GREEN BUILDING DESIGN

300 H STREET NE WASHINGTON DC

Wei Yao

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Master of Architecture

Paul Emmons, Chair

Jaan Holt

Marcia Feuerstein

December 17th, 2009
National Capital Region, Virginia

Keywords: green, architecture, urban

©2009, Wei Yao
Abstract

How to understand the concept of GREEN in an architectural perspective is the aim of my thesis. Aside from the basic concepts of sustainable building design, such as climate responsive layout, natural systems from daylight to fresh air providing a superior environment for the occupants as well as a better long-term contribution to the surrounding urban environment, more emphasis has been put on the understanding of GREEN from the historical and cultural perspective. Based on the inspirations from an in-depth typological research of the town house and its respondence to the nature environment and urban contexture, a set of comprehensive GREEN design strategies have been developed in this thesis work.

Dedication

Dedicated to Mom & Dad
Acknowledgement

Working on this thesis has been a journey of rebirth in my life. I am grateful to my mentors, friends and family who have supported me along the journey.

I would like to thank Professor Juan Irribar, especially, who not only provided me guidance and instruction on my thesis work with his broad knowledge, but also continuously gave me warm encouragement during my work and study at school.

I am very grateful for the help from my committee chair, Dr. Paul Emmons, whose great insight and perceptive were critical to each step of the development of my work.

I would also like to thank my instructor, Dr. Maria Feuer for her enlightening ideas and many warm encouragements and concerns.

Along this journey I owe a special gratitude to my parents who gave me their self-less support from my hometown.

Many thanks to Glen, with his support and encouragement, many difficult times of my work have turned into beautiful memories.

Also thanks to my friends, Dafang, Rachel. There are so many joyful and painful times we have spent together.

Without your support, I can not be where I am right now.

List of Figures
Introduction

This is a green building. This is a green building in the city. It provides the attempt of how to understand the green building in an architecture way. Versatile of public activity and dwelling needs have been researched and redeveloped in the green building design based on the understanding of traditional town house urban contexture and typology features. Retail, office, culture spaces are organized with a series of green spaces consist of green roof gardens, terraces, sunken plazas and water systems.
The site of my thesis is located at the intersection of H street and 3rd street. It is within five minutes walking distance from Union Station and it has the typical town house based urban contexture mixed use on H street: residential and commercial.

H street is one of the most popular commercial destinations of DC since the 1920s. Similar to many other commercial regions in the city center, the once flourishing street life has gradually wiped out of people’s living. Now the street is experiencing the regeneration, which includes the construction of the street car, small scale of renovation of the retail spaces along the street and cultural facilities, most importantly, people begin to have the confidence of the street development and moving back again.

There will be large scale of regeneration project above the bridge, which give my project a broad mixed use urban contexture. And how to realize a transformation of large scale project above the bridge to the relatively small projects on the H street will be one of the focus of my project.
Figure 14. Site map

Figure 15. Sanborn map 1928

http://sanborn.umi.com/

Figure 16. Baist map 1913

http://www.loc.gov/index.html

Figure 17. Sanborn map 1959

http://sanborn.umi.com/

Figure 18. Baist map 1921

http://www.loc.gov/index.html

Figure 19. Analysis of the existing buildings on site

There are five buildings in the site. Two of them are temporary house which will be removed from in my design. The other three are town house and in well condition. The vacant spaces between these three existing buildings are in two different scales, one is a typical 6-7 bay of town house space, the other is one typical town house space.

The site is located in the east gateway of the street, it is the first block of the street. This makes my thesis project the landmark of the entire H street.

The site also experiences the sensitive transformation from the larger scale of urban context like Union Station to the smaller ones, the 3-4 stories town house along the entire H street.

Figure 20. Analysis of the sun light and air circulation

Sun angle will change during different times of the day and different days through four seasons. During summer, shading space of the building should be created. Measures such as louvers on the windows, shading panel above the window can be adopted. In winter, the warm sunlight can be one of the major nature heating resources of the building.

In traditional town houses the nature ventilation is mainly depends on the windows of the front and back wall of the building. Usually, the south facing windows are not big enough to let the fresh air in. And the vertical ventilation is not good enough.

Research on Green Design Concept

How to understand the green concept. Does it mean that green is only the substitution of the sun energy, fresh air and natural light? Of course, these are all counted in green design. But there should be the spirit of green design from ARCHITECTURE perspective.

