.9</td>
<td>1,369</td>
</tr>
<tr>
<td>Chengdu</td>
<td>2,123.0</td>
<td>1,382</td>
</tr>
<tr>
<td>Fuzhou</td>
<td>1,282.8</td>
<td>1,043</td>
</tr>
<tr>
<td>Guangzhou</td>
<td>2,725.9</td>
<td>1,444</td>
</tr>
<tr>
<td>Hanoi</td>
<td>23,690.4</td>
<td>46</td>
</tr>
<tr>
<td>Qingdao</td>
<td>1,924.7</td>
<td>1,102</td>
</tr>
<tr>
<td>Shanghai</td>
<td>10,358.6</td>
<td>793</td>
</tr>
<tr>
<td>Shenyang</td>
<td>1,336.1</td>
<td>3,495</td>
</tr>
<tr>
<td>Tianjin</td>
<td>1,367.4</td>
<td>4,276</td>
</tr>
<tr>
<td>Wuhan</td>
<td>2,483.2</td>
<td>1,627</td>
</tr>
<tr>
<td>Xi'an</td>
<td>3,336.3</td>
<td>861</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>30,000.0</td>
<td>-</td>
</tr>
<tr>
<td>Barcelona</td>
<td>17,433.0</td>
<td>98</td>
</tr>
<tr>
<td>Chicago</td>
<td>4,637.9</td>
<td>89</td>
</tr>
<tr>
<td>London</td>
<td>1,667.0</td>
<td>3 (Rest of Metro: 1,598)</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>2,836.0</td>
<td>1,216</td>
</tr>
<tr>
<td>New York</td>
<td>9,166.6</td>
<td>800</td>
</tr>
<tr>
<td>Paris</td>
<td>20,647.0</td>
<td>105</td>
</tr>
<tr>
<td>Tokyo</td>
<td>13,973.0</td>
<td>598</td>
</tr>
</tbody>
</table>

Such towns have in common exotic building styles and town layouts contrasting to the Chinese rural environment. The government and developers claim sensitive sustainability in the imitation of foreign towns. However, the problem is that they are interested in European townscapes and traditional visual images more than the system and pertinence of urban sustainability. For this reason, these new towns are blamed for lack of local identity and for theme park-like development. These towns follow the New Urban Village concept, involving traditional European town features.
3.3.2 Garden-centered Grid Cities

These new towns are characterized by irregular grid patterns and large-scale public green space in the center of the town. However, these grid patterns are different from those of traditional Chinese cities. The grids are winding and modified unevenly according to the topography and for aesthetic reasons, instead of being restricted to straight lines with regular intervals. The modules are varied, based on the scale of the projects, generally ranging between 50m and 500m with a square shape. In these towns, green space, usually occupying half of the total area, involves natural patterns of waterways, which penetrate the whole site as well as forming main axes of the plans. This public green space as a focal point of the sites is combined with cultural facilities such as athletic stadiums, convention centers, and theaters.

Such urban space integrated with the natural landscape is distinct from the old capital cities. The ancient plans hardly dealt with garden space in urban settlements, and, if any, gardens were designed at the perimeter or outside of the towns, and only for royal families. Compared to the old capital cities, these towns represent an ecologically friendly concept by introducing a great portion of natural landscape into the central urban structure. This approach shares the garden city concept with the tropical cities' practices for sustainability. As mentioned in the previous chapter, vegetation has good physical effects on the modification of temperature in urban space as well as preservation of the ecosystem. However, it also imposes a limitation on the efficiency of land use and infrastructure design.
<table>
<thead>
<tr>
<th>Plans</th>
<th>New town</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td>Renhuangshan New District in Huzhou</td>
</tr>
<tr>
<td></td>
<td>Area :: 2.33 km²</td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /></td>
<td>Key Area in Shenbei New City, Shenyang</td>
</tr>
<tr>
<td></td>
<td>Area :: 270 km²</td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td>Core Area of Tongzhou District in Beijing</td>
</tr>
<tr>
<td></td>
<td>Area :: 2.38 km²</td>
</tr>
<tr>
<td><img src="image4.png" alt="Image" /></td>
<td>Xin Jiang Wan Cheng in Shanghai</td>
</tr>
<tr>
<td></td>
<td>Area :: 1.69 km², Population :: 33,100</td>
</tr>
<tr>
<td>Area Description</td>
<td>Area (km²)</td>
</tr>
<tr>
<td>------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Xinqian Block of Huangyan Economic Development West Zone</td>
<td>7.6</td>
</tr>
<tr>
<td>Foshan City</td>
<td>18</td>
</tr>
<tr>
<td>Xinyu High-Tech Economic Development Zone</td>
<td>14.3</td>
</tr>
<tr>
<td>Taking-off Zone of Xuzhou’s New Downtown Area</td>
<td>14.98</td>
</tr>
<tr>
<td>Population:</td>
<td>3,000,000</td>
</tr>
</tbody>
</table>
3.3.3 Water-based Cities

