Sustainable Urban Design in China

by
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Abstract

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What constitutes sustainable architecture? Clearly, this is a question very much in vogue nowadays, and contemporary responses have been framed for the most part by topics such as new building technologies, energy conservation, climatically and environmentally responsive design, recyclable materials, and so on. Though sustainable architecture must certainly be about many, if not all of these things, my thesis proposes a much more familiar architectural response. Namely, I argue that the design of spaces that facilitate and promote communities is not only a necessary condition for a sustainable architecture, it is the necessary pre-condition.

How does an architecture facilitate and promote communities? I have chosen the problem of housing as the vehicle to answer this question, because I believe one's living arrangement ought to be a critical opportunity for community life. To take advantage of this opportunity, I have tried to provide for variety and flexibility in public spaces, because these contribute directly to the viability and longevity of any community. I have tried to think of ways that architecture can actually give people something to do, activities that can be shared, perhaps even by cross-sections of society that do not typically have much to do with one another, because such successful collaboration is essential for the vitality of any community. And I have tried to strike a realistic balance between the day-to-day demands of contemporary lifestyles and the long term goals for a globally sustainable environment, because communities can best be expected to thrive when the needs of both the present and future generations are met.

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Andrew Scott
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Introduction

Notwithstanding that global ecology has become increasingly prominent in people's minds, conditions are getting worse. Simply put, there is an increasing demand being placed on a decreasing supply of natural resources, and this disparity is growing exponentially. Housing represents a critical dimension of this problem. World population had remained relatively stable for 7500 years, but increased five-fold in the last 500 years. Moreover, the population is expected to be 10.02 billion in 2050, nearly double what it was in 1994. However, in the same time frame, inhabitable land has largely remained the same. History's solution to this problem has been the urbanization of world demographies, i.e., large-scale migrations towards denser concentrations of people. The question is whether this has proved successful; certainly, evidence of the global environment dramatically worsening would contravene this success.

In its farthest-reaching implications, my thesis shall posit an alternative to past patterns of urbanization. In doing so, I assume that such patterns have not been entirely successful as solutions to the aforementioned disparities, owing to the ecological devestation they have wrought. Moreover, I shall also assume that the solution must be an urban one, as opposed to, say, a rural one which might entail the return to agrarian societies. My reasoning here is that non-urbanistic proposals are essentially non-starters insofar as they contradict the presumably irreversible trend towards increasing densities of habitation. The question is whether these densities can be achieved in significantly better ways than we have seen thus far.

Specifically, I shall propose a project for sustainable housing in Beijing, China. My reasons for choosing this location are as follows: firstly, because of the unique situation in the world that Beijing and China occupy; and secondly, because of the unique opportunities being afforded here by the Building Technology department's work in sustainable urban housing in China.

The site I have chosen is located on the eastern edge of Tsinghua University, located at the northeastern edge of Beijing. This choice is the result of a number of factors. Firstly, the Architecture Department here at M.I.T has had a long-standing collaberation with their counterparts at Tsinghua, and as a consequence, a wealth of resources are readily available to provide for a robust investigation. Secondly, and more importantly, the campus itself provides for an interesting case. It has long been engaged in efforts to create a more sustainable campus, but the results have been questionable at best. What it does have working in its favor, however, is its own history. Originally the site of the Royal Gardens for the Imperial family, it remains something of a sanctuary in the middle of a city that has largely been a disaster of urban sprawl. It is, in its own rights, a city within a city, and is currently in the throes of massive re-development. In fact, I would venture to say that Tsinghua is at a critical moment in its own urban history. Although some of the first indications of its direction are not very promising, it is not too late. But a different strategy for urban design is needed, and it is the articulation of this strategy that is at the heart of my project.

A Definition of Sustainability

What does sustainability mean in the context of the built environment? In the broadest sense it can perhaps be defined as an adherence to the following goals:

> ecological balance (preserving the resilience of natural environments and balances); economic performance (enabling markets for generating production and consumption patterns); institutional capacity (meeting the organizational needs of private entities and firms and public agencies); and viable governance (ensuring effective policy, regulation, and accountability).[1]

At the level of the building, sustainable architecture can be defined as a

> means of making buildings that are more user responsive, more humane places to inhabit, more intelligent in the way they balance their energy flows, more respectful of nature and the resources it offers, and more understanding of buildings having a life span during which they undergo substantial change and adaptation. Put together, it simply equates to better designed places in tune with the environment.[2]

In fact, the meaning of sustainability is a topic worthy of being a thesis topic unto itself, and is not the subject of this thesis per se. Nevertheless, as the immediately preceding definition would suggest, it seems safe to say that sustainable architecture is by and large synonymous with what we generally understand to be good architecture: namely, the design of interesting and engaging spaces which represent a qualitative improvement in our lives.

To this, I would like to add further that sustainability must also entail the design of spaces which are succesful in fostering and promoting community. It is not enough to ponder one's own relationship to the environment-- we are no longer islands unto ourselves, and the actions of our fellow human beings, we have learned, can effect the natural environment in ways that have direct bearing upon any one individual's life. Moreover, it is clear that sustainability refers not only to the viability of the world around us, but also to our own viability, as a species, as collectives of persons, and as individuals. Since it is imperative that we facilitate our mutual cohabitation in order to ensure the longevity of each of these three groupings, the facilitation of community is at the crux of the issue of sustainability.

Nowhere are these issues more relevant than in China. Being in the first place, a communist country, and in the second place, a country with a long Confucian heritage that espouses the importance of social interconnections, the notion of community is one that must be dealt successfully in any architectural undertaking if that undertaking is to be at all successful. This thesis focus on this brand of sustainability. The question then becomes, how can we, as architects, design buildings and landscapes are not only inhabited by communities, but in fact make them flourish?

Notes

[1] Scott, p. ix
[2] Scott, p. 2

Methodology

By methodology, I mean a kind of procedural map that shall guide the process of design in its succesive stages. The methodology proposed here involves an examination of the problem of sustainable community design in a series of 4 scales: the scale of the city, the scale of the campus, and finally, a scale which addresses 3 proposed typologies.

The first scale is that of the city. The examination begins with some background on China in order to put the city in context. Next, the history of Beijing's urban development will be researched and an attitude toward the role that that history should play in the project design shall be arrived at. A discussion of the Forbidden City will follow, as it figures prominently in the shaping of Beijing's urban form. The city grid which resulted from the footprint of the ancient city will then be examined. Finally, the courtyard configuration, which is itself a derivative of the grid, will be introduced as a possible prototype for urban development.

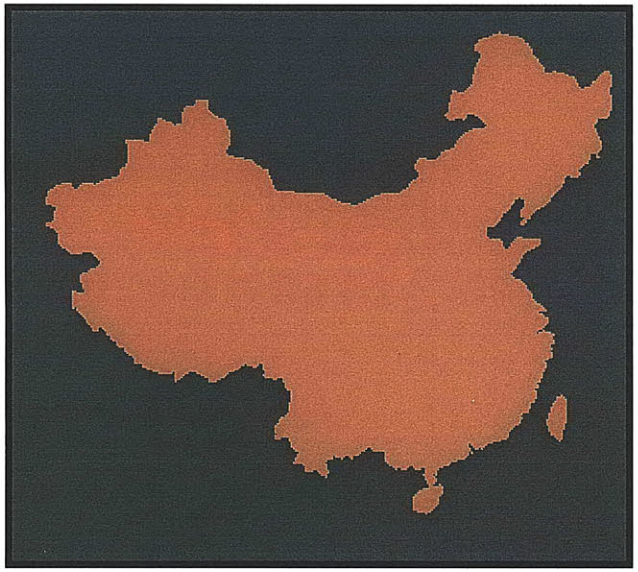
The second scale will be that of the campus. This investigation beins with background information on the University. Then, the campus's relationship to the rest of Beijing will be discussed. Next follows a study on Tsinghua's strategies for campus planning- past, present, and future. The major themes of Tsinghua' projected masterplan will be identified as a strategy for formalism and a strategy for zoning. Finally, the essential climate conditions of the campus will be articulated.

The last scale shall involve the proposal of three different building typologies. These typologies are the river-edge type, the live-work type, and the courtyard type, which receives the greatest degree of attention. Naturally, they are not meant to be all-inclusive examples, but rather embodiments of the main idea of a sustainable community design.

A Study of 4 Scales

At 1.3 billion persons, China is currently the world's most populous country, and thus represents a major challenge to any solution to the disparities of supply and demand in housing. With a projected population of 1.8 billion in 2050, this disparity threatens to be even greater. To confront these challenges, an estimated 2.5 billion square meters of total construction areas will be completed in urban areas in the next five years, and 3.5 billion square meters in rural areas. In other words, an area roughly equivalent to the size of Connecticut is being proposed as new built floor area for China.

Contemporary map of China

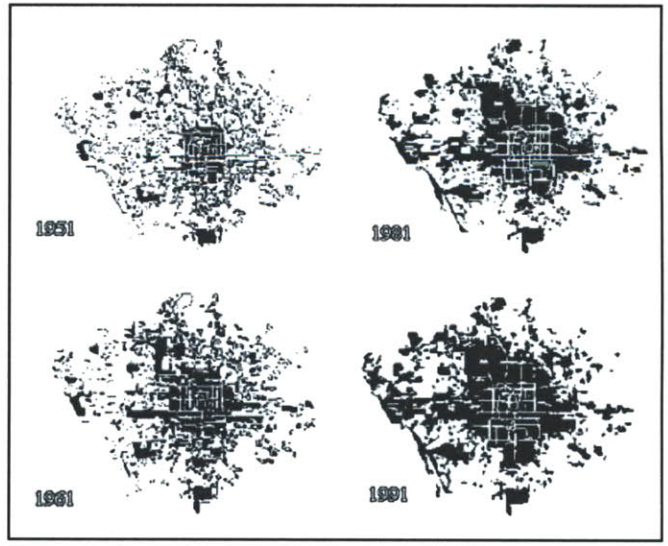


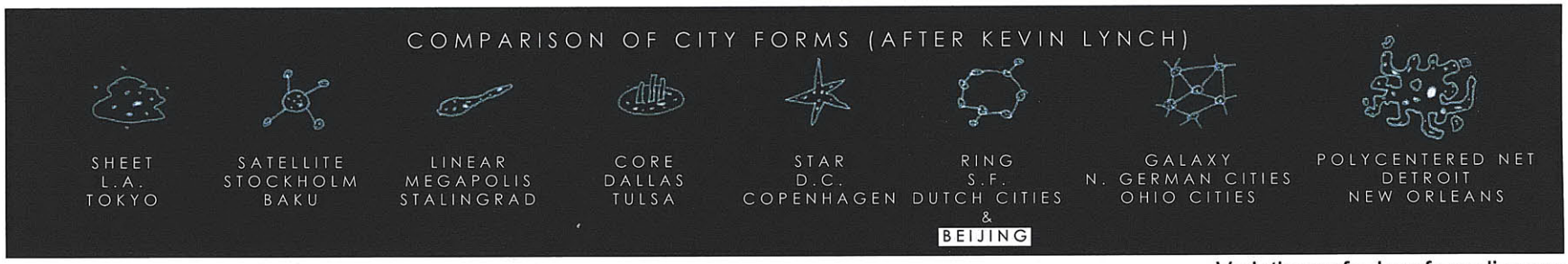
Cities and geography of China

Beijing, the nation's capital, is a hyper-example of these tremendous forces. As the below illustration shows, the densities of Beijing are growing exponentially. In 1998, 1.519 million square meters were sold for housing at 8.78 billion yuan. This represents an increase in square meters sold of 110 percent from just one year ago, but an increase in yuan spent on housing of 180 percent within the same time frame. Consequently, housing prices are currently more than twice the national average, at 4,100 yuan ($494) per square meter. If current trends persist, housing shortages will be so great as to be untenable for the long-term sustainability of Beijing. Recent dramatic increases in homelessness in Beijing are testimonials to this problem.