Sun angle will change during different times of the day and different days through four seasons. During summer, shading space of the building should be created. Measures such as louvers on the windows, shading panel above the window can be adopted. In winter, the warm sunlight can be one of the major nature heating resources of the building.

In traditional town houses the nature ventilation is mainly depends on the windows of the front and back wall of the building. Usually, the south facing windows are not big enough to let the fresh air in. And the vertical ventilation is not good enough.
Figure 21. Analysis of the wind of the site

As far as my site I analyzed the wind in winter and summer seasons. During the winter, the dominate wind direction is N-NW. In the summer, the dominate wind direction is S-N.

In this process, the wind flow has slightly grouped or changed so that it can pass through the site. The north-south axis of the existing buildings made the winter wind distribution easier, which made me have a clearer understanding of the wind on the site.

Figure 22. Dominate wind in winter and summer across the site

The trees on the site have an impact on the wind on the site. The wind speed has been slowed by the trees.

Figure 23. Air circulation through the typical town house (above)

The shadow parts of the diagram are the open and public space of the town house, such as court yards or the back yards. The air flow through the open space of the town house can promote the natural circulation of the building.

Figure 24. Diagram of wind circulation whenever there is one building, two buildings, buildings with landscape. (opposite above)

For one building, the only way for wind penetration is the openings on the building, such as the windows on the front and back walls of the town house.

For two buildings which have the perpendicular space relation, except from the openings on the buildings, the wind path can also be the space between the buildings.

Buildings with landscape can moderate the negative impact of the wind in winter time.

Figure 25. Shading analysis of the existing buildings in different time of July 1st (right)
Based on the thorough research of typology of the town houses and apartment buildings’ overall physical forms, including response to the nature environment, gardens and relationship with streets and blocks, a sustainable strategy focusing on the diversity possibilities of human activities based on urban environment has been developed. This is a city within a building. It provides nearly all kinds of the dwelling needs which is properly when it is located on a once prosperous commercial street and a place located in the five minutes walking distance from a major transit center of the city.
Sun, wind and light

How to bring air, sun light and daylight in my project is the main issue I focused on. Take advantage of the channels formed by the parallel walls between the living unit and different shape of openings of the facades, the whole building has become a container for sun, wind and light.

Figure 36. Study model-the retail space on the street floor and the sunken plaza
The ground floor of the building has been freed from the limitation of the traditional parallel walls of the town houses.

Figure 37. Study model-the typical living unit
A courtyard has been inserted in the middle of the living unit for better nature light and air ventilation conditions of the interior living environment.
Figure 38. Study model - the mixed use project combined with channels, full of sunlight, nature light and fresh air.

Figure 39. Study model - the typical living unit combined with live and work spaces.

Figure 40. Study model - mixed use.

The structure of the office space is column structured. The living space is made of walls which is the typical structure and functional features of the town house.

Figure 41. Study model - view from H street.

The strong contrast of the public and private facades of the building comes out of the understanding of the traditional town houses. On one hand, they formed the continuous streetscape outside. On the other hand, they contained the terraces, balconies and backyards for the private life interior.

Figure 42. Site plan 1:500.
Few building types come with more constraints than town houses. They are tightly enclosed, with somewhat awkward interior arrangements and rooms often piled-up vertically. Town houses bear the public and private spirit at the same time. They belong to the part of the street with uniformed street facades. Also, they have the pleasant private life spaces, terraces, balconies and backyards. They have the feature to be treated as an individual unit and as a group. They form the continuous streetscape and claim the individual property firmly by parallel walls between each unit. Though the town house is a typology of enormous restrictions, it is a laboratory of creative possibilities within a very limited realm.

Figure 43. Model study of typology
From left to right: Model research of the structure of sky village, town house, collective apartment, coffee. All of them are oriented from the traditional townhouse, which are structured by two parallel partial walls.
Gardens have become one of the most inspected development elements of the town house. Different shapes of the garden with versatile plants, flowers, colors and smells have been piled vertically and connected them via the door stair and corridors, combined with the elements of the air flows in and out of the building, thus a beautiful music comes out of the music instrument.

In my design, the light of sun set has been introduced into the building through the big west opening of the tower. Whenever the moments of open/close of the door, there would be light penetrate the tower and form the light axis of the podium.