A few projects, located at strategic points adjacent to the water, introduce water on a large scale as a critical element for urban planning. In such proposals, the grid system is interrupted or abandoned by introducing irregular waterways into urban structures, dividing the land into several pieces. These separate pieces of land can develop individually, having different functions and structures. These towns offer water transit as an alternative to land routes and good water space as public open space. Introducing waterways into urban space is easily found in historical southern cities of China. However, whereas in the traditional cities the waterways were framed into grid patterns according to the road networks, in these new towns waterways define the forms and patterns of settlements.

The canals, lakes, or the sea bordering the towns are conceived as central places of the town, furnishing unique local identities and eco-friendly urban images. Combining with natural landscape and leisure places, bodies of water draw out more picturesque perspectives of towns. However, since they also divide urban areas into small settlements, they impede close connections between districts and limit the potential urban expansion.
Table 4. Cases in Water-based Cities

<table>
<thead>
<tr>
<th>Plans</th>
<th>New town</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Qingpu new town designed by SWA</td>
</tr>
<tr>
<td></td>
<td>Area :: 7 km²</td>
</tr>
<tr>
<td></td>
<td>Qingpu new town designed by Sasaki</td>
</tr>
<tr>
<td></td>
<td>Area :: 7 km²</td>
</tr>
<tr>
<td></td>
<td>Central area in Yueqing</td>
</tr>
<tr>
<td></td>
<td>Area :: 18.2 km²</td>
</tr>
<tr>
<td></td>
<td>Population :: 140,000</td>
</tr>
<tr>
<td></td>
<td>Xinbu Island, Haikou</td>
</tr>
<tr>
<td></td>
<td>Area :: 9.23 km²</td>
</tr>
<tr>
<td>Knowledge Forest Island in Tianjin</td>
<td>Key location of Yun Donghai in Sanshui District, Foshan city</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Area :: 14.65 km²</td>
<td>Area :: 18 km²</td>
</tr>
</tbody>
</table>

![Knowledge Forest Island in Tianjin](image1)

![Key location of Yun Donghai in Sanshui District, Foshan city](image2)
3.3.4. Compactly-Developed Cities

These types of plans minimize urban development areas and preserve the existing cultural and natural resources along the sites as they are. By intensifying micro-scale urban settlements in separated spots, the rest of the land can keep a low-rise townscape, natural landscape, or rural farmland, released from urban sprawl pressure. At the same time, concentrated massive built areas can offer iconic landmarks and legibility, contrasting with the surrounding areas (Figure 30).

Fig. 30 The plan for Guangming Eco-City designed by Rainer Pirker proposes mixed-use urban vertical blocks sharply distinguished from their surroundings. (Source: http://www.rainerpirker.com/)

Fig. 31 The plan for Guangming Eco-City designed by Studio 8 is laid out with integrated circular clusters. (Source: http://vyonyx.com/index.php/pro/all/guangming-eco-city-china)
As seen in Fig. 31, Studio 8’s proposal for Guangming Eco-City resolves the problems of social sustainability and urban sprawl by proposing integrated suburban clusters including housing, institutions, farming, cultural facilities, and so on. This multifunctional cluster can be conceived as a vertical mixed-use block or new vertical enclosed community, and it reduces travel requirements and distance by providing a public service and work place inside for the residents.

On Chongming Island, the winning master plan proposes several development pieces as small-scale settlements, leaving most of the land as a natural landscape. Each separate community is connected by public transit. This plan presents the aspect of dispersed settlements rather than compactness, since each town is planned with typical low-rise buildings. However, proposing not a single core but a series of intensely developed urban areas, the plan reduces travel distances as well as limits the expansion of the development against ecological environment.