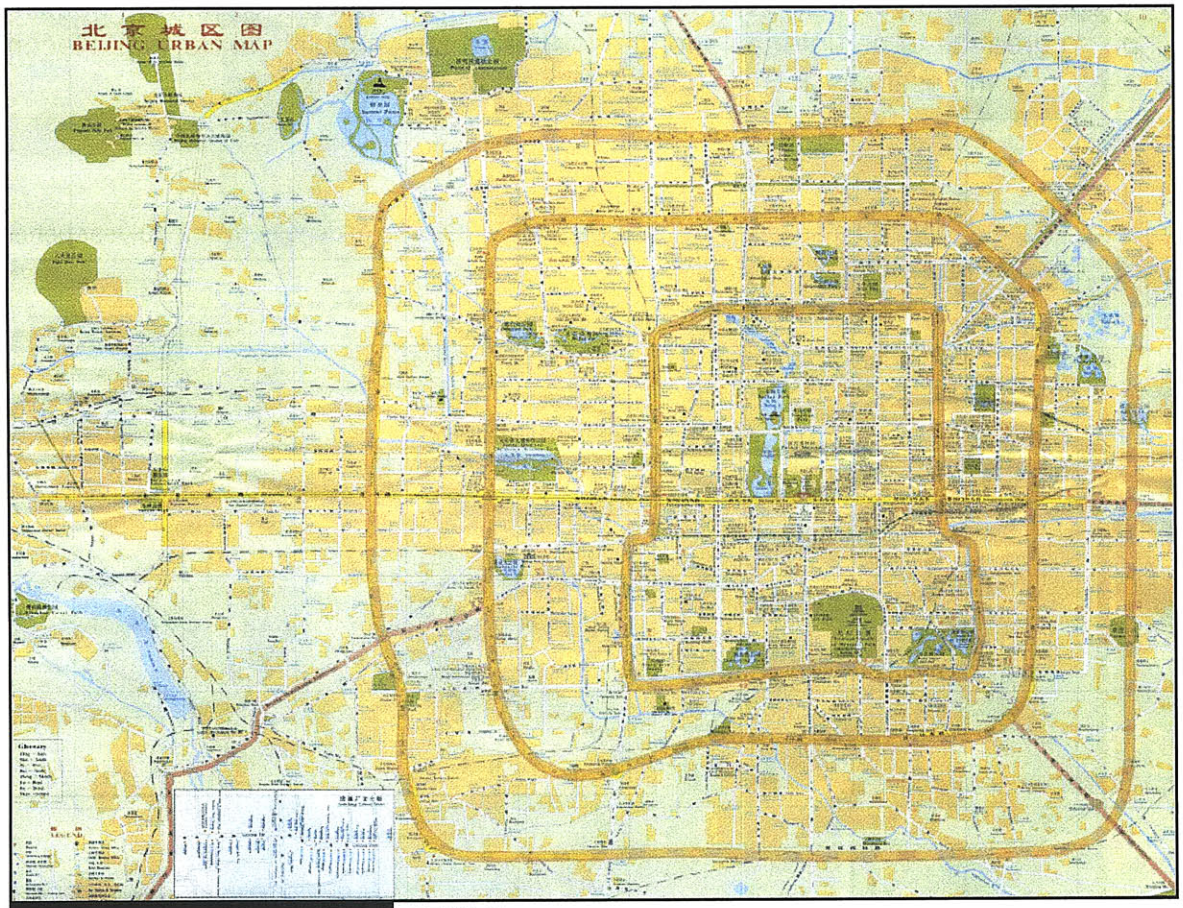
Road map of Beijing

Growth in density over a 40 year period





Variations of urban form diagram

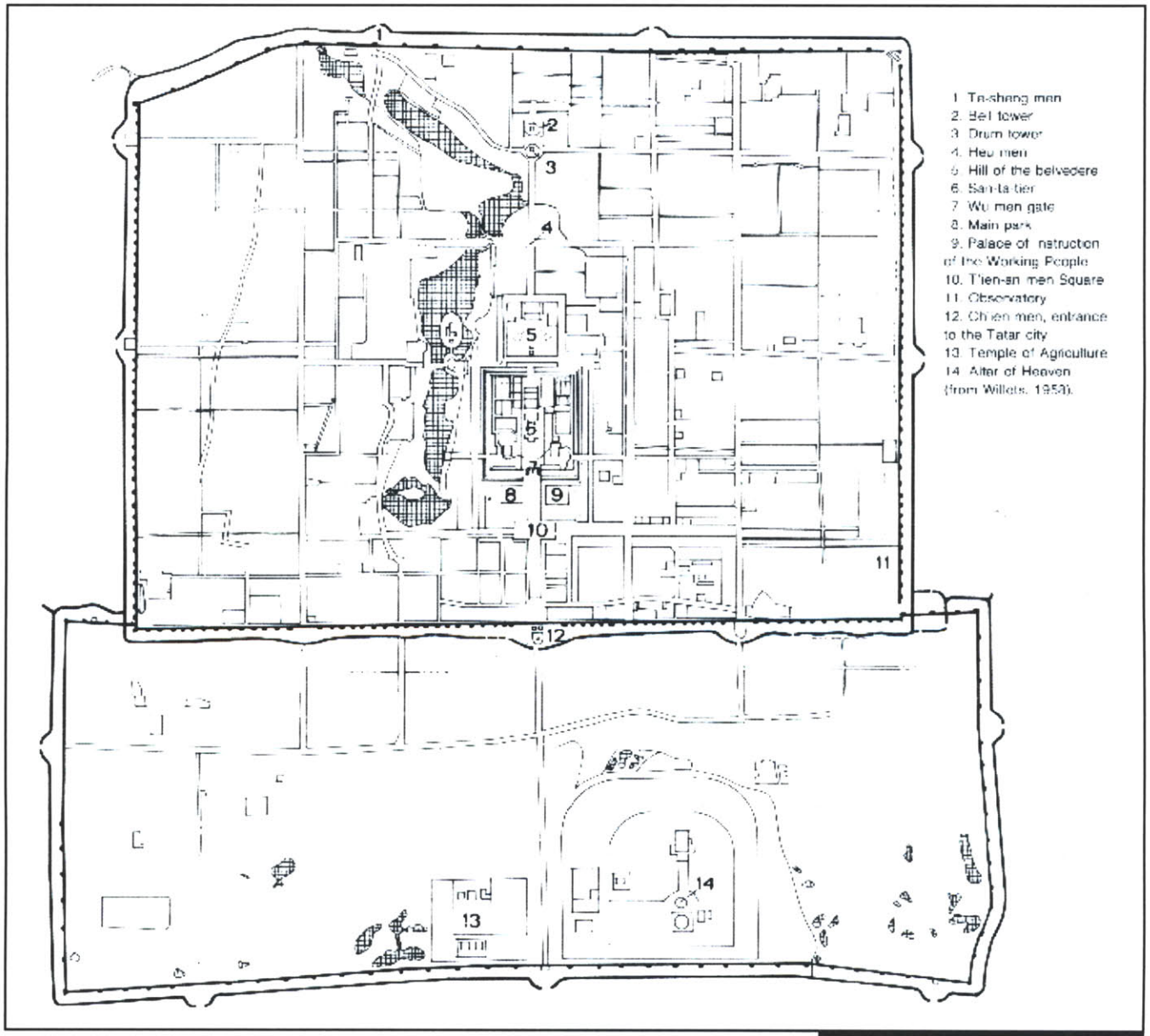


C I T Y BEIJING

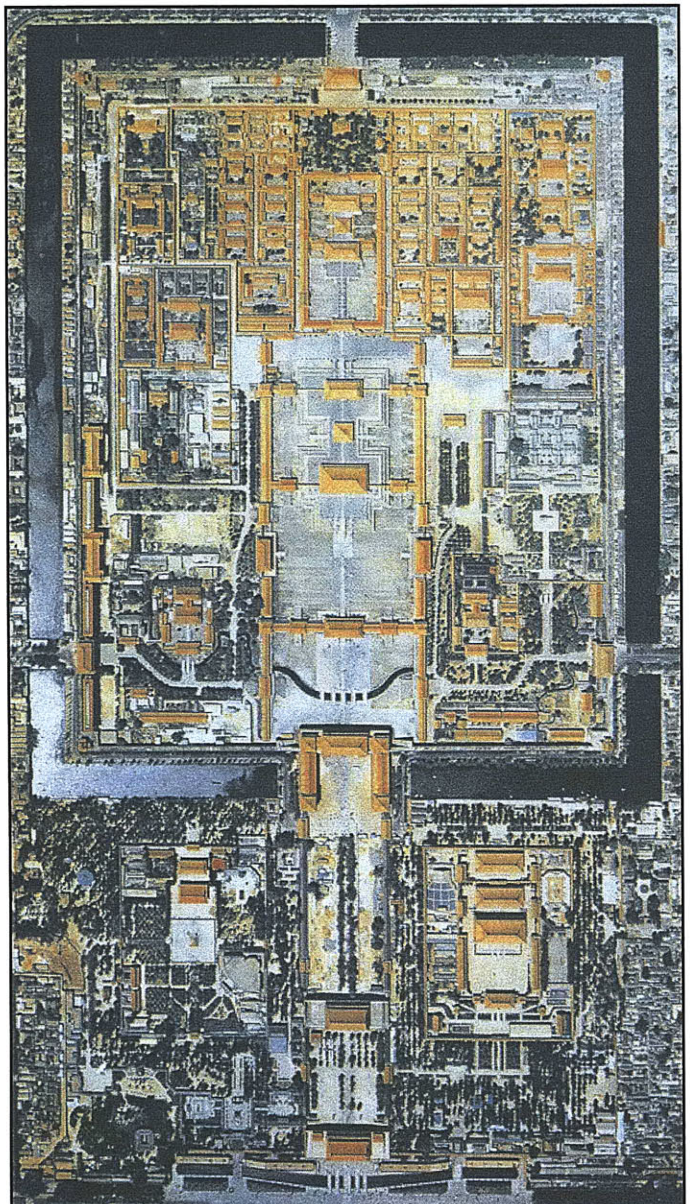
City map of Beijing, highlighting the ring roads

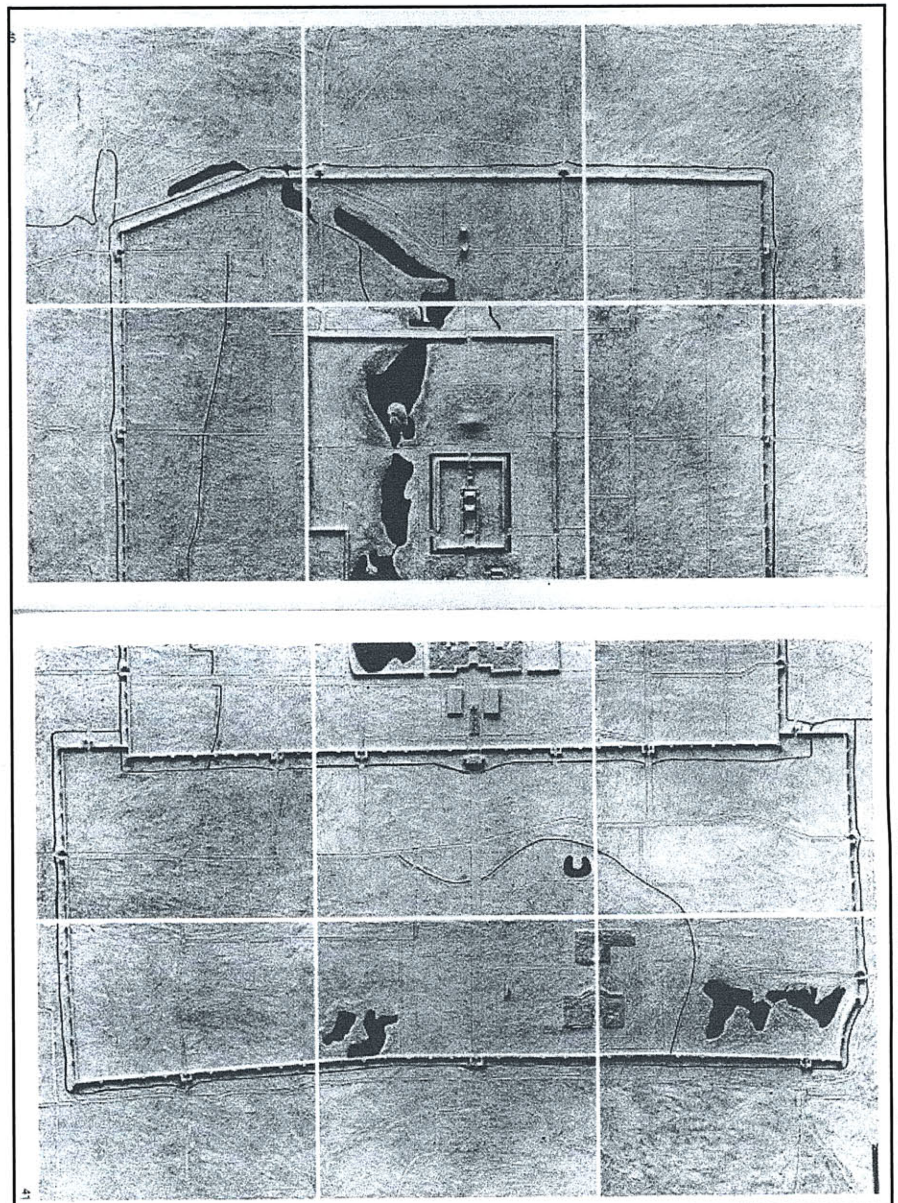
A comparison of city forms helps us appreciate better Beijing's essential urban form, which can be associated with a ring configuration. This form has its origins in the Forbidden City, which lies at the center of the city. The ancient city was encircled by a wall. When the city grew beyond these confines, the wall was demolished and a road was built on top, This process was repeated, resulting in a growth pattern of concentric circles. Beijing has undergone profound changes to these configurations, but traces of these original patterns remain in the 4 ring roads that define the city.

As a result of the centrality of the multiple ring configuration, a strict hierarchy of space was established. In the Forbidden City per se, this was accentuated by placing the emperor's seat in the north, at the base of the mountain, and the temple, the seat of the gods, at the center.

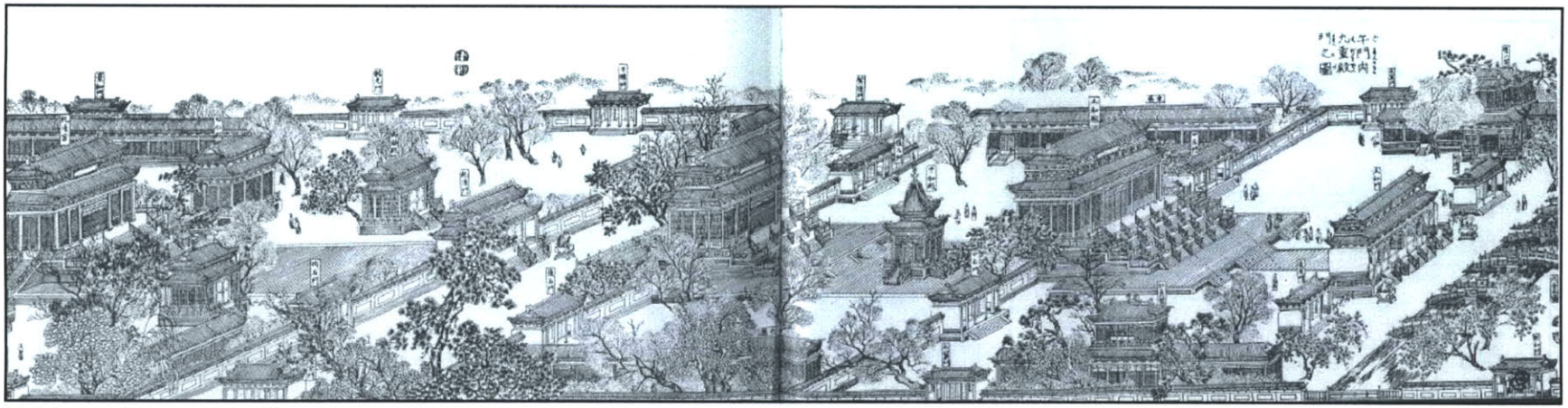


Map of the Forbidden City





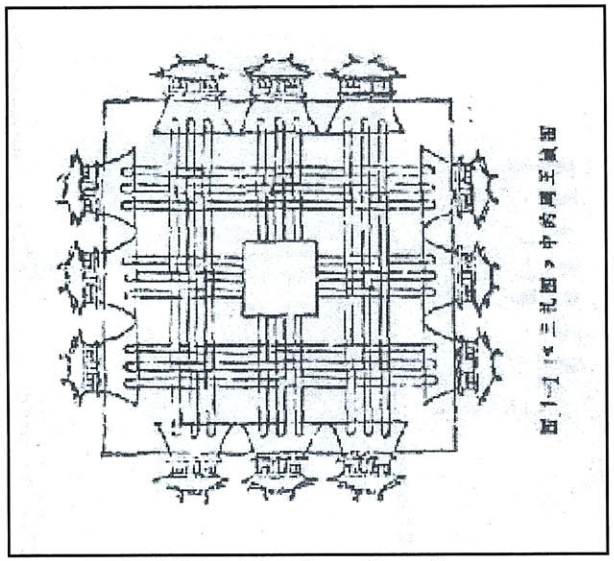
Aerial views of the Forbidden City



Forbidden City in ancient times

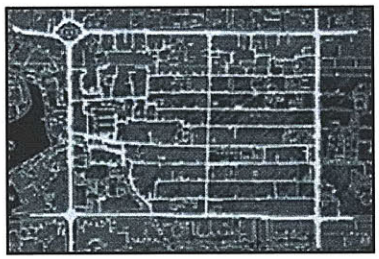
One of the most conspicuous characteristics of the Forbidden City is its horizontality. Not only is it largely flat, but the planar quality of the ridge roofs reinforces this horizontally, and this feature has defined the nature for all of Beijing, both in the past and in the present.

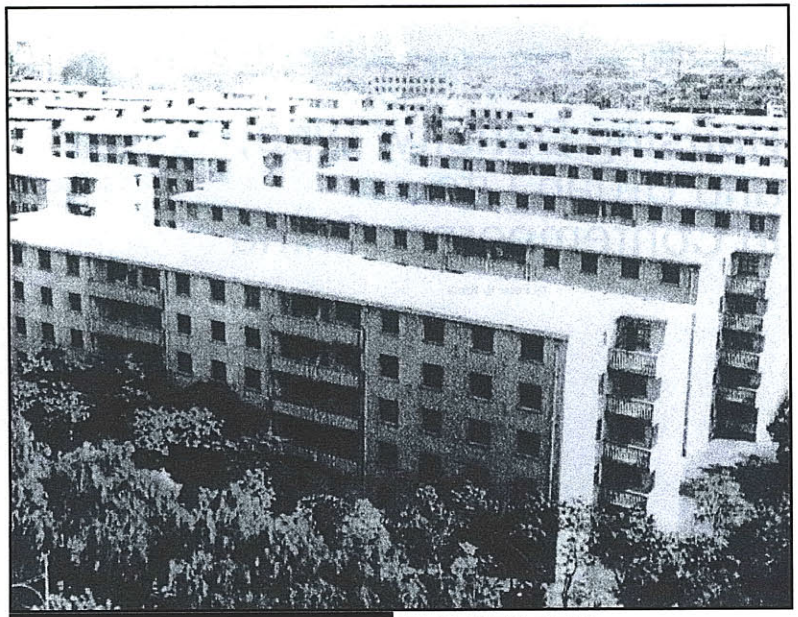
Photo of present day Forbidden City & Beijing in the background



Original 9-cell configuration

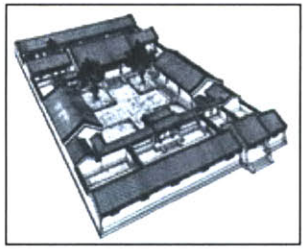
Fishbone block pattern



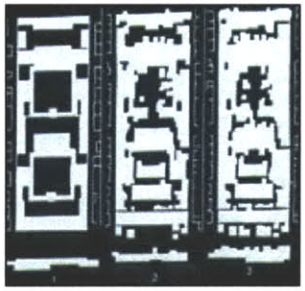


Contemporary example of housing in China

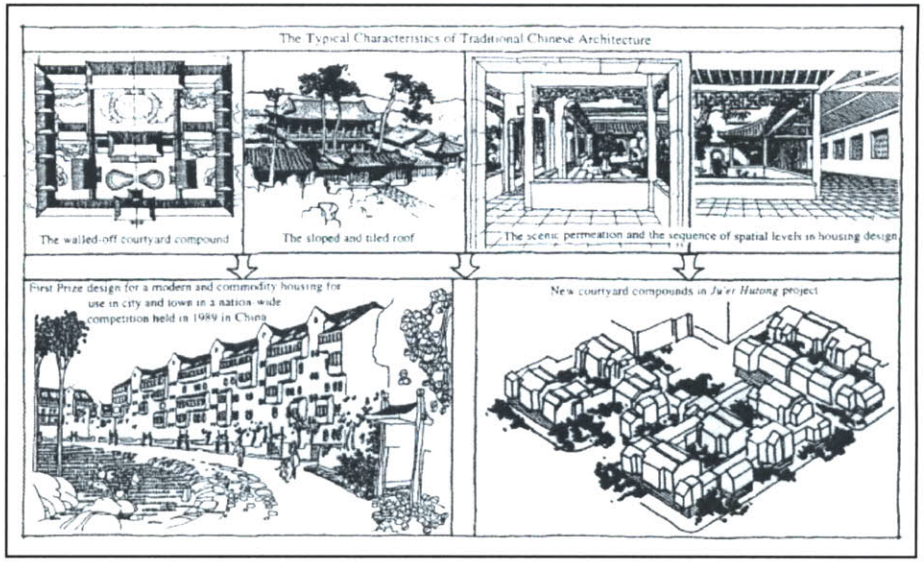
The influence of the Forbidden City on the rest of Beijing has been pervasive. One of the critical examples of this has been the proliferation of the original 9-cell grid pattern into the contemporary urban fabric. This orthogonality has resulted in a scheme that can be characterized as a "fishbone pattern," with major roads along the perimeters, long blocks oriented along the north-south axis, and a minor arterial in the middle for enhanced accessibility. One unfortunate consequence of this has been a tendency to design buildings that fit easily into this rigid orthogonality, thus resulting in monotonous and repetitive building blocks.