The eco-system comprised of green outdoor spaces, such as roof gardens, terraces, balconies. All of the green plants of the system are coming from native places, they take advantage of the rain water collecting and recycling systems to realise the balance of irrigation and maintenance.
Live/work units embodied the essence of adaptation of town house to urban site layout. Aside from the compact physical envelope, the flexibility function of the ground floor has become the other most important feature of the town house. The green feature of the housing is the solar house in the south, which is the dining room and kitchen of the house. This solar house can absorb solar energy in winter and transfer heat and energy to the interior space of the north and also upstairs to the bedroom.

Aside from the public space in front and the private back yard, there is an alley between each two live/work units. These alleys not only provide a semi-public space belonging to the house, but also form a channel for fresh air flow into the atrium of the building.
Figure 58. Collective apartment

Collective Apartment meets the needs of young professionals by maximization. Their dwelling require flexibility between day and night, high efficiency and social life. The green feature of the housing type is its high density and efficiency. According to the living patterns for young professionals and students, the design of the house emphasized on the day/night flexibility. During the day, the bed can be put inside the space below the closet forming a live/work space for the occupant. At night, when the bed is pulled out, the live unit becomes a typical bedroom. In this way, the efficiency of the housing has been improved. The corridor, kitchen and balcony have become major public and communication spaces for the dwellers.

Figure 60. Collective apartment level 3 plan

The street view house has been retained in my final design. The design concept lies in the promotion of communication among neighbors. The house is a short depth south facing housing type, which can use its natural and sunlight well and its high design maximized the ventilation of nature.
Figure 63. Town house plan

Town houses were elevated from the ground level. Its typology is stemmed from the traditional town house. The improvements lie in the use of natural light, fresh air, the sky court yard and the connection with the street live downstairs. The green feature is mainly about the use of sun energy in the south and daylight. The court yard in the middle can facilitate the flow of nature air. In the final design, the depth of the house has been shortened to introduce the light and air for the public space of the third level.

Figure 64. 3D model of town house

Figure 65. Hotel level 1 plan

Figure 66. Hotel level 2 plan

Figure 67. Hotel level 4 plan

The green feature of the design is introduce a light atrium in the middle of the building to let in the sun light and fresh air. All the hotel room have been arranged in the two ends of the building.
Final Proposed Design
Figure 72. Level 2 plan

Figure 73. Level 3 plan

Figure 74. Level 6-12 plans
Figure 81. East elevation
Figure 82. South elevation
Figure 83. West elevation
Figure 84. North elevation
Figure 85. Detail section of sunken plaza
Figure 86. Sunken plaza plan
Figure 87. Section of sunken plaza plan
Figure 93. View of the north elevation.

Figure 94. View of the live/work unit and the sky village.

Figure 95. Shadow casted by the north facade on H street.

Figure 96. Street view of the windows of the Sky village.

Figure 97. View of the main entrance.

Figure 98. View of the north windows of the sky village.

Figure 99. View of the north facade of the hotel.
In the original design, there is a big horizontal opening in the north elevation. The design concept of this opening is to make people on the street to be able to see the interior activities inside of the building. Since I thought it is a spirit of H street, I hoped this big opening can be a media to embody this spirit.

But there is a conflict between this opening and the small scale of townhouses, which are three to four stories and 5-6 meters wide. So I redesigned the north elevation according to the comments of my committees to establish a harmony and continuous relationship with surrounding urban context.

In the design, I divided the north elevation according to a basic 5-6 meters width system. It is a system which combined with mixed-use functions, such as retail, office, culture and entertainment, and also green spaces, such as three full building height gardens and green path along the office space.

There are two layers of elevation system of the facade. The exterior layer is comprised of translucent glass with tiny holes system, which would have the fresh air coming in and out. The interior layer has the rational opening needs for different functions inside.

Bibliography


VITA

WEI YAO

Education

01/2009-12/2009
Master of Architecture, Virginia Polytechnic Institute and State University.

03/2002-11/2005
PhD in Architecture Design and Research, Tong Ji University,

09/1999-03/2002
Master of Architecture, Tong Ji University,

09/1994-09/1999
Bachelor of Engineering in Architecture, Tai Yuan University of Technology.

Professional Experience

02/2006-08/2008 Architect, John Portman & Associates, Shanghai

2006, Watercolor Artist, RTKL, Shanghai (part time)

2003-2004 Project Architect, Shanghai Da De Planning and Architecture Design Co., Ltd

1999-2003 Architect/Researcher, City Planning Institute, Tong Ji University