These proposals for compact development respond to recent global concerns and the results of discussions of sustainability. They share the idea of minimization of urban settlement and having a clear boundary with the surrounding neighborhoods and farm lands.
Table 5. Cases in Compactly-Developed Cities

<table>
<thead>
<tr>
<th>Plans</th>
<th>New town</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chongming Island</td>
</tr>
<tr>
<td></td>
<td>Area :: 1214 km²</td>
</tr>
<tr>
<td></td>
<td>Guangming Eco-City designed by Rainer Pirker</td>
</tr>
<tr>
<td></td>
<td>Area :: 8.4 km²</td>
</tr>
<tr>
<td></td>
<td>Guangming Eco-City designed by Studio 8</td>
</tr>
<tr>
<td></td>
<td>Area :: 8.4 km²</td>
</tr>
</tbody>
</table>
3.4 Conclusion

To sum up, historical Chinese urban development began with universal thoughts and the cosmology of a harmonious and orderly system, which were represented in a geometrical form. Although the early city form has been transformed over time, rectilinear symmetrical grids as a fundamental structure have been maintained in the cities. Looking at these historical towns that have become major cities in each region, the question comes to mind, Have they been sustainable? More precisely, which aspects of these cities are sustainable? One of the most valuable characteristics is probably the compact development within limited territories creating a clear edge from suburbs. The traditional Chinese cities are fundamentally enclosed by an urban wall, which limits urban areas, so that the cities cannot help but have compactness around a strong center. Also, the street system and block sizes determined by cosmological logics function rationally to provide legibility to people. The traditional Chinese city also shows an initial mixed-use pattern in that houses facing artery streets are usually combined with retail shops in front of residential space. Within a clearly bounded area, main functions are separated but are accessible in close proximity. However, as the cities are losing this accessibility due to their expansion over time, many questions are being raised in debates over sustainability.

In the communist development pattern, the work units provide a solution for walkable distance development. Each self-sufficient community isolated from the whole city certainly reduced the travel distance of residents, but it also restricted the freedom of travel by blocking circulation and excluding admission of visitors passing through. Monotonous building styles and repetitive community layouts were also criticized.

However, while rapid urbanization (or modernization) in suburbs on
a large scale has been experienced over a few decades, the desire for a high quality of urban environment has been more strongly reflected in developments for the new towns than ever before. Such internal desires, along with consciousness about the global crisis and doubts about modern urban planning, required new high-standard urban forms different from both the historic capital city planning and generic urban design.

Fig. 32 Relative sizes and forms of new towns. (Source: author, based on multiple sources)

In examining a great number of proposed design practices for the new towns, it has been found that most of them embody the sustainability concept with ecological landscape elements and visual effects rather than rational structures and organizing systems. According to their featured urban patterns, the town plans have been classified as: Copies of Western Historic Identity, Garden-centered Grid Cities, Water-based
Cities, and Compactly Developed Cities. Each type of city is mainly formed by importing model city townscape, introducing large-scale green belts in the center of the towns, establishing cities near water, and developing urban settlements compactly. Although it is too early to assess success or failure in attaining sustainability in these new towns, since they are still in the process of establishment, it is necessary to build on these by adding more ideas about saving energy resources and drawing out the desirable urban forms corresponding to the concrete principles of sustainable development, namely, clearly defined urban area, intensified mixed-use blocks, and efficient public transit and infrastructure.

4. Reconsideration of Linear Group Forms

This chapter investigates two urban proposals with linear group forms that have potential for sustainable urban development. Through briefly summarizing two projects, “Tel Aviv City Center (1962)” designed by Van den Broek and Bakema, and “Spatial Retaining Bars (1989)” by Steven Holl, the paper draws out common ideas from the two projects about the design of building forms in a relationship with a city that can support and reinforce the practices of sustainability.

4.1 Case Study 1: Tel Aviv City Center (1962)
The proposal for Tel Aviv, Israel, was designed by Van den Broek and Bakema to create a complex metropolitan civic center with a composition of megastructure buildings. Tel Aviv, facing the Mediterranean Sea (see Figure 33), needed an integrated strong civic core between old and new neighborhoods, as well as between nature and urban areas (Figures 35 and 36). The architects resolved this issue by proposing multifunctional megastructure building forms, which link the civic core with intermediate buildings and thence to small dwelling units in neighborhoods.
Bakema also clearly defined the urban area with a continuous series of urban wall buildings, which run both along the edge of the city facing the coast line, and through the civic center like a backbone. These mega buildings are placed on the main roads and at the major intersections of the roads, blending in urban infrastructure. Such surrounding core wall buildings, around the civic center, present distinctive visibility and identity that contrasts with local settlements.
Fig. 39 A composition of linear mega forms was built along the major roads and at their main intersections around the civic core. (Source: author, based on Risselada and Heuvel, 2005, 144)

Fig. 40 Building footprints display clearly the edge of the city separate from the sea and the urban spine passing through the downtown. (Source: author, based on Smithson, 1965, xx)
As seen in Figures 41 and 42, building forms combined with a road structure not only reduce the travel distance but also increase accessibility to the urban core by integrated transportation systems. Moreover, large-scale pedestrian decks separate from motor vehicle roads encourage creation of walking-friendly cityscapes.