Traditional courtyard prototype



Densification of courtyard type

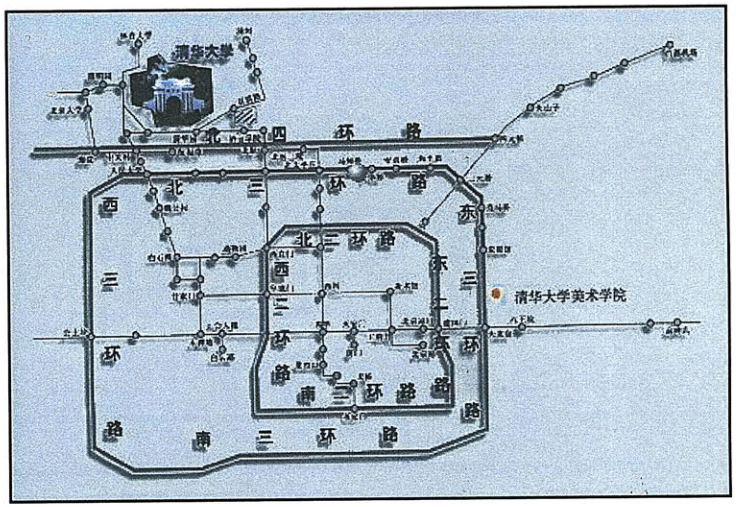


Transition of traditional forms to contemporary models

It is clear that the traditional precedents could be employed in much better ways. One promising example would be the courtyard configuration. This involves a rectangular void space defined by surrounding buildings. In fact, the courtyard still persists in the central areas of the city, although, as a matter of necessity, the density of its configuration has greatly increased.

Densification of courtyard type

Aerial view of Tsinghua University



Campus location in Beijing

Tsinghua University is located on the northeast edge of Beijing. Public transportation to and from the campus is somewhat limited-- there are no nearby subway lines. Nevertheless, the area surrounding the University is thoroughly metropolitan in nature, although the campus itself has some distinctively agrarian features.

C A M P U S OVERVIEW

Like Beijing, one of the key features of Tsinghua's campus is its expansive horizontality. The campus itself is verdant and lush, which unfortunately is indicative of the excessive carbon monoxide in Beijing and the city's chronic pollution.

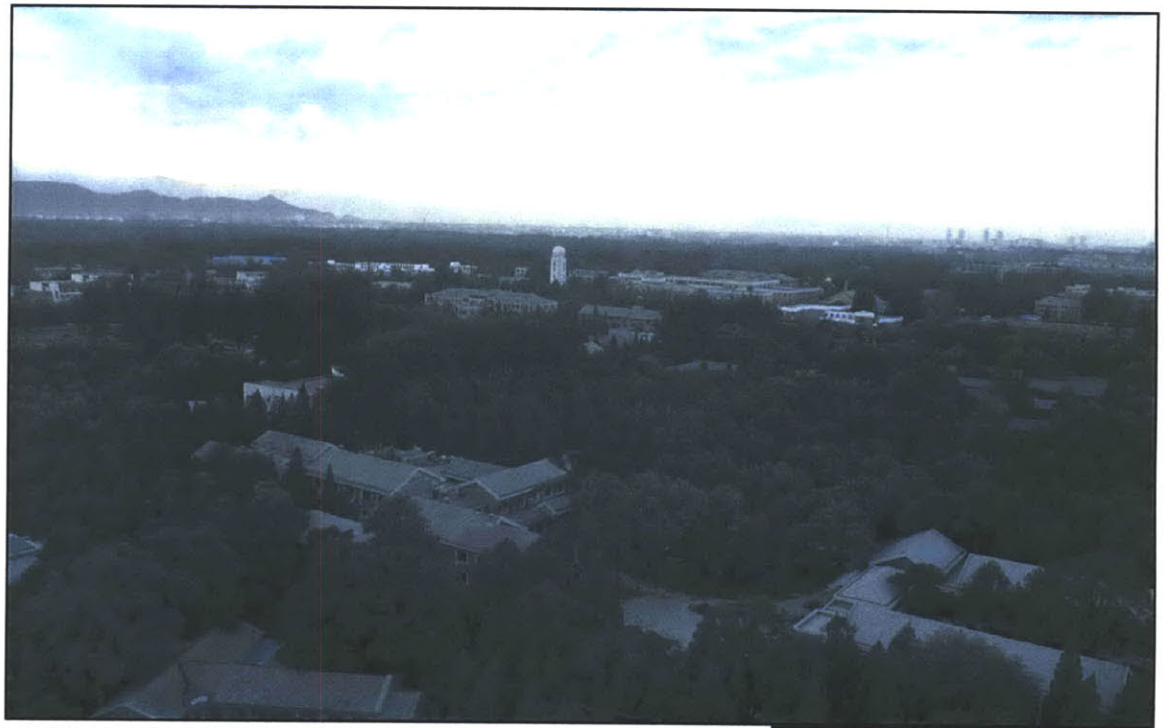


Photo of Tsinghua University

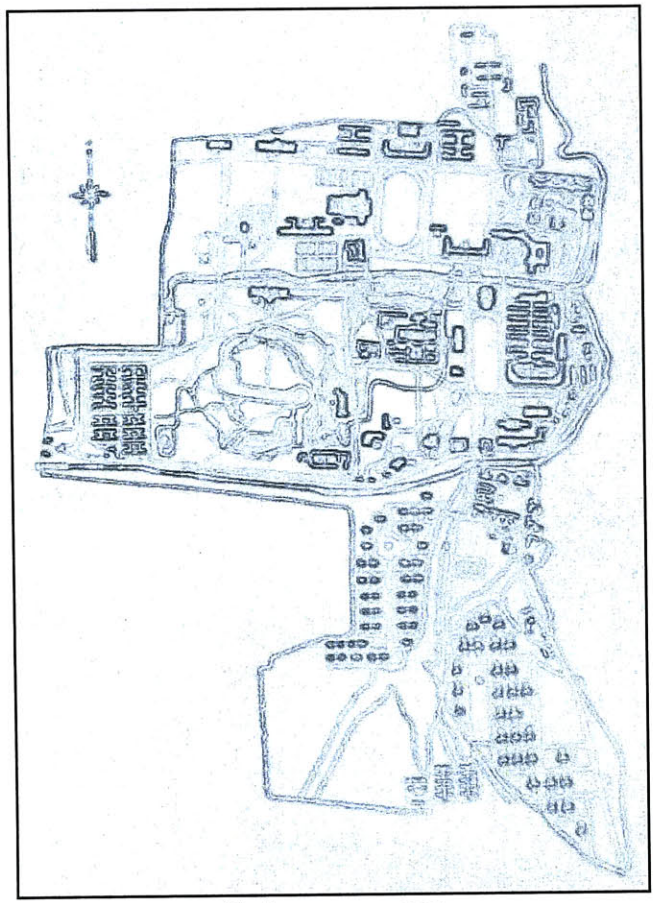
Like Beijing, the identity of Tsinghua University is defined largely by the presence of ring-roads. The entire campus is surrounded by a road, which, on the campus-side, is fronted with a wall, effectively seperating the university from the rest of the city.

Photo of Tsinghua University

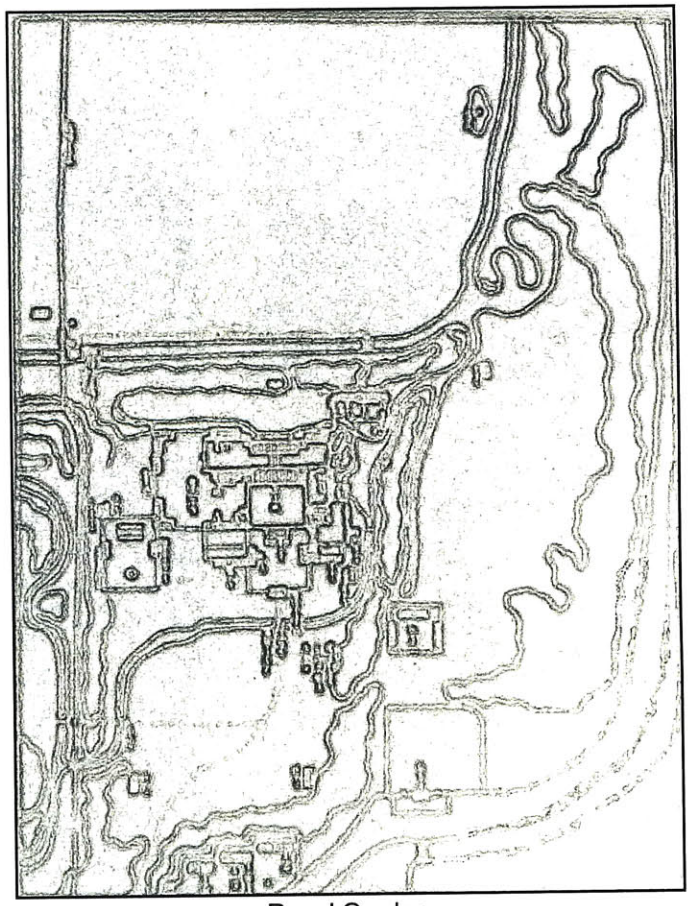
Detail of the wall

The road encircling the campus

The city at the edge of Tsinghua

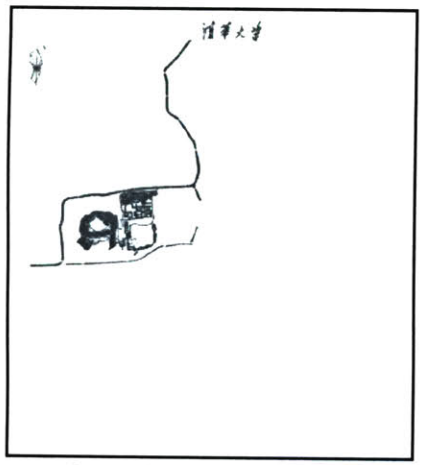


Early campus map

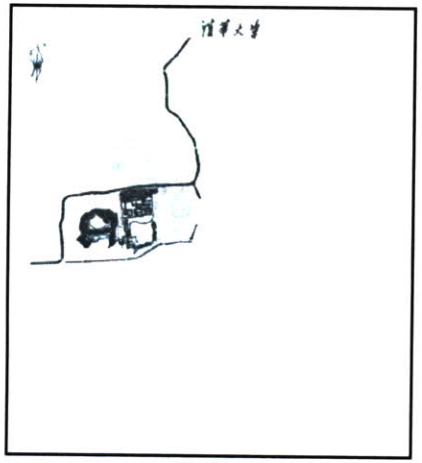


Royal Garden

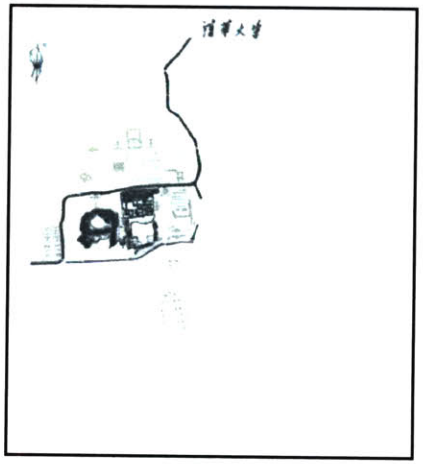
The University was originally the Royal Gardens for the Imperial family, and was converted to a university at the turn of the century. The footprint of the Gardens, including the lily pond and the river, remains largely intact today. The history of growth of the University mirrors the history of Beijing, and has likewise developed in concentric circles, expanding ever-outward.



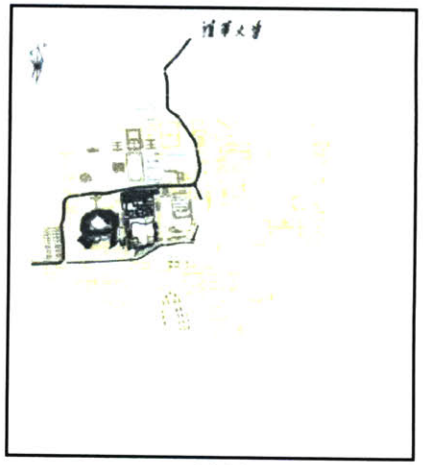
Royal Garden, 1762-1909



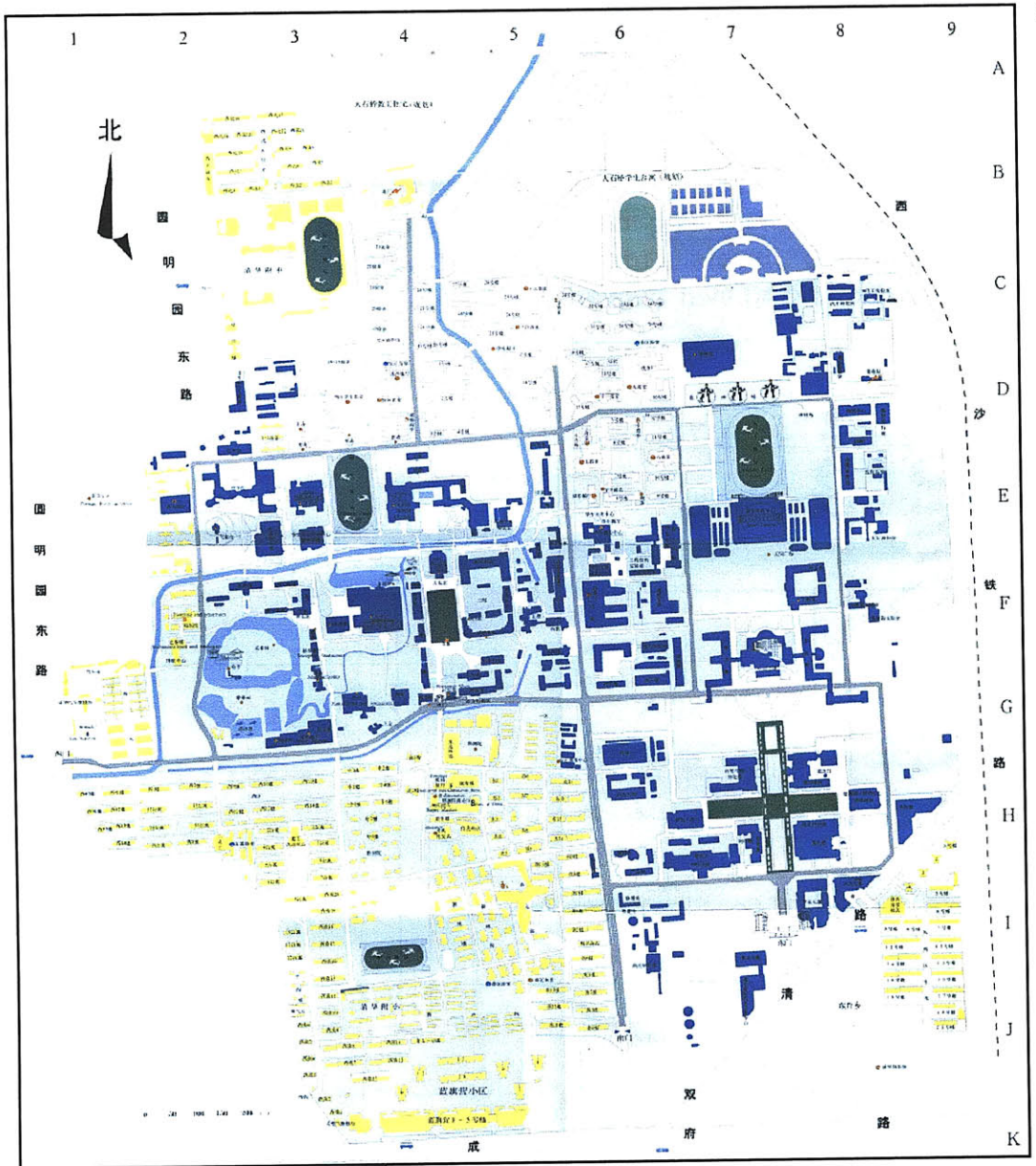
1935



1965



2002

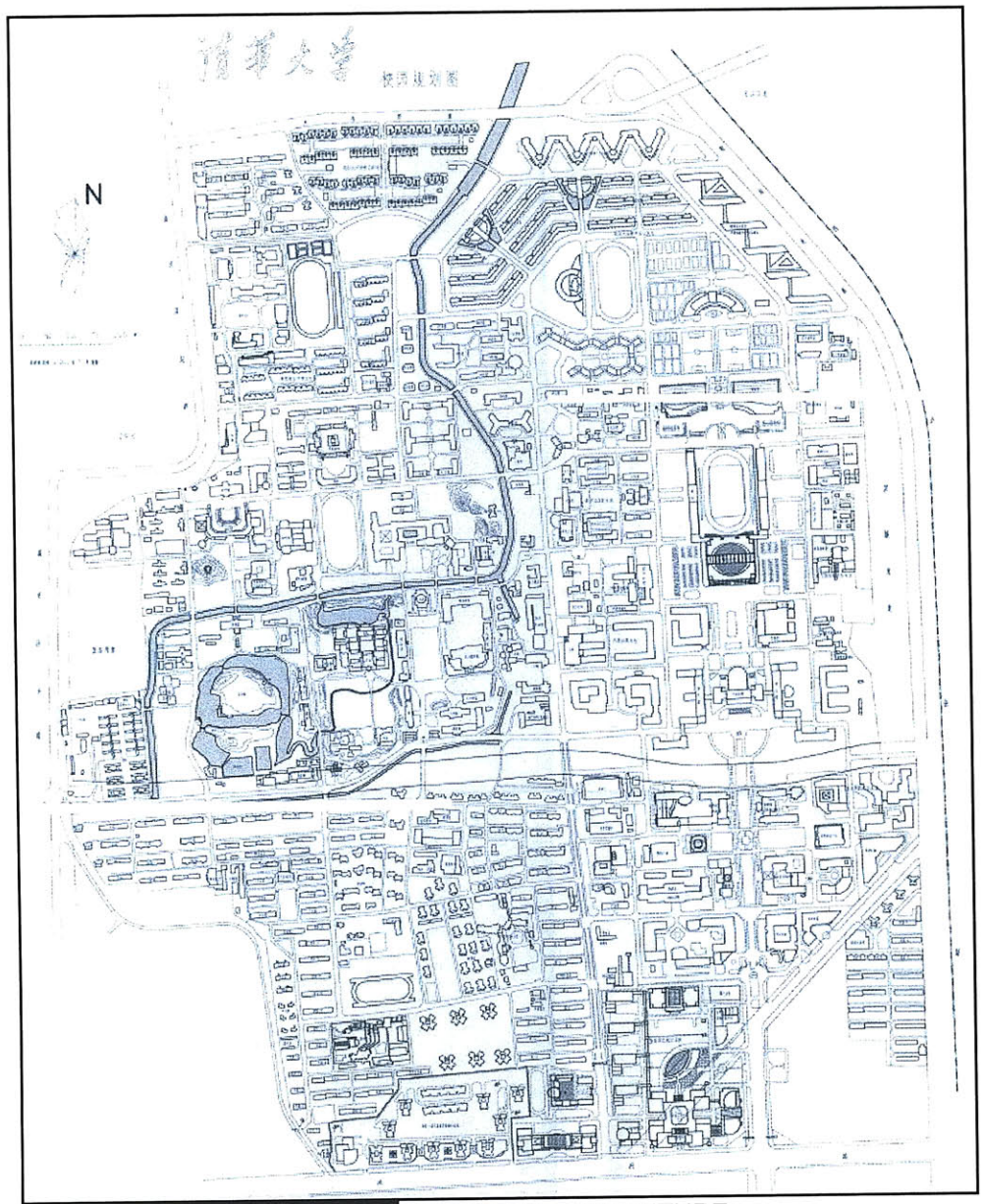


Present-day map of campus

In the map to the left, blue represents academic buildings, yellow represents faculty housing, and pink represents student housing.

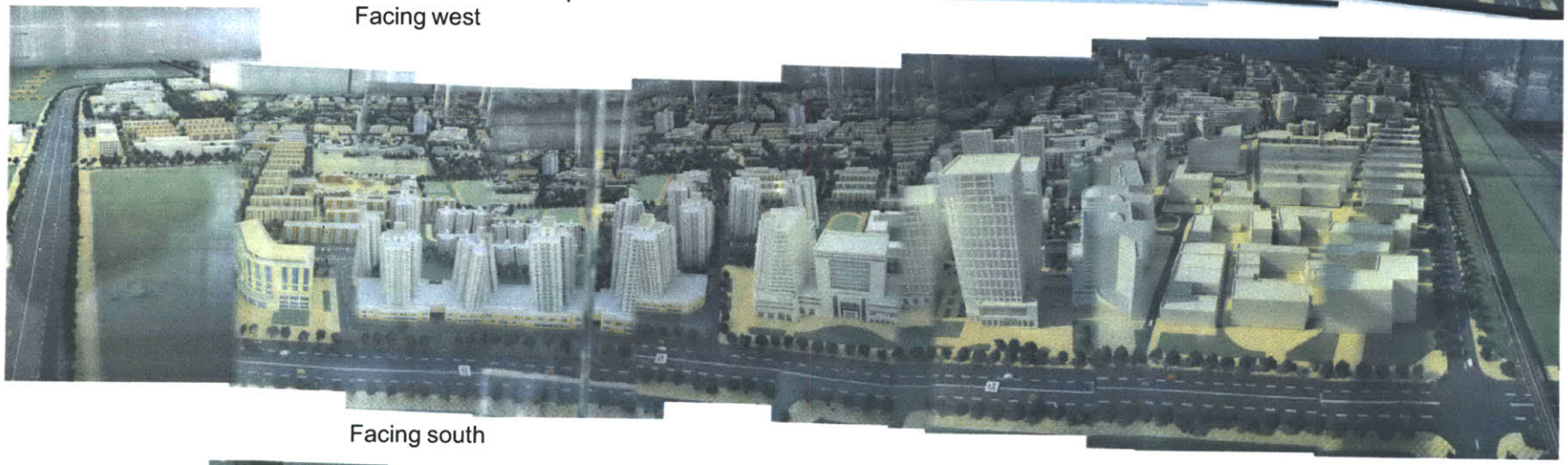
Masterplan for Tsinghua University

The map to the left shows existing buildings in addition to the scheme for Tsinghua's future masterplan. Brown represents academic buildings, dark yellow represents student housing, pink represents the science park, and light yellow represents faculty housing. The faded colors represent proposed building projects. Of particular note is the difference between the two halves of the University, divided by the central north-south road. The western older half tends to be more dynamic and much smaller in scale. The eastern newer half tends to be more formal, defined predominately by axial relationships, with buildings at a much larger scale.

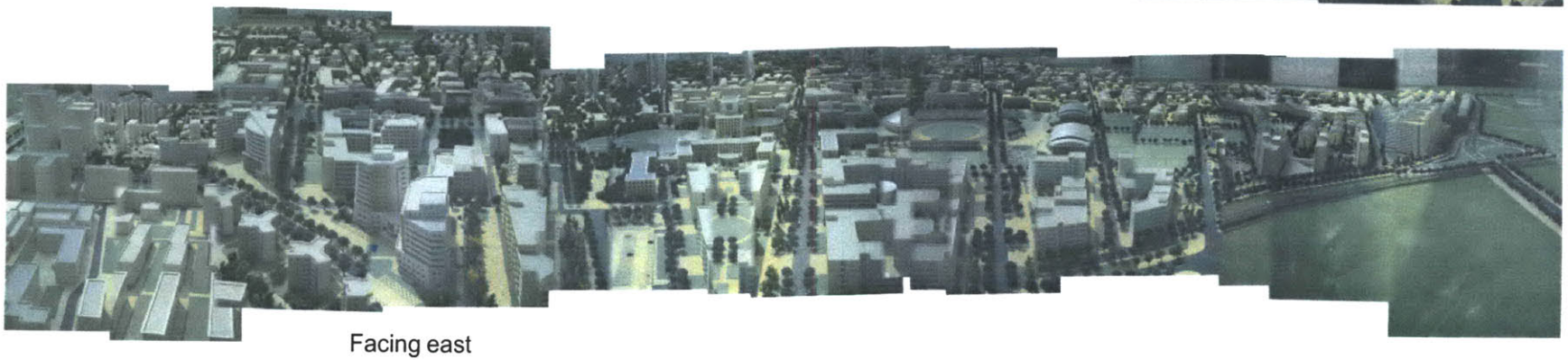


Masterplan for Tsinghua University

Model of future campus
Facing west



Facing south



Facing east

Diagram of urban forms

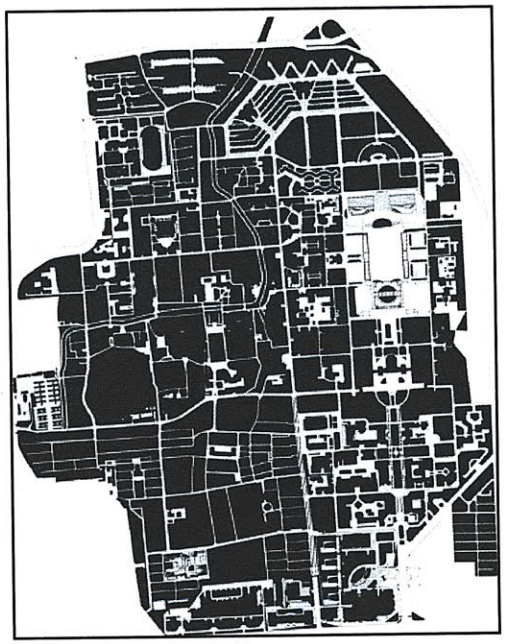


Figure-ground map
of the campus buildings

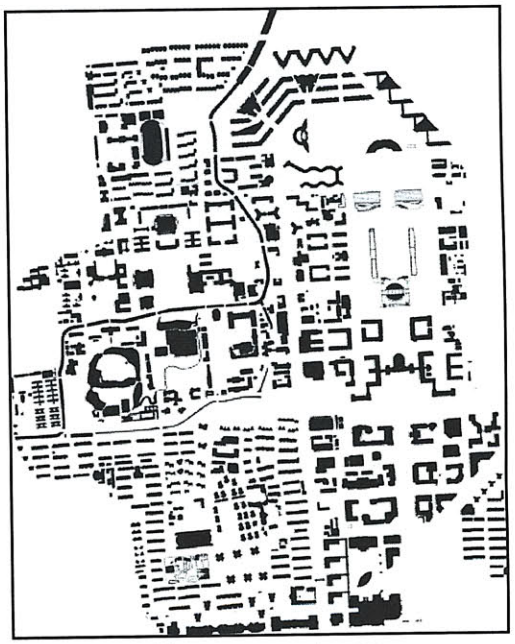


Figure-ground map
of the campus circulation

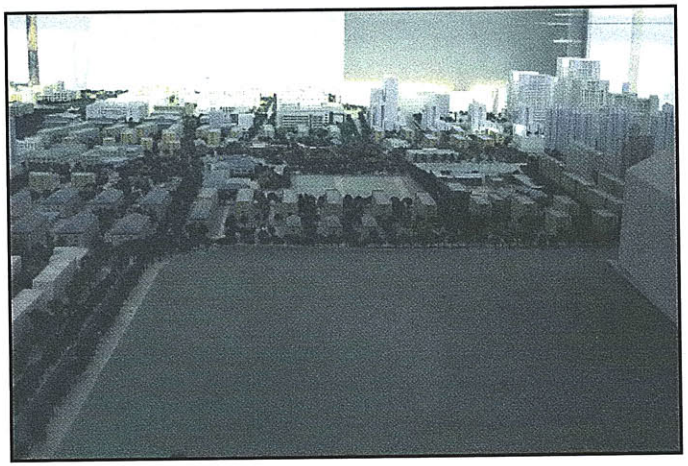
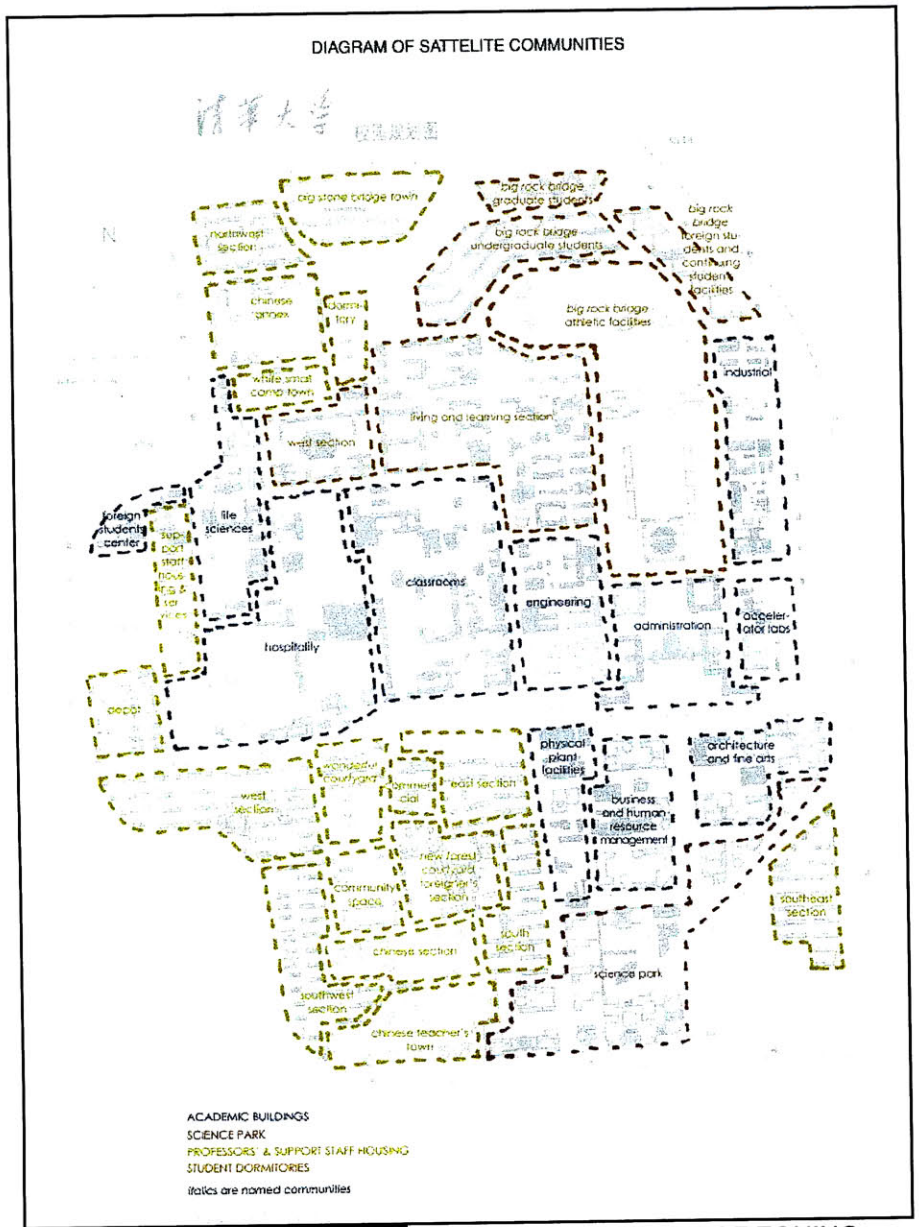


Photo of campus model, showing two halves of campus

Although it is clear that the present plan for Tsinghua University is bound for more formalism and masterplanning based on composition and magastructures, there is a better solution. As I will suggest, urban planning based on senisible grouping offers greater promise.