In terms of efficiency and compactness of a city, another remarkable feature of Bakema's mega form is its closely linked multi-functions in
buildings, including housing, offices, retail shops, cultural institutions, parking lots, and so on. Like a small city in a unified building, this composition of urban wall buildings joined diverse uses together, from public places like a city hall to private dwelling units with a hierarchy, in order to intensively encourage vertical and horizontal movements within the defined urban core.

Fig. 43 Perspective views of the Tel Aviv proposal (Source: Risselada and Heuvel, 2005, 147)

Fig. 44 Conceptual section drawings: mixed-use urban walls are closely connected vertically and horizontally with each other. (Source: Smithson, et al., 1964, 18)
4.2 Case Study 2: Spatial Retaining Bars (1989)
Steven Holl’s design proposal for Phoenix, Arizona, shows the idea of re-structuring a city to limit its urban expansion. Phoenix has experienced in only one hundred years rapid urban growth due to spread of private vehicles and suburban development. As a result of this continuous expansion, the city has grown till it borders on surrounding desert. In such a process of merging urban settlements and nature, or menacing nature, Holl attempted to redefine the urban territory by building gigantic urban walls consisting of individual units. Placing linear group forms along the border line between the city and the desert at three different regional corners of the city, the architect intended to make a clear edge of the city and to revitalize the urban periphery area, which shows a generally dispersed urban character. Each building, looking like a huge frame having a large void on the façade, enables people to see nature (specifically, the desert), as well as forming a symbolic fence enclosing the whole city (Figures. 42 and 43).
Fig. 50 Plans and axonometric views of a linear group form: each building consists of individual small units. (Source: Holl, 1996, xx)

Fig. 51 Frame-shaped unit models (Source: Holl, 1996, xx)
To build units based on mixed use, such as residential units, working space, and public and cultural facilities, reduces the dependence on the public civic core, and also makes this periphery area able to function as a self-sufficient central community.

Fig. 52 A hierarchical mega form vs A group form consisting of similar units (Source: author)

In contrast with Bakema’s proposal, one valuable aspect in “Spatial Retaining Bars” is that it consists of similar independent units instead of one whole megastructure linked spatially and functionally within a restrictive hierarchy. The structure can be partially removed or replaced without influence on the whole system, as well as allowing variations as an open structure. Whereas the limits of mega forms are mostly in the rigidity of massive structures, such flexibility in the relationship of individual units makes continuous macro-scale developments possible in urban settlements.
4.3 Conclusion

In both Bakema’s proposal for Tel Aviv’s civic center and Holl’s Spatial Retaining Bars for Phoenix, we have reviewed the template of linear built forms as a potential sustainable urban form. Such macro-scale group forms implied many aspects responsive to the principles of sustainable development. First of all, their visuality, derived from a large vertical structure, defines the clear edge of urban territory contrasting with surroundings and provides strong legibility to residents. The high-rise and high-density group forms also satisfy the practical necessity of increasing urban population, as well as minimizing the construction of infrastructure. Above all, the mixed use and integrated circulation system in a building are the greatest contributions to a sustainable way of life in regards to energy efficiency and compact uses.

Fig. 53 Kiyonoiri Kikutake, Marine City (1958-63) (source: http://www.archinect.com/images/uploads/kikutake_city.jpg)

Fig. 54 Kenzo Tange, Tokyo Bay Project (1960) (Source: http://www.archinect.com/images/uploads/tokyotange.jpg)
These two investigated projects are closely related to urban design projects proposed by Metabolists in the 1960s. As an initial solution for the rapidly increasing population and urbanization, the Metabolism suggested such mega structures as a small city. However, as in the case of Tel Aviv’s civic center, the complex megastructure buildings have been generally questioned and criticized for a long time as beyond human scale, inflexible in structure, and brutally machine-like in image. If we can maintain the possibilities for variations in growth, the linear built form can be a useful template for sustainable cities.
5. Micro-scale Networking Cities for Typical Chinese Towns

On the basis of the previous literature review and case studies, this chapter proposes an urban template for sustainable development in typical Chinese towns, which are built in the countryside. This model city embodies previously mentioned principles for sustainable development: clear boundaries preserving the natural environment, compact development with mixed use, an efficient public transportation and infrastructure system, and provision for expansion.

5.1 Clear Edge :: Urbanity and Nature

Only 0.3% of China’s land territory has been urbanized. Despite an exploding urban population, China still retains a great majority of farmlands and intact landscape all through the country. However, China is in a critical dilemma between preservation of its natural environment and industrialized urban development. Given this situation, I propose an intensively-developed linear urban form distinct from rural landscapes, thus preserving the landscape.