Model & photo of formal half of campus

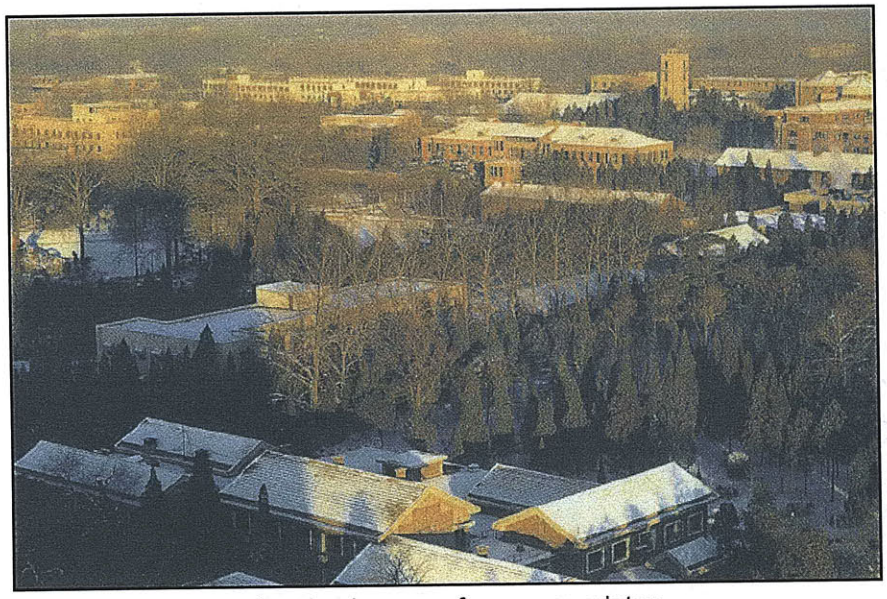
Model & photo of faculty housing complex



Another unfortunate trend in Tsinghua University's master-planning scheme is the tendency towards separating the programatic requirements of the university into physically distinct zones. This is further reflected in the architectural vocabulary of the campu-- a hodgepodge of styles, without any apparent cohesion between them.

Diagram of zoning on Tsinghua campus

Matrix of architectural vocabularies



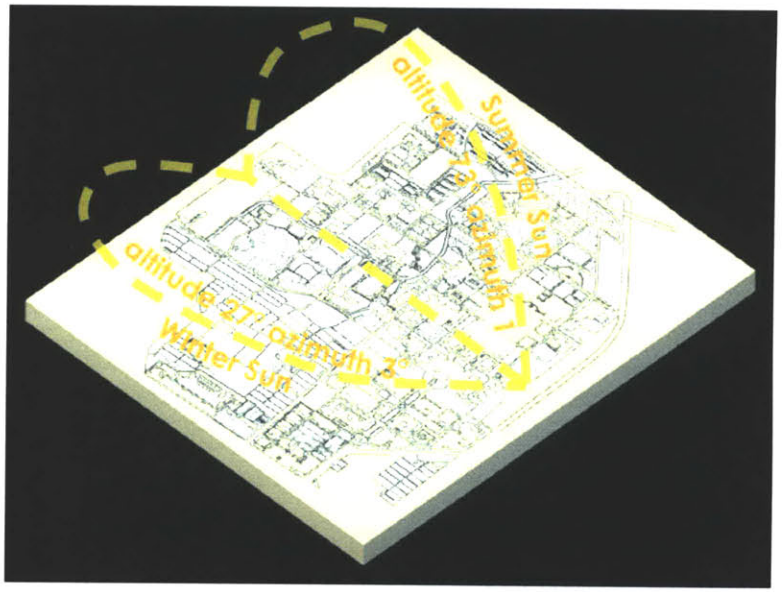
Academic zone of campus: winter

Commercial zone of campus

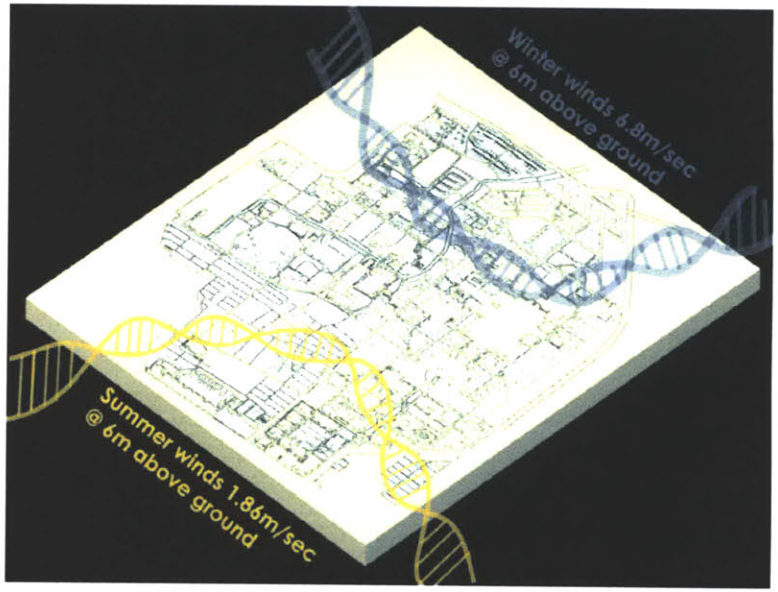
Though this strategy of separating program has some inherent flaws, the underlying condition is highly promising: namely, that Tsinghua University has a multitude of programmatic elements. In fact, the campus is a city unto itself, with its own commercial areas, housing, hotels, hospitals, and energy plants.

Academic zone of campus: summer

Climate conditions must play a vital role in determining a design strategy for a more sustainable urban planning scheme. The seasonal sun conditions are similar to Boston, and would suggest that buildings oriented along the north-south axis are preferrable-- and this is, in fact, the prevailing trend on campus. But the more important design imperative is to keep winter winds out, which would could be facilitated by larger structures on the northern edge. Natural ventilation in the summer would be desireable, but since the wind speeds are quite low, this can not be considered a design imperative.



Seasonal sun conditions

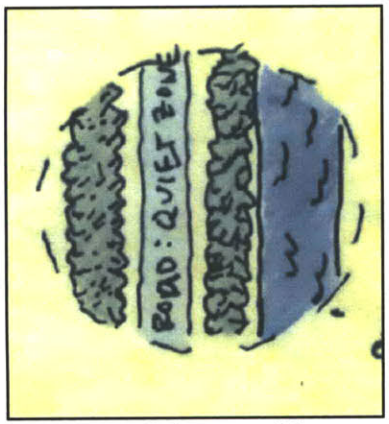


Seasonal wind conditions

Site map

I choose the western edge of the campus for the location of my site. Included in this area is part of the original site for the Royal Garden and part of the center ring road of the University.

S I T E SITE LOCATION



Detail of river condition

There are a number of key features of the site worth mentioning. It is important to note some of the most significant buildings: they include a hospital, an old gym (for which my proposal includes a re-use and addition), an observatory, a hotel, an international students compound, some academic buildings of colonial style (mainly science-related), and housing in the traditional Chinese vernacular. Also noteworthy is a large presence of derelict buildings. In terms of landscape, there are some critical features, including the lily pond and the river. The river behaves as almost like a barrier, and itself functions as a quiet zone due to the presence of trees running along both sides. There is a very strong axial relationship evident on this site running north-south, along which a number of academic buildings are aligned.

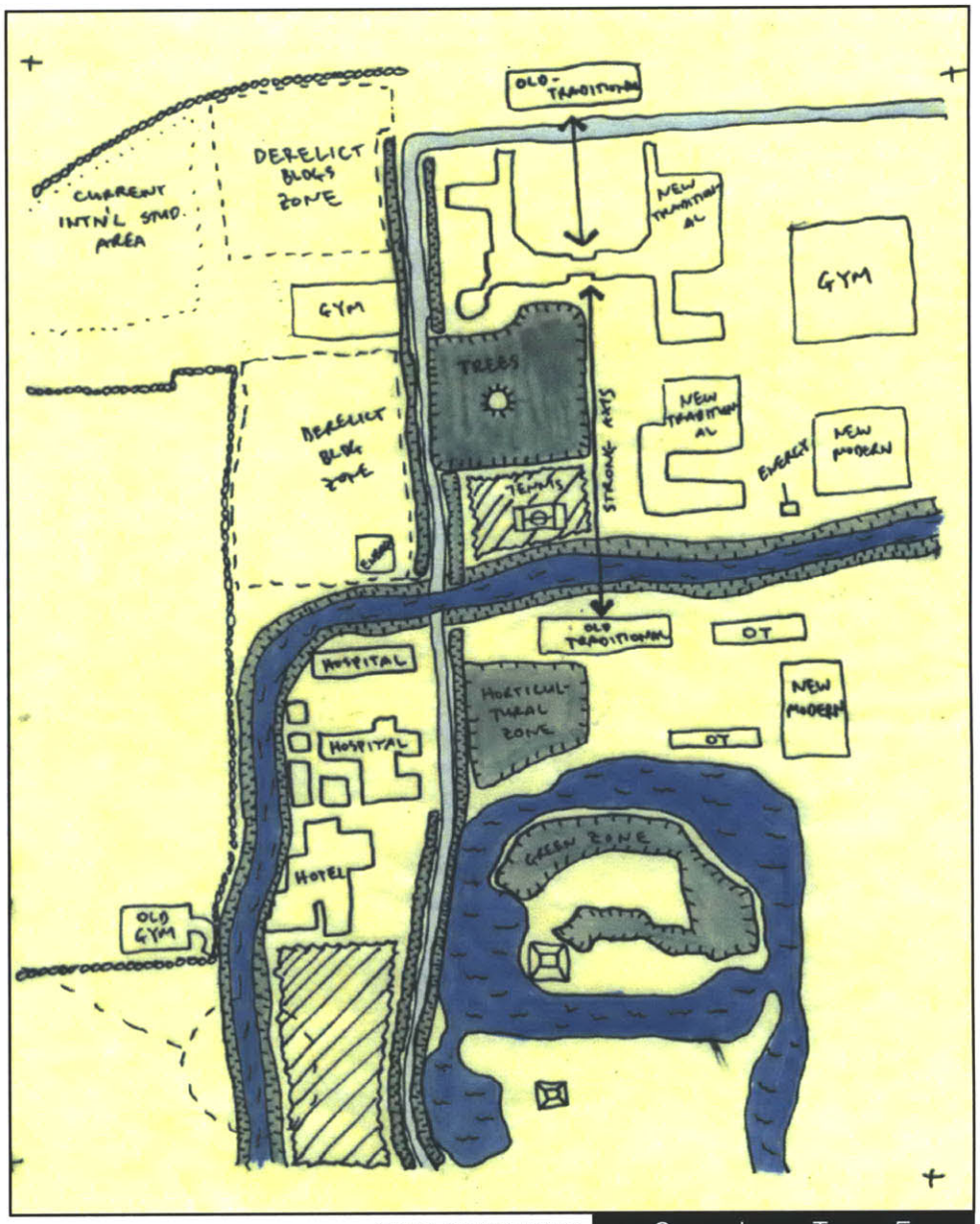
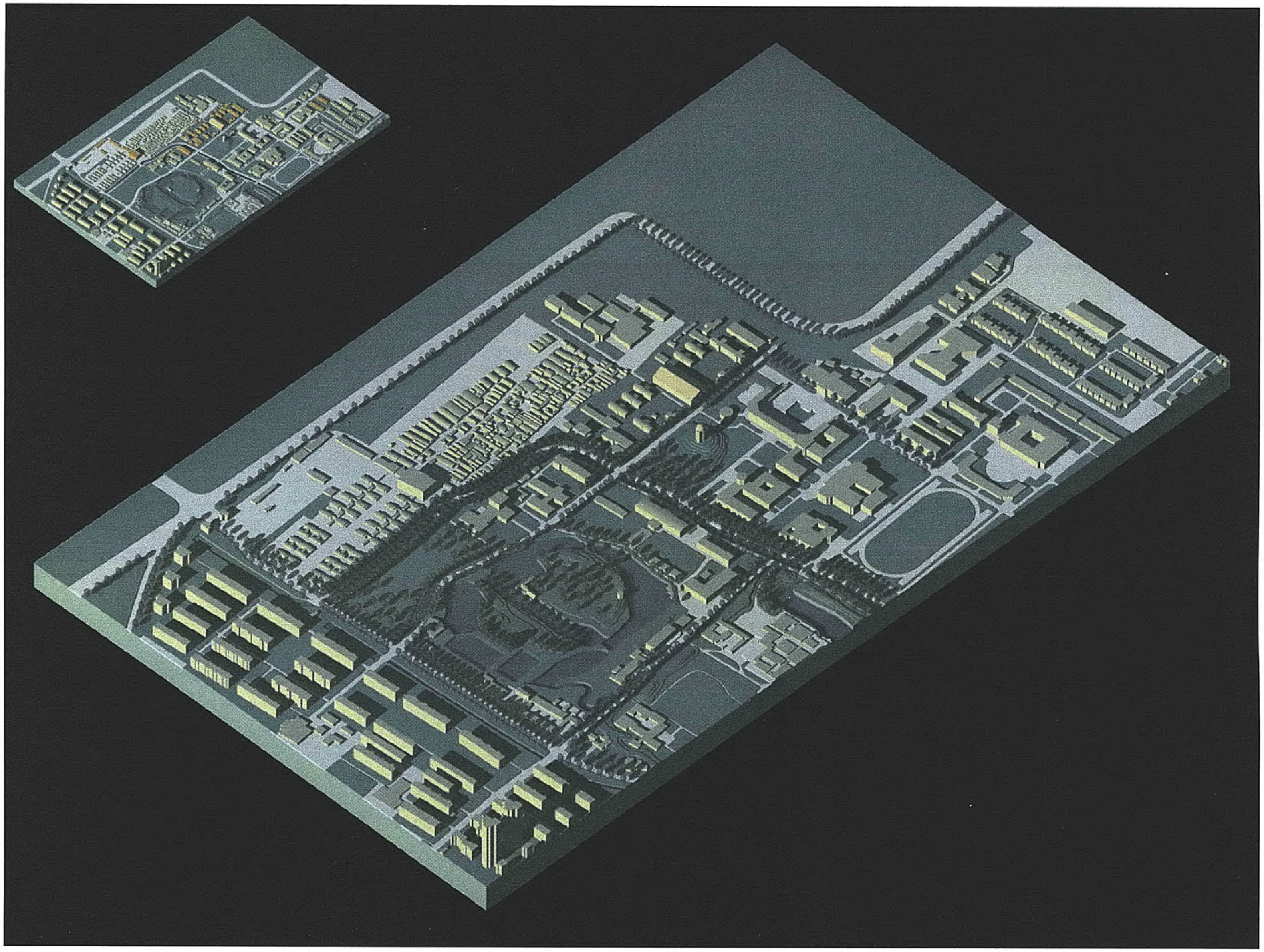
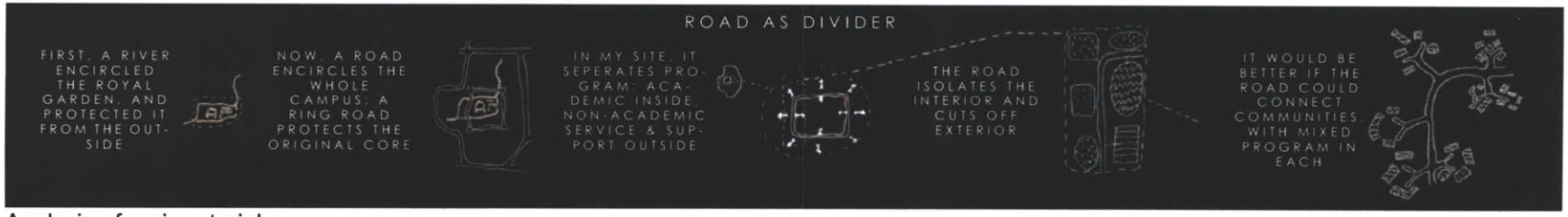


Diagram of key features

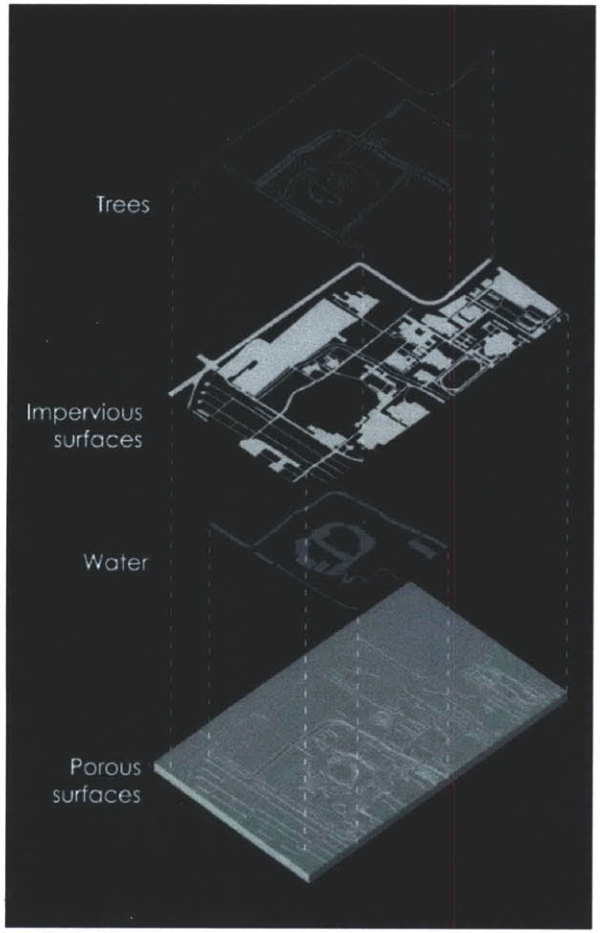


Site model and miniature indicating derelict buildings

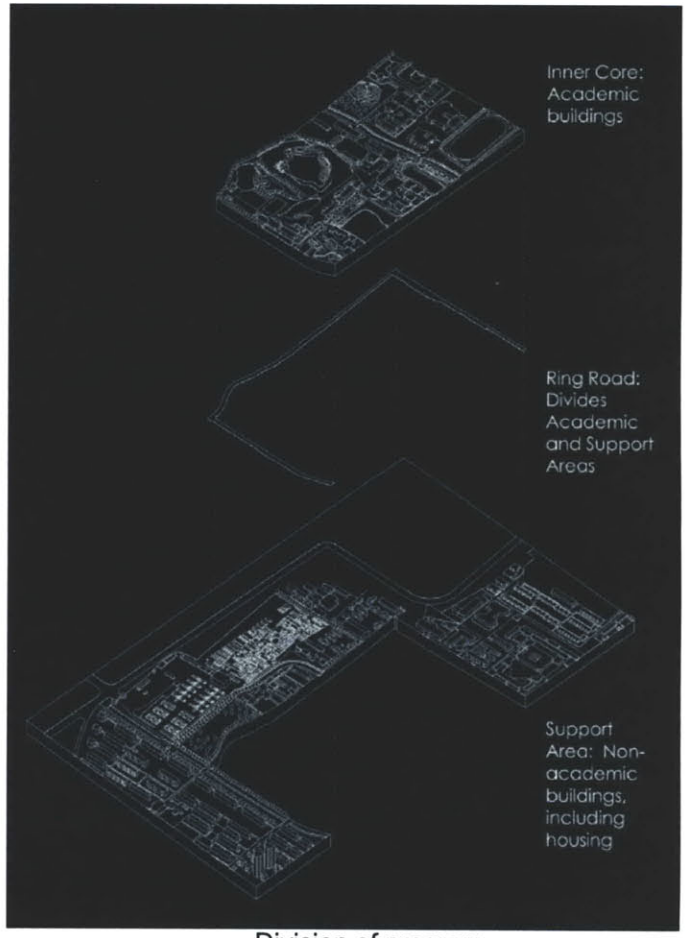


Analysis of main arterial

The site exhibits a number of important design opportunities. The presence of the water features is a most critical factor. Also important is the proliferation of several programs. There are, however, some crucial shortcomings. Unfortunately, Tsinghua has turned its back to the river. At present, it is little more than an expansive trench; the water itself is far below ground level and wholly inaccesible to users. And despite the presence of diverse programs, they are nonetheless strictly segregated by the central ring road. Moreover, being at the edge of campus, this locale keenly exhibits the isolation of the campus from the rest of the city.



Relationship between built and natural form



Division of program

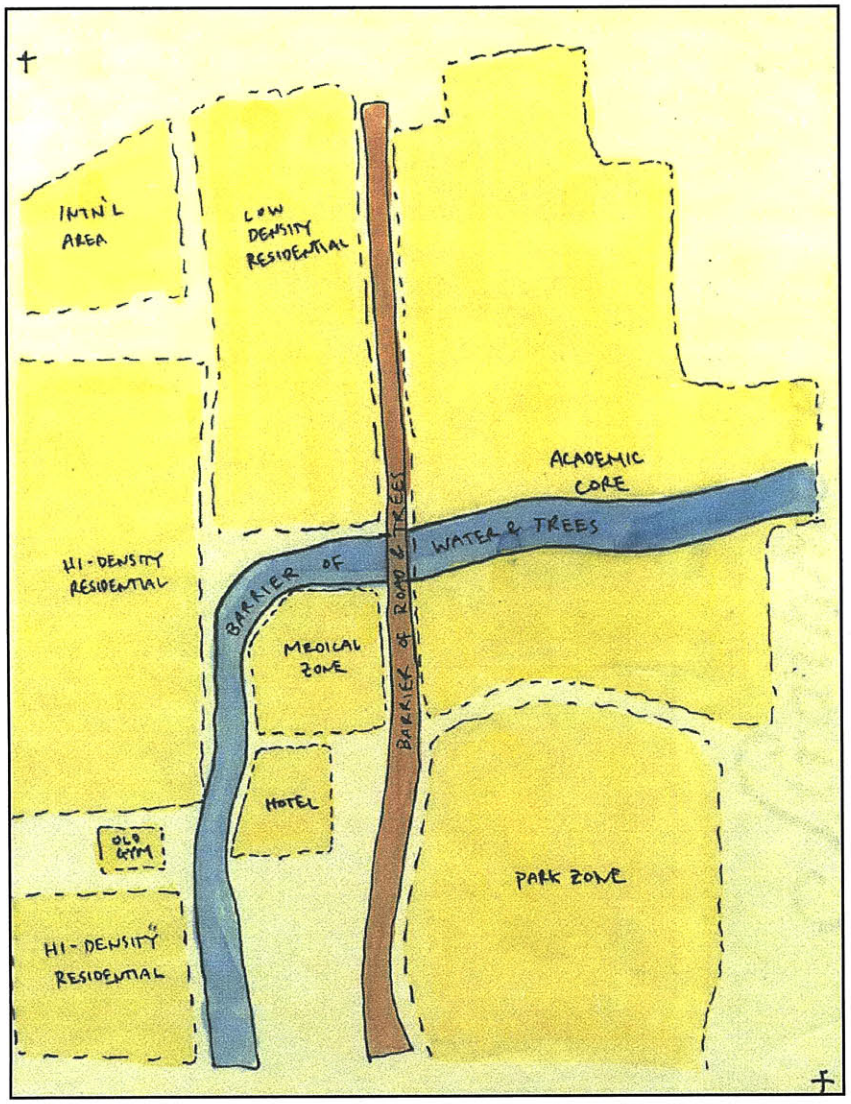
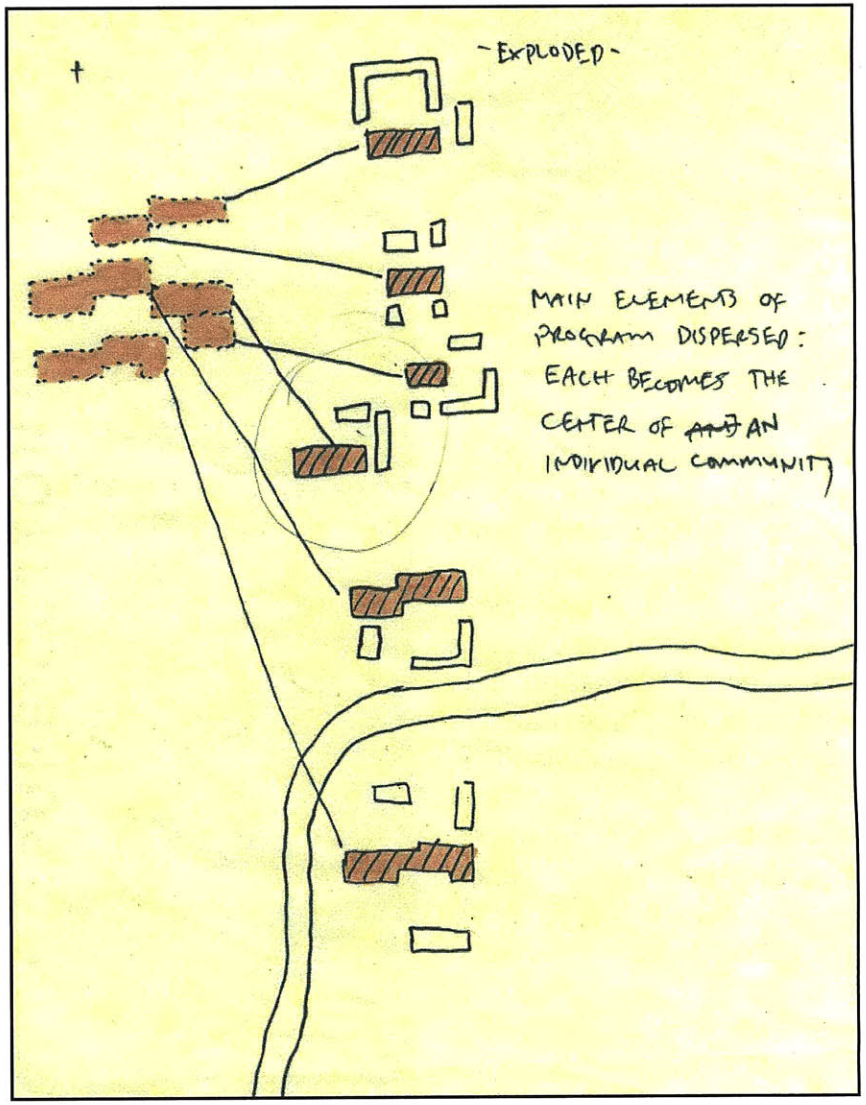
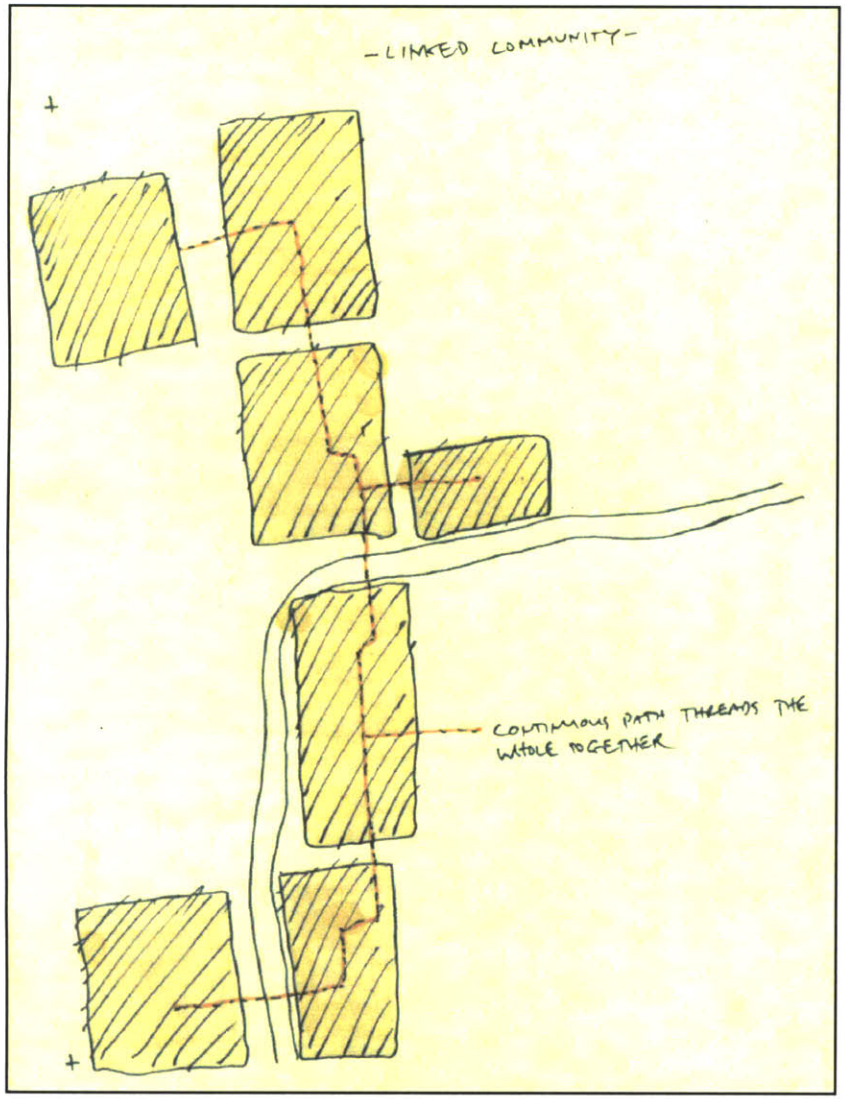


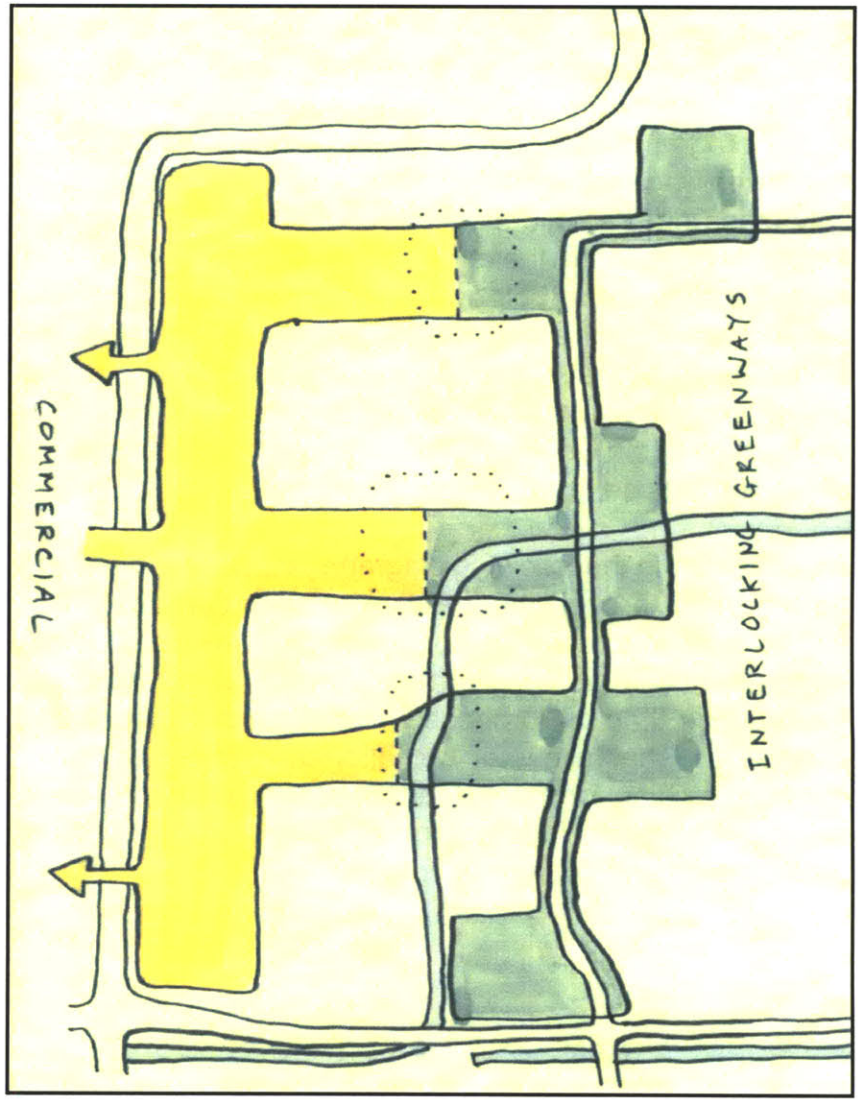
Diagram of existing zoning conditons for site



Program redistribution



Clusters linked by paths



Greenways connect campus with the city

As illustrated by the preceding diagrams, the stratification of program represented by the existing zoning conditions for the site might be remedied in a few important ways. Firstly, program should be "exploded"-- that is, redistributed to different locales within the site rather than groupings of only those programatic elements that are similar with one another. Secondly, these exploded elements will in turn serve as centers for their own respective clusters. Thirdly, these clusters are themselves are linked together by a series of pathways. Finally, through the use of greenways and landscaping, these clusters will extend outwards, beyond the borders of the University, to link the campus with the rest of the city outside.

As illustrated in the following diagrams, these objectives will be achieved through the creation of an urban fabric that can be likened to a village configuration, a series of neighborhood clusters at a scale that is considerably smaller yet more dense than the proposed design for the east side of campus. It shall allow for two alternative types of movements, providing for more freedom of choice for the users, and it will be joined together through the interconnection of roads, water, and courtyards.