Fig. 56 Overlaying urban frame of a grid pattern on the rural landscape (Source: author)
This proposed urban template is based on a grid-patterned infrastructure which is running through the countryside and is necessary to organize land parcels. By constructing urban blocks along the infrastructure and integrating with it, urban settlement areas are minimized and present strong visibility. At the same time, rural landscape and farmlands are preserved as they are.

Fig. 57 Site plan: each linear urban strip crosses others at regular intervals, and as a result, urban grid frames surround rural landscapes, preserving them. (Source: author)
These linear urban strips sharply separate their territories from rural landscapes, and expand within and along the grid patterns, containing various landscape elements inside of the frames. Such preserved landscapes can function as productive farmland, recreation places, scenic parks, or wild nature, giving easy access to people.

5.2 Integrated Infrastructure :: Efficient Transportation

Although the width of each urban strip varies depending on the population and development scale, it includes road and public transportation infrastructure. The intersections of linear strips are ideally placed at 1 kilometer intervals based on a five-minute walking distance, which means people can reach crossroads from anywhere in five minutes. At every intersection, multimodal transport stations are located to support transferring to regional rails, local trams, motor vehicles, cycles, or walkways. People can efficiently travel at stations along the grid patterns connecting to other cities.

Fig. 58 Road structure integrated with public transit (Source: author)
An elevated road infrastructure allows pedestrians and cyclists to move freely on the ground level without concerns about motor vehicle traffic.
5.3 Compactness :: The Building Unit as a Mixed-use Block

Each building unit develops as a high-density and high-rise form with mixed uses. This development pattern minimizes the need and distance of daily travel, as well as revitalizing internal movements in each building unit. The area within a five-minute walking distance is a self-sufficient community.

Fig. 61 Mixed-use pattern on the plan (Source: author)

Fig. 62 Mixed-use pattern in the sections of buildings (Source: author)
5.4 Expansion of Settlements :: Networking Cities

The growth of urban areas is inevitable, and dispersed decentralization is the greatest impediment to sustainable development. When expanding, the city needs more land and construction of supporting infrastructure, and loses efficiency in resource uses. In this regard, the grid-patterned linear city form provides an alternative for expanding indefinitely along the continuing infrastructure. The urban strip sets limits to extending in width, but this linear form can develop above and along the road structure. This expandable linear urban strip can be overlaid with the existing infrastructure in rural areas, along highways, and on the water, linking with other cities by public transit.

Fig. 63 Urban template overlaid on farmlands (Source: author)

Fig. 64 Urban template overlaid on waters (Source: author)
6. Conclusion

The phenomena of rapid growth and urbanization in China are becoming critical concerns, as they influence future prospects going beyond those of China itself. Exploding global urban population and increasing built-up areas, as well as consciousness about crises in natural resources and arable lands, motivate people to consider such phenomena that are happening in the country having more than one-fifth of the world population. Given such global concerns and understandings, this thesis has examined Chinese urban developments from historical background to new town plans, widely relating them to various discussions and practices originating in other countries, in order to propose ideal sustainable urban forms for such typical small new towns in the suburbs of China.

Recent developments in new towns have importantly dealt with their sustainability issues and improvement of the quality of life in urban areas. In this connection, the thesis has reviewed various previous ideas and practices relevant to sustainability. Although the sustainability concept has become popular since the 1980s, there have been various efforts and understandings about it in different periods of time. Feng Shui theory, with a long history in China, is still effective in urban planning, providing a concept for adapting settlements to the natural order and system. Tropical cities' guidelines and the Garden City concept have inspired efforts in the construction of Chinese new towns to incorporate urban space into the natural environment on a large scale in different ways, by introducing large-scale vegetation into the urban structure and by placing green belts around urban space. The new Urban Village and New Urbanism movements have offered the idea of efficiency in small-scale communities based on public transit. Finally, a compact city has recently been conceived as a desirable urban model in that compactness minimizes built-up areas and intensifies efficient...
urban activities, preserving arable lands and the natural world.

These plans for new towns in suburbs of China are distinguished from both the historical cities and urban models previously discussed for sustainable development. Whereas historical capital cities were based on rectangular geometrical forms with a strong axially and central administrative place, and during the Maoist period cities were restructured as isolated gated community units, new towns have reflected many attempts that were inspired by contemporary practices and foreign historic cities. Most of them are classified in four categories based on featured elements: copies of historic identity, garden-centered grid cities, water-based cities, and compactly developed cities. These new towns are commonly intended to be small-scale communities featuring low-rise buildings and plenty of natural landscape, contrasting to the existing overcrowded mega-cities. Despite the size, shape, or building styles of cities being of little importance in sustainability, these new developments are too much under the influence of visual images, rather than being logically formed.

Building on a literature review and investigation of the accepted principles for sustainable development, this study proposed a model urban form as an alternative for sustainable growth in rapidly expanding Chinese new towns. This model, named "micro-scaled networking cities," is characterized by transit-oriented linear compact urban blocks, productive landscape framed by urban grids, and efficient integrated infrastructure, including public transit. This built form has no centralized single core, but continuous civic cores along the infrastructure, networking each other up until the major cities. By allowing urban blocks to expand only along the integrated infrastructure, the footprints of built-up areas are minimized, and at the same time, these linear urban blocks frame the countryside, preserving its characteristics. Above all, this model aims to control excessive urban sprawl into rural areas,
to maintain the food output from arable land, and to share the urban advantages of major cities by connecting closely with them.

Construction of typical Chinese new towns in the countryside with a goal population of 50,000 to 500,000 is inevitable and is becoming accelerated. Since these towns are like a frontier menacing the natural world, they are required imperatively to have a firm vision and criteria for sustainable development, more than the existing major cities have. Although the proposed micro-scale networking urban form along the integrated infrastructure needs further study in feasibility and detail, it can contribute to attracting attention and efforts against the typical new town construction. I conclude this paper by predicting that if China continuously makes more efforts for developing sustainable concepts and structures in urban planning, East Asian urban forms will be definable in the near future as eco-friendly sustainable templates.
Notes

2. Song and Ding, ed., Urbanization in China, 4-6.
5. Ibid.
6. Ibid.
7. Ibid.
9. Ibid., 174.
11. Rodwell, Conservation and Sustainability in Historic Cities, 32.
15. Ibid., 42, 48, 59.
17. Ibid., 251-252.
25. “One City Nine Towns”: The newly developed satellite cities such as Songjiang, Anting, Luodian, Fengjing, Pujiang, Gaoqiao, Zhoup, FengCheng, Buzhen, and Zhujiajiao were modeled on existing British, German, Scandinavian, Canadian, Italian, Dutch, American, Spanish, European-American, and southern Chinese cities, respectively.
27. Ibid.
28. Song and Ding, Urbanization in China, 4.
List of Figures and Illustration Credits

Fig. 1. Trajectory of Chinese urbanization level: Urbanization is sharply increasing and it is expected soon to reach up to seventy percent of the national population. (Source: author, based on multiple data sources (Song and Ding, 2007, 5))

Fig. 2 Economic development level measured by per capita GDP in provinces (2004): Chinese economic growth and population have been concentrated on the east coast area including Beijing and Shanghai. This concentration of wealth has been increasing the demand for and speedy construction of new urban areas. (Source: Song and Ding, 2007, 8)

Fig. 3 The change of global ecological footprint: Whereas in 1961 only half of the planet earth was enough to support world population, the human demands exceeded the capacity of the earth over the past forty years. China's fast growing resource consumption is accelerating the global demand on the earth's ecology. (Source: http://bp3.blogger.com/_OvfZJS12mQ/RyYNUXWCPqI/AAAAAAAAADk/reWewBosxtg/s1600-h/world_1961_sm-eco+footprint.jpg)

Fig. 4 Global trends: each datum indicates that we are standing at an important moment to modify our way of life and development patterns with exploding world population and urban settlement areas as well as rapid change in technology. China is creating a steeper slope for each datum. (Source: MVRDV, 2005, 24-27)

Fig. 5 Chinese Feng Shui Bagua Symbol: Each direction having its own color and material stands for a different kind of wealth, happiness, and good luck. (Source: http://www.fengshuifusion.com/images/bagua-feng-shui-colors.gif)

Fig. 6 The Notion of Ideal Site in Feng Shui: The ideal habitat site is surrounded by mountains and facing waters in the south. (Source: Awotona, 1999, 272)

Fig. 7 Examples of vegetation belts in urban areas: Greenbelts placed in an east-west way block the cold wind in winter as well as uncomfortable setting sunlight from the west. (Source: Schiller and Evans, 1998, 173-177)

Fig. 8 Plan of the whole municipal area (Source: http://www.library.cornell.edu/Reps/DOCS/howard2.gif)

Fig. 9 One section of the Garden City concept (Source: http://www.library.cornell.edu/Reps/DOCS/howard3.gif)
Fig. 10 Growth of the Garden City: If the city exceeds the population of 30,000, another city is established by moving out from the existing town and the surrounding green belt. (Source: http://www.library.cornell.edu/Reps/DOCS/howard5.gif)

Fig. 11 Letchworth Garden City in 1903. (Source: http://www.uky.edu/Classes/PS/776/Projects/Howard/g-city20.gif)

Fig. 12 Welwyn Garden City in 1919. (Source: http://cyberium.co.uk/parkhistory/welwyn.html)