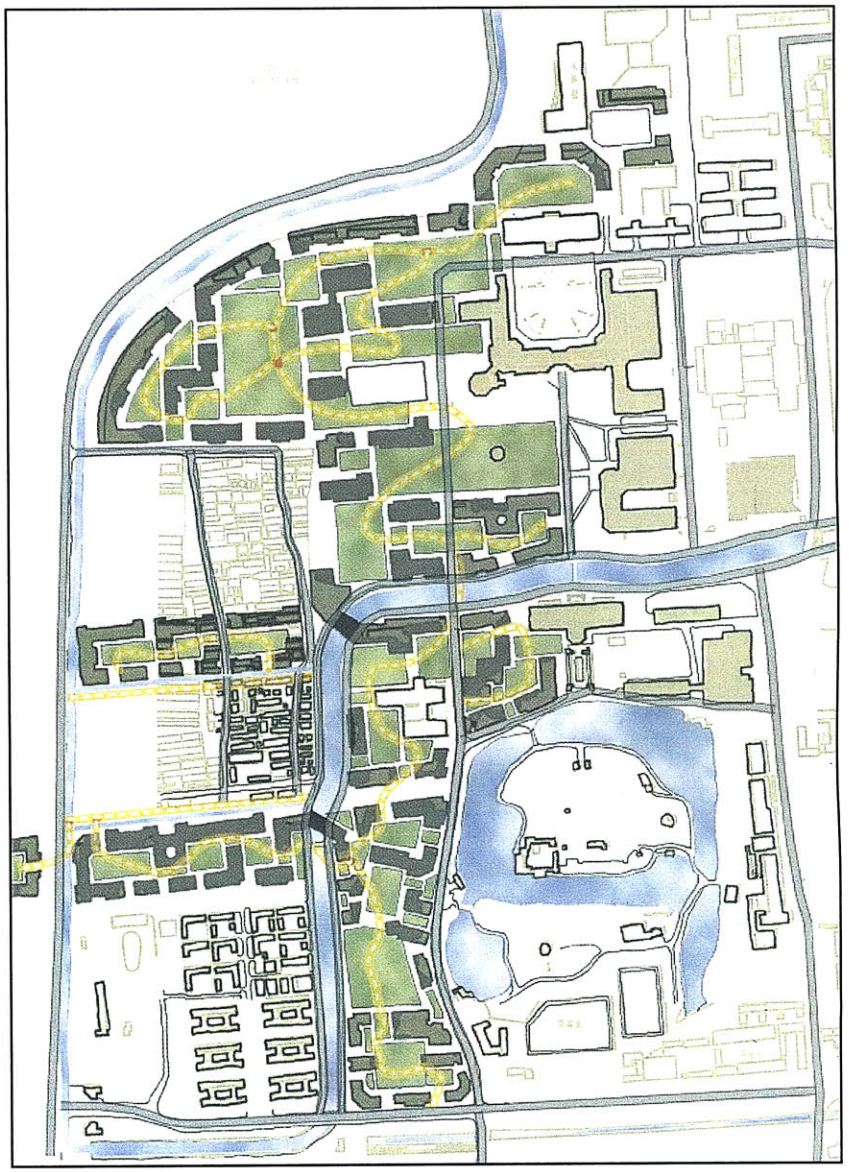
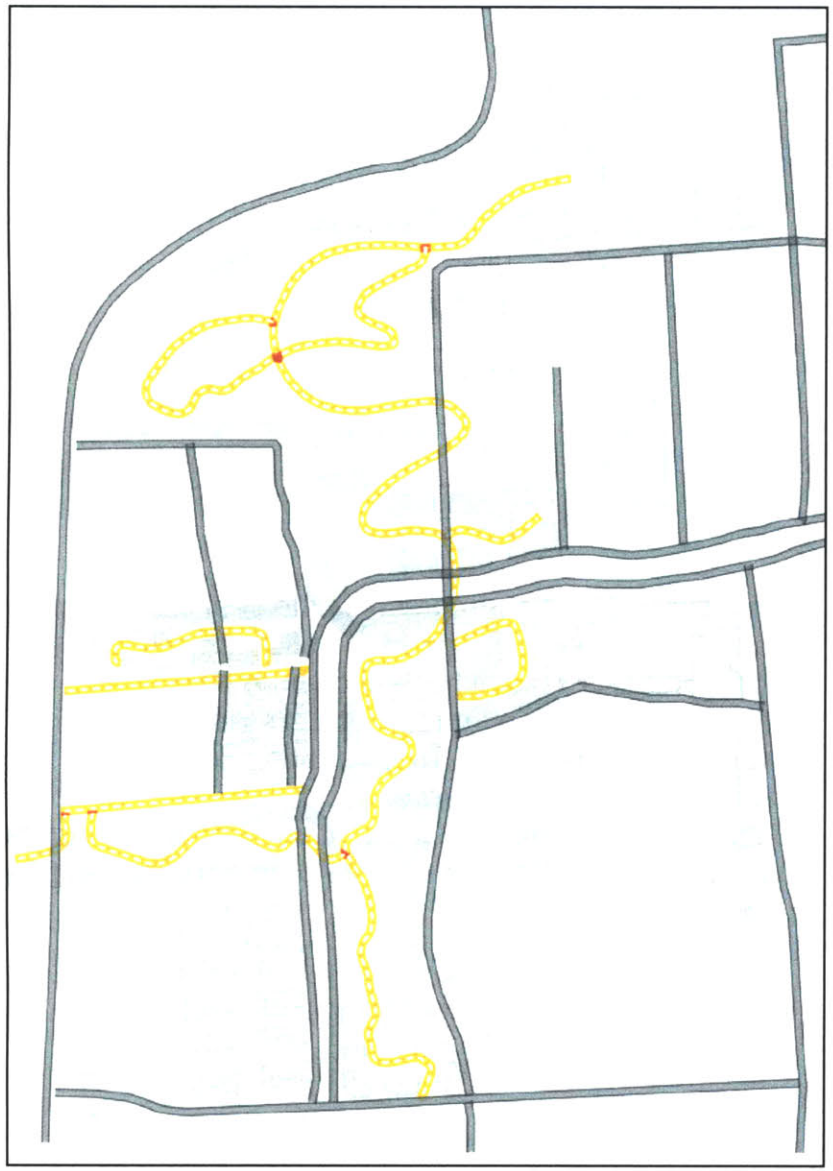
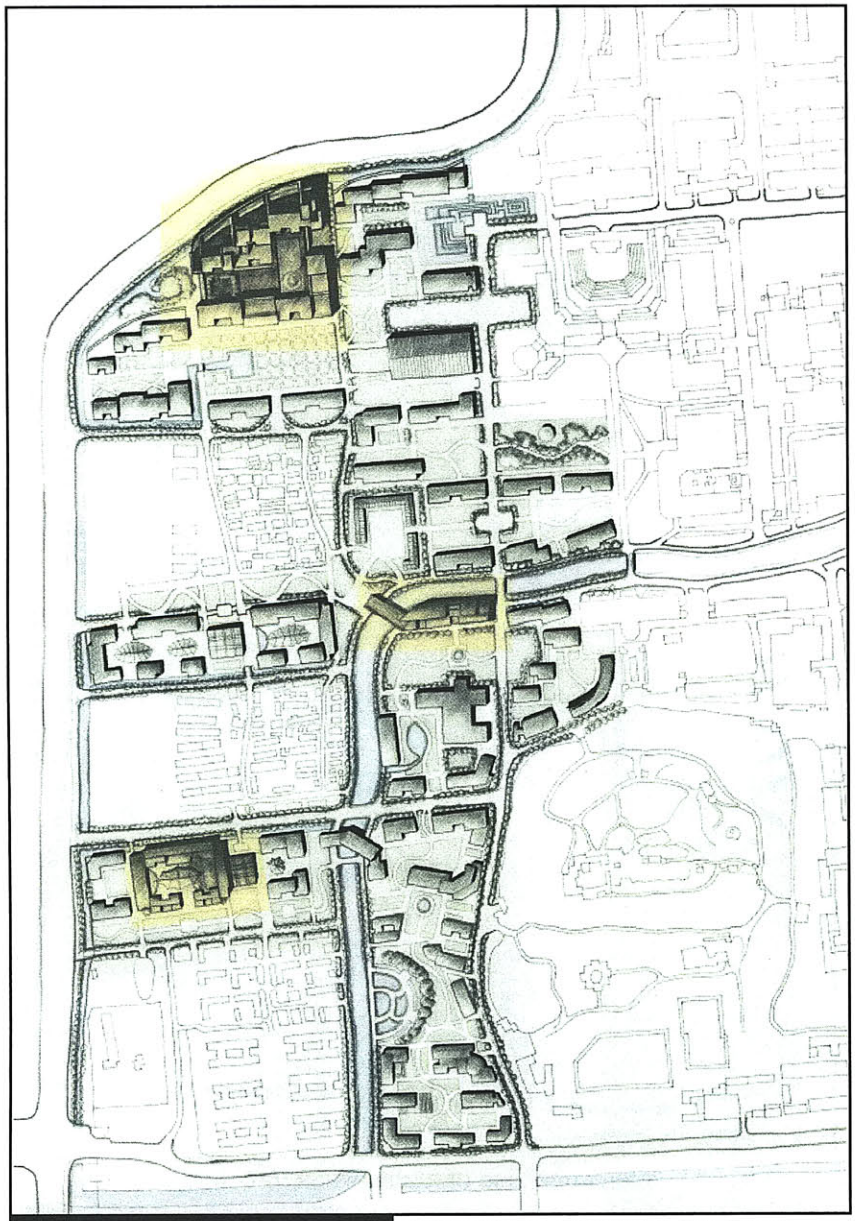


Diagram of site proposal



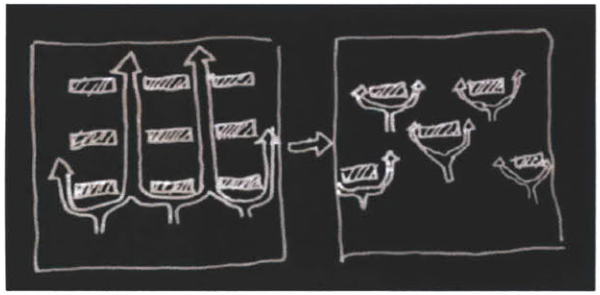
Two different kinds of movement

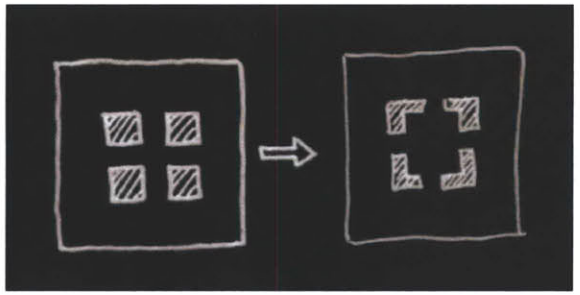
Interconnection of roads, water, & courtyards

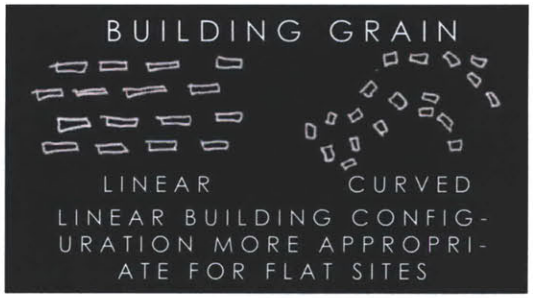


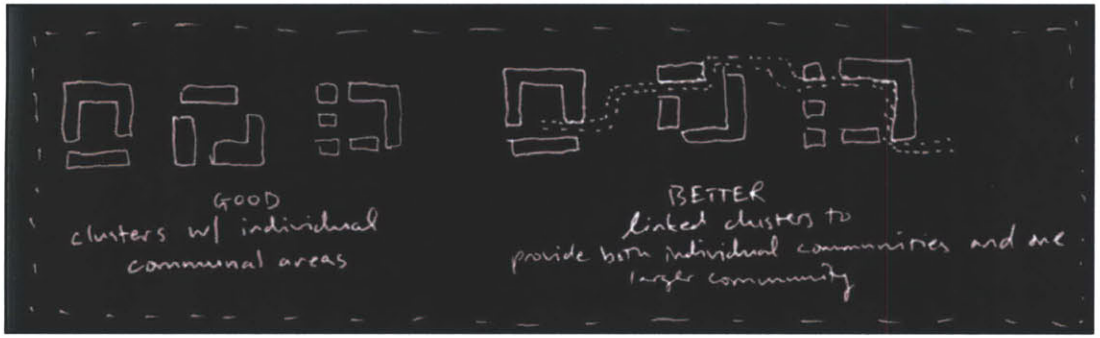
Site plan design proposal

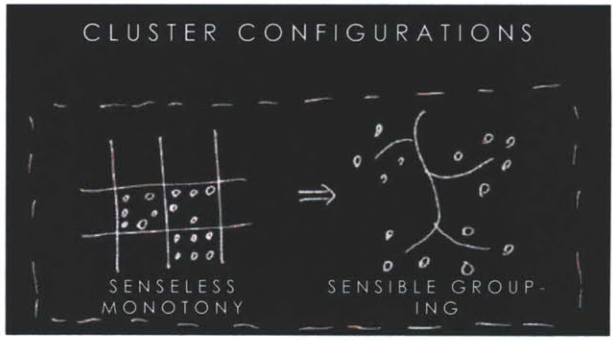
The drawing to the left represents the final site design proposal. The areas highlighted in yellow correspond to the three typologies which I have chosen to investigate. Many of the ideas at work in this site plan are illustrated in the following set of diagrams. The first two rows express ideas about the relationship between buildings as a function of such factors as climate and the rules of cogent groupings. The last row indicates some of the programmatic strategies employed.

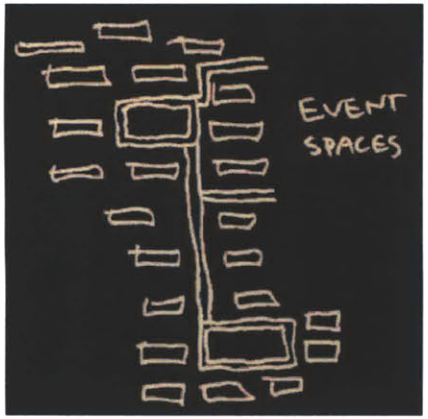


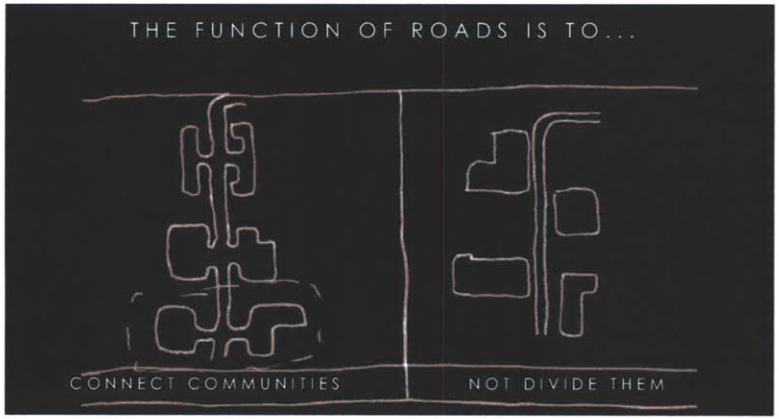












Diagrams of design guidelines

Interconnection of roads, trees, and waterways

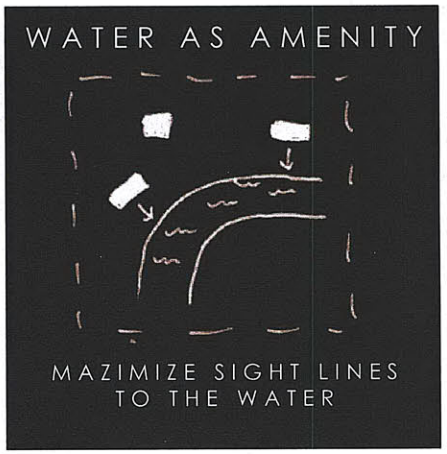


Diagram of strategy for water

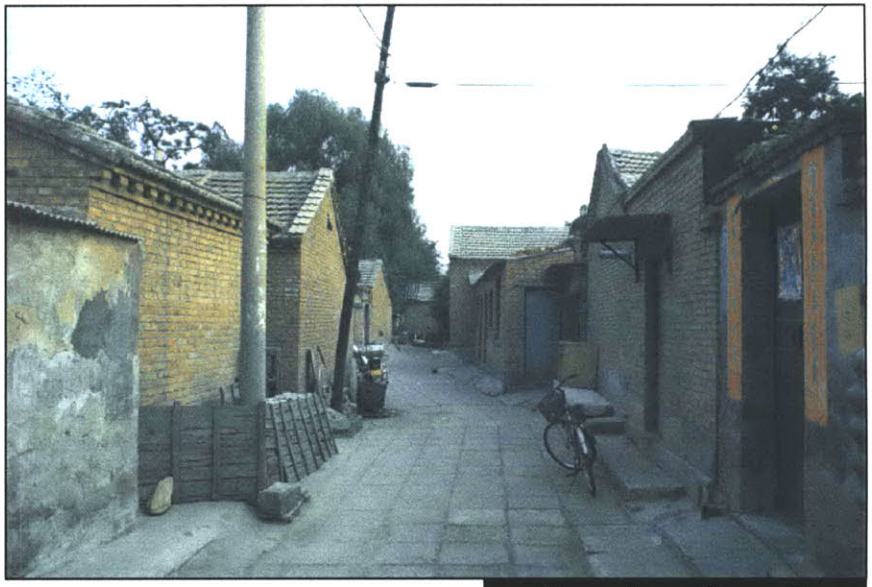
Water as event space

The site plan proposal is also meant to reflect a highly proactive attitude towards the role of water as an amenity for the site.