Fig. 13 Master plan of Poundbury designed by Leon Krier. (Source: http://www.cabe.org.uk/AssetLibrary/2943.jpg)

Fig. 14 The center of Poundbury. (Source: http://www.ablarchitecture.com/images/tom/poundbury/poundbury-004.jpg)

Fig. 15 View of Poundbury. (Source: http://governing.typepad.com/13thfloor/images/poundbury_roofs.jpg)

Fig. 16 Curitiba public transport: The public transit routes represent the shape and boundary of the city. (Source: http://upload.wikimedia.org/wikipedia/commons/1/1/6/Curitiba_PublicTransport.png)

Fig. 17 Map of Curitiba. (Source: http://commons.wikimedia.org/wiki/Image:Curitiba_49.23395W_25.45921S.jpg)

Fig. 18 Curitiba skyline: High-density downtowns are developed following the public transit routes. (Source: http://en.wikipedia.org/wiki/Image:Curitiba0079.JPG)

Fig. 19 Canonical plan of the royal Zhou Capital (11th century-221 BCE) (Source: Golany, 2001, 95)

Fig. 20 Evolution of Chinese capital cities (all plans drawn to the same scale) (Original source: Wu, 1986, 89-90. Referred source: Wu 1999, 5)

Fig. 21. Comparative evolution of design and size of five Chinese capitals: Luoyang, Nanjing, Xian, Beijing, and Suzhou. (Source: Golany, 2001, 90-91)

Fig. 22 Evolution of Beijing’s site since the twelfth century: Zhongdu in the Jin dynasty, Dadu in the Yuan dynasty, and Beijing in the Ming and Qing dynasties (Original Source: Wu, 1986, 67. Referred source: Wu, 1999, 7)
Fig. 23 Chang An and its six main streets: “The enormous expanse of the so-called heavenly Road, measuring 150m-155m across, provided the central axis that linked the imperial complexes to the Gate of Luminous Virtue to the south, one of the four cardinal gates of the city.” (Source: Friedmann, 2005, 4)

Fig. 24 The water canal system of ancient Suzhou City had a grid design similar to that of the countryside, and was used as the major transportation route. (Source: Golany, 2001, 97)

Fig. 25 Academic work unit (danwei) housing and high school campus, Beijing, mid-1990s (Source: Friedmann, 2005, 14)

Fig. 26 Site plan of the living quarters of Meishan Ironworks (1969-71) (Source: Lu, 2006, xx)

Fig. 27 Map of the Ministry of Construction, Beijing (Source: Lu, 2006, 55)

Fig. 28 Medieval European city fabric characterized with walkable distance community and distinct central public space
(Source: http://www.palgrave-journals.com/udi/journal/v12/n1/images/9000180f15.gif)

Fig. 29 Reconstructioned View of 4th C. Bath
(Source: http://www.roman-britain.org/places/images/bath_4th_c.gif)

Fig. 30 The plan for Guangming Eco-City designed by Rainer Pirker proposes mixed-use urban vertical blocks sharply distinguished from their surroundings.
(Source: http://www.rainerpirker.com/)

Fig. 31 The plan for Guangming Eco-City designed by Studio 8 is laid out with integrated circular clusters. (Source: http://vyonyx.com/index.php/pro/all/guangming-eco-city-china)

Fig. 32 Relative sizes and forms of new towns. (Source: author, based on multiple sources)

Fig. 33 An aerial view and map of Tel Aviv, Israel (Source: Smithson, 1965, xx)

Fig. 34 Existing street views in Tel Aviv (Source: Smithson, 1965, xx)

Fig. 35 The circumstances of Tel Aviv (Source: author)

Fig. 36 The fifty-year-old suburbs built by European immigrants (above), and the ancient port of Jaffa found in Biblical times (below) (Source: Smithson, 1965, xx)
Fig. 37 Development sketches by Bakema (Source: Risselada and Heuvel, 2005, 144)

Fig. 38 Master plan of Tel Aviv civic center (Source: Risselada and Heuvel, 2005, 145)

Fig. 39 A composition of linear mega forms was built along the major roads and at their main intersections around the civic core. (Source: author, based on Risselada and Heuvel, 2005, 144)

Fig. 40 Building footprints display clearly the edge of the city separate from the sea and the urban spine passing through the downtown. (Source: author, based on Smithson, 1965, xx)

Fig. 41 Mega form on a city scale (Source: author)

Fig. 42 Road networking on a city scale (Source: author, based on Smithson, et al., 1964, 17)

Fig. 43 Perspective views of the Tel Aviv proposal (Source: Risselada and Heuvel, 2005, 147)

Fig. 44 Conceptual section drawings: mixed-use urban walls are closely connected vertically and horizontally with each other. (Source: Smithson, et al., 1964, 18)

Fig. 45 Interweaved circulation system: the core wall buildings are closely integrated with vehicle ways and pedestrian paths. (Source: author)

Fig. 46 Urban pattern of Phoenix, Arizona 1989 (Source: Holl, 1996, xx)

Fig. 47 Expansion of Phoenix, Arizona, over one hundred years (Source: Author, drew by Rafael Luna)

Fig. 48 Urban edge separate from nature: by redefining urban territory with massive built forms, the urban development is intensified towards the central place. (Source: Author, drew by Rafael Luna)

Fig. 49 Visibility of the urban edge (Source: Holl, 1996, xx)

Fig. 50 Plans and axonometric views of a linear group form: each building consists of individual small units. (Source: Holl, 1996, xx)

Fig. 51 Frame-shaped unit models (Source: Holl, 1996, xx)

Fig. 52 A hierarchical mega form vs A group form consisting of similar units (Source: author)
Fig. 53 Kiyonoiri Kikutake, Marine City (1958-63)  

Fig. 54 Kenzo Tange, Tokyo Bay Project (1960)  

Fig. 55 Arata Isozaki, Clusters in the Air project (1962)  
(Source: http://www.thecityreview.com/arcnowf.jpg)

Fig. 56 Overlaying urban frame of a grid pattern on the rural landscape (Source: author)

Fig. 57 Site plan: each linear urban strip crosses others at regular intervals, and as a result, urban grid frames surround rural landscapes, preserving them. (Source: author)

Fig. 58 Road structure integrated with public transit (Source: author)

Fig. 59 Zoomed-in intersection plan (Source: author)

Fig. 60 Circulation system at crossroads: elevated road structures support railroads in the middle and high- and low-speed motorways on both sides. Pedestrians and cyclists can freely move on the ground level. (Source: author)

Fig. 61 Mixed-use pattern on the plan (Source: author)

Fig. 62 Mixed-use pattern in the sections of buildings (Source: author)

Fig. 63 Urban template overlaid on farmlands (Source: author)

Fig. 64 Urban template overlaid on waters (Source: author)

Table 1. Cases in Copies of Western Historic Identity
(Source:  
Pujiang new town, http://www.gregottiassociati.it/  

Table 2. Central city population densities, Chinese cities and other major cities
(Source: Richardson, Bae and Baxamusa, ed. Jenks and Burgess, 2000, 28-29
Barter, ed. ed. Jenks and Burgess, 2000, 272)

Table 3. Cases in Garden-centered Grid Cities
(Source:
Renhuangshan New District in Huzhou, Urban Planning Annual, 2007,
Key Area in Shenbei New City, Shenyang, Urban Planning and Design Annual, 2006,
Core Area of Tongzhou District in Beijing,
Xin Jiang Wan Cheng in Shanghai,
Xinqian Block of Huangyan Economic Development West Zone,
Xinyu High-Tech Economic Development Zone,
Taking-off Zone of Xuzhou’s New Downtown Area)

Table 4. Cases in Water-based Cities
(Source:
Qingpu new town designed by SWA, http://www.swagroup.com/
Central area in Yueqing,
Xinbu Island, Haikou
Knowledge Forest Island in Tianjin
Key location of Yun Donghai in Sanshui)

Table 5. Cases in Compactly-Developed Cities
(Source:
Chongming Island, http://www.som.com/content.cfm/chongming_island
Guangming Eco-City designed by Rainer, http://www.rainerpirker.com/
Guangming Eco-City designed by Studio, http://www.bdonline.co.uk/Pictures/336xAny/g/m/j/Guangming_01a_ready.jpg)
Bibliography


Powell, Robert. *Ken Yeang: Rethinking the Environmental Filter.* Singapore: Landmark Books,
1989.


Smithson, Alison. “The work of Team 10.” *Casabella Continuita,* 293 (1965)


*Urban Planning and Design Annual.* Wuhan: Huazhong University of Science and Technology Press, 2006.


Biographical note

Sunhwa Son (b. 1980) was born and raised in Seoul, Korea. She attended Ewha Womans University, where she obtained her B.S. (2002) and M.S. (2006) in Architecture. Her Master of Science thesis, entitled “A Study on the Proposed Remodeling of Dongdaemun Stadium based on the Feature of a Conventional Market as the Spontaneous Program,” investigated the possibility of regeneration in obsolete architecture and the reform of the old city. She is interested in the public realm and significance of architecture and the transformation of urban structures. She attended MIT from 2006-2008 to pursue this research concentrating on Architecture and Urbanism.