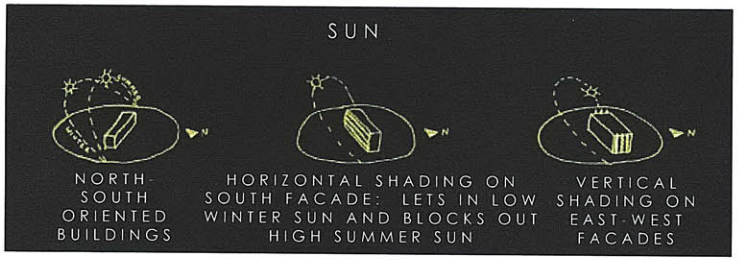
S I T E PROPOSAL FOR SITE DESIGN

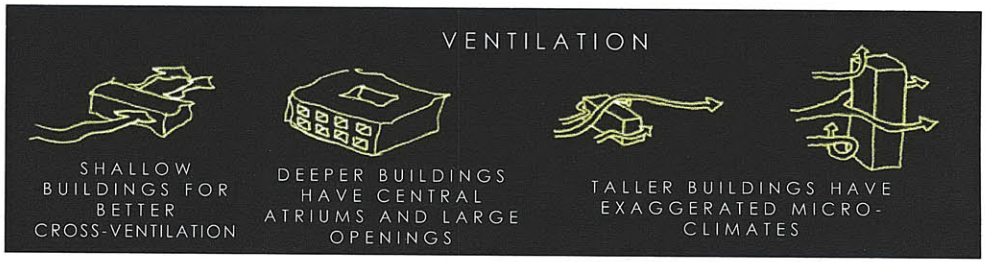
Example of residential densities at western edge of campus

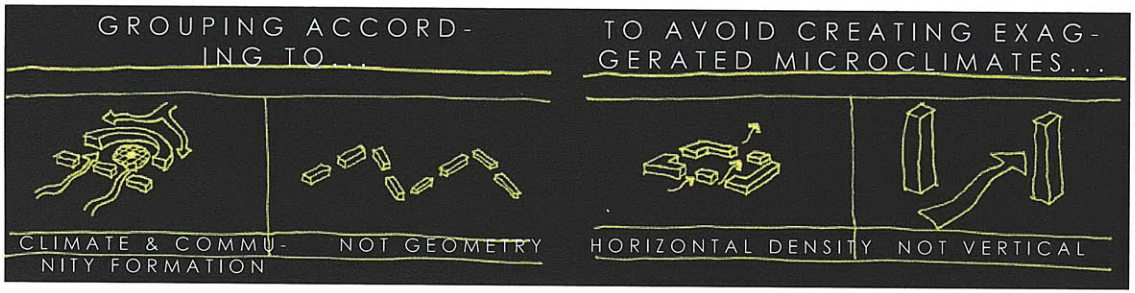
Moreover, the siteplan also represents a rejection of densities that cannot be legitemately thought of as sustainable for Tsinghua campus. Not only is the extravagant scale of the east side of campus rejected, but the densities of residences in the vicintiy of the site are also rejectd as being inappropriate for Beijing's climate.

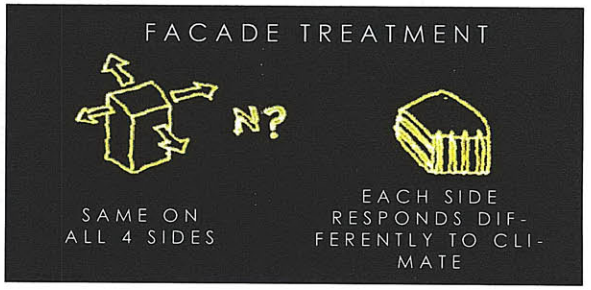


Correlation of densities and climate

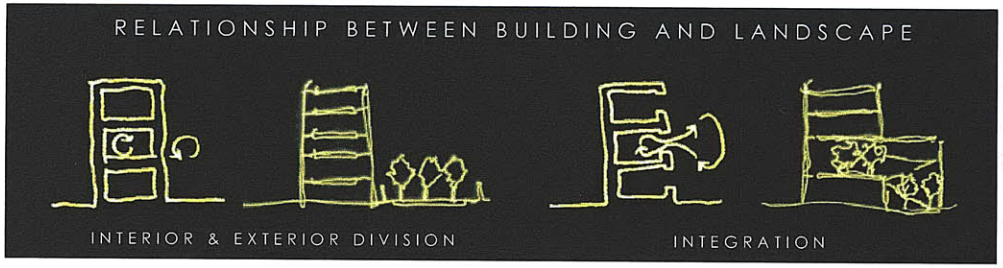


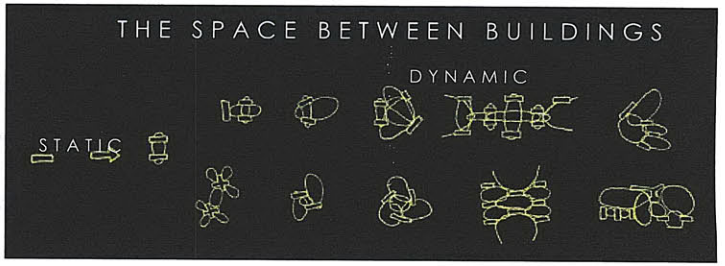


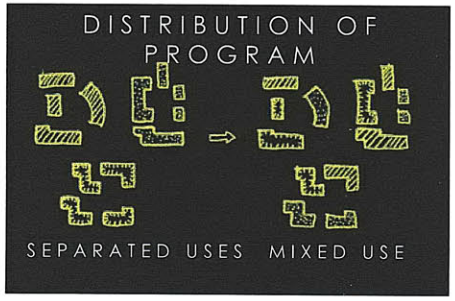




Climate conditions diagrams





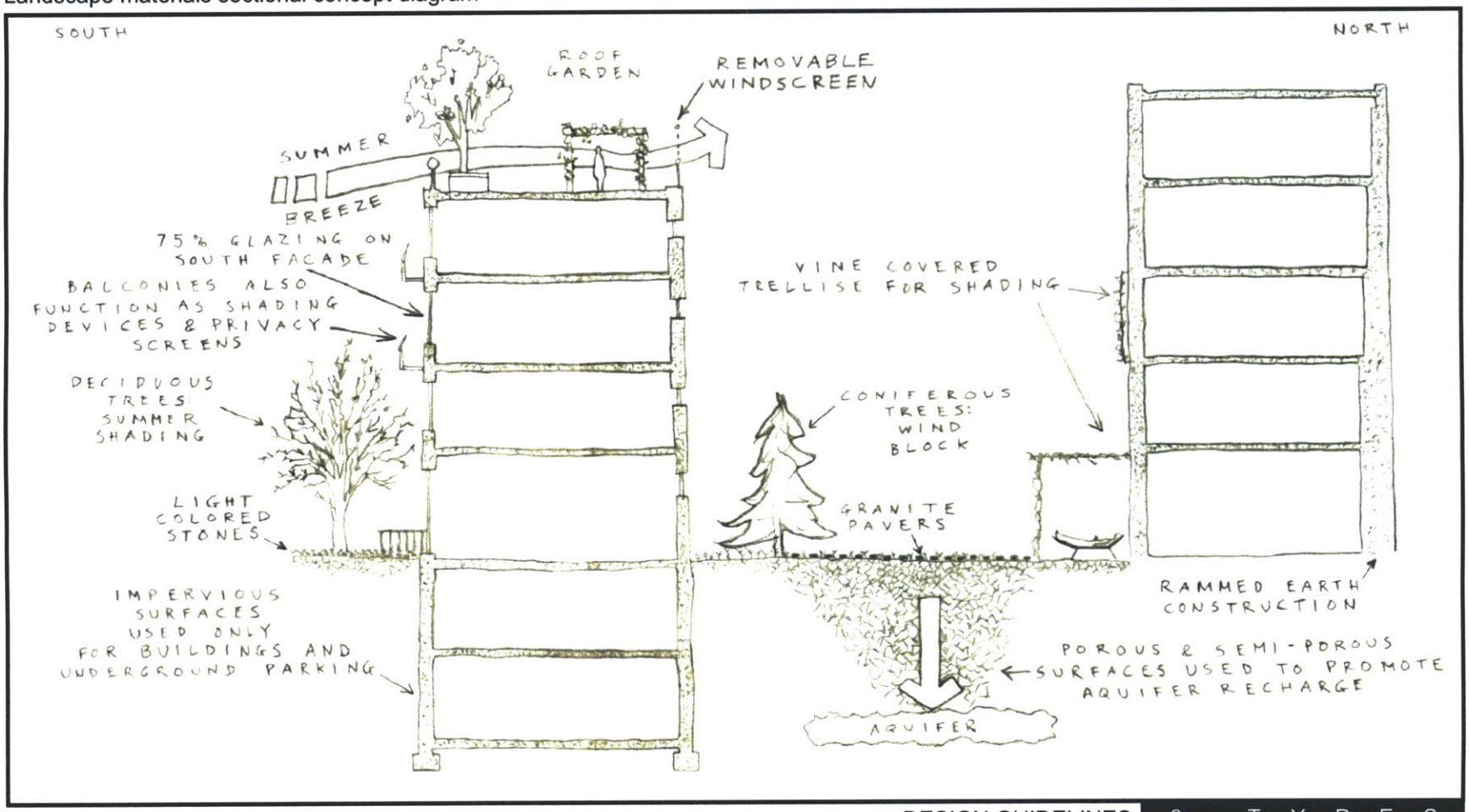


Building relationships diagrams

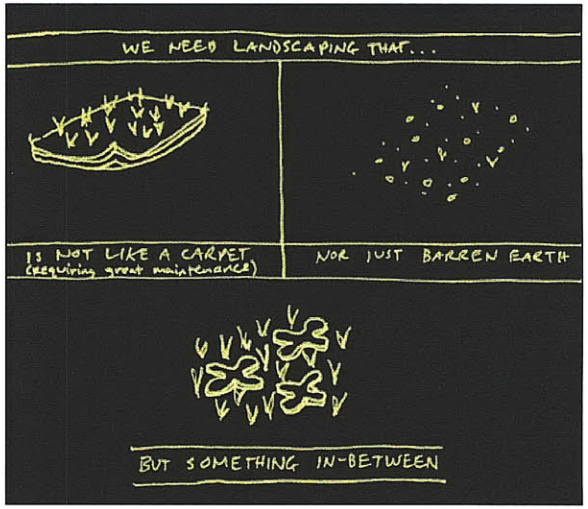
This section deals with the articulation of three typologies that embody the spirit of the design. To provide structure to this investigation, and as an ends unto themselves, I began with an inquiry into what guidelines I would use to develop these typologies. These diagrams represent some of the thinking towards such a set of design guidelines.

As an important step towards the goal of determining design guidelines, I developed a kind of "materials pallette," e.g., a collection of materials that would be conducive to sustainable community design.

Landscape materials sectional concept diagram



Strategy for a "green campus"



Landscape materials concept diagram

Indigenous planting

In fact, Tsinghua University has itself been embarking on a project for building a sustainable campus, but in terms of their "materials pallette," there are many questionable practices. For the most part, "sustainability" seems to mean for them, a literal "greening" of the campus. But planting so much of one species of grass, for example, can not be considered a environmentally viable option. Instead, it would be more responsible to plant a variety of species so as to promote biodiversity.

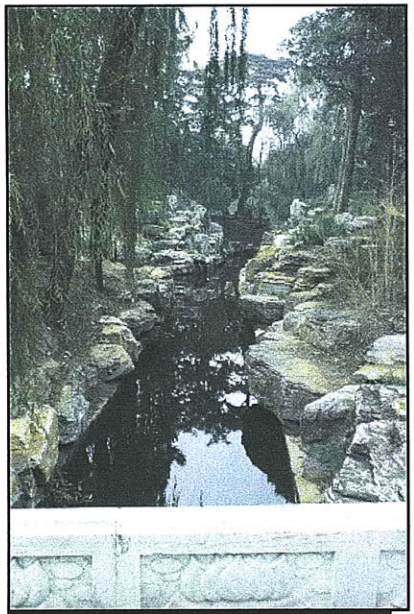
Diversity is a key issue in all aspects of this project, including diversity of public spaces. Such a diversity would be required to better accomodate the various needs and requirements of a large population. A design of a typolgy should provide for this.

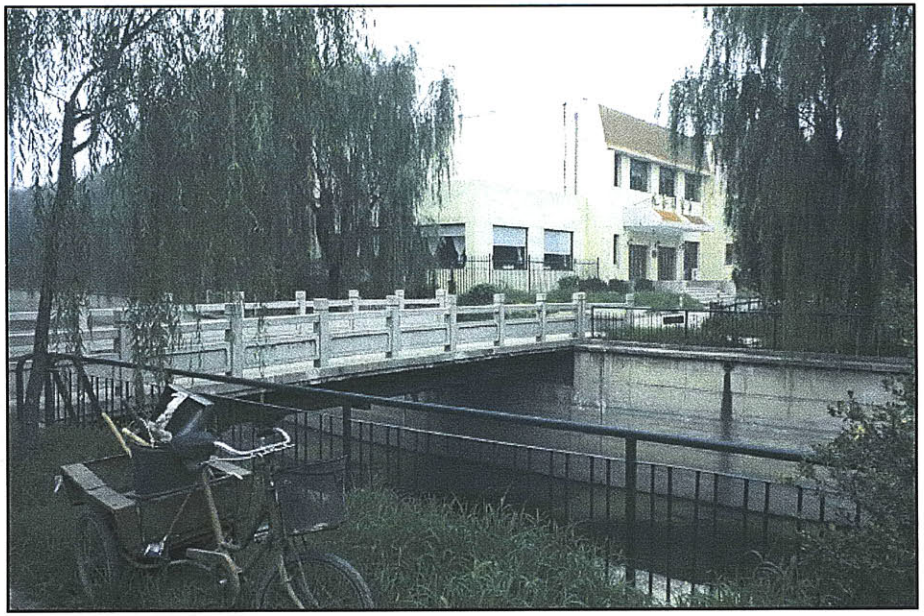
Active spaces

Quiet spaces

View of liliy pond

View of liliy pond

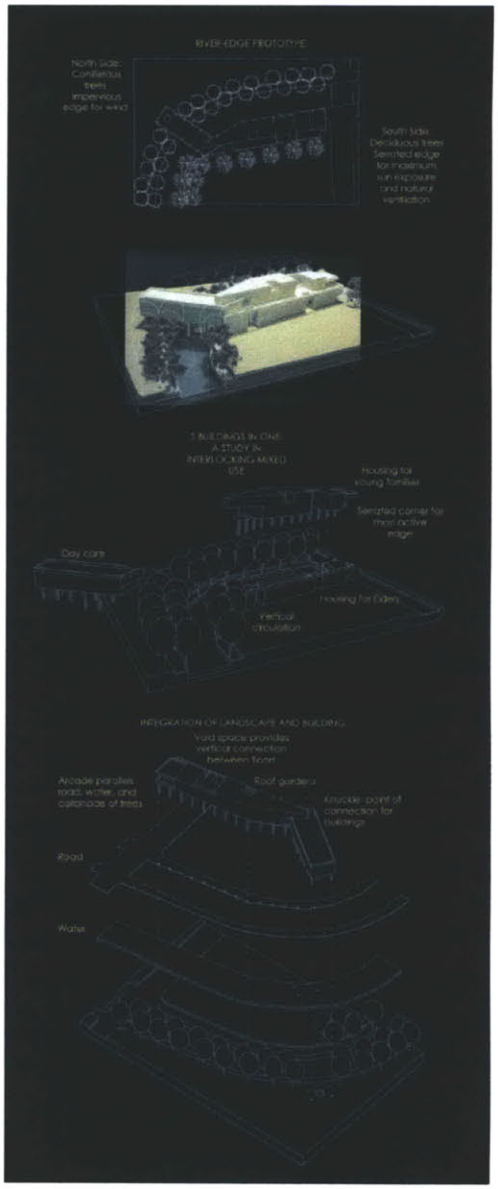




The most important element of the materials pallete is water. Its presence is already quite prominent on the campus, and implicit in each of the three typologies is an attempt to incorporate and make full use of this amenity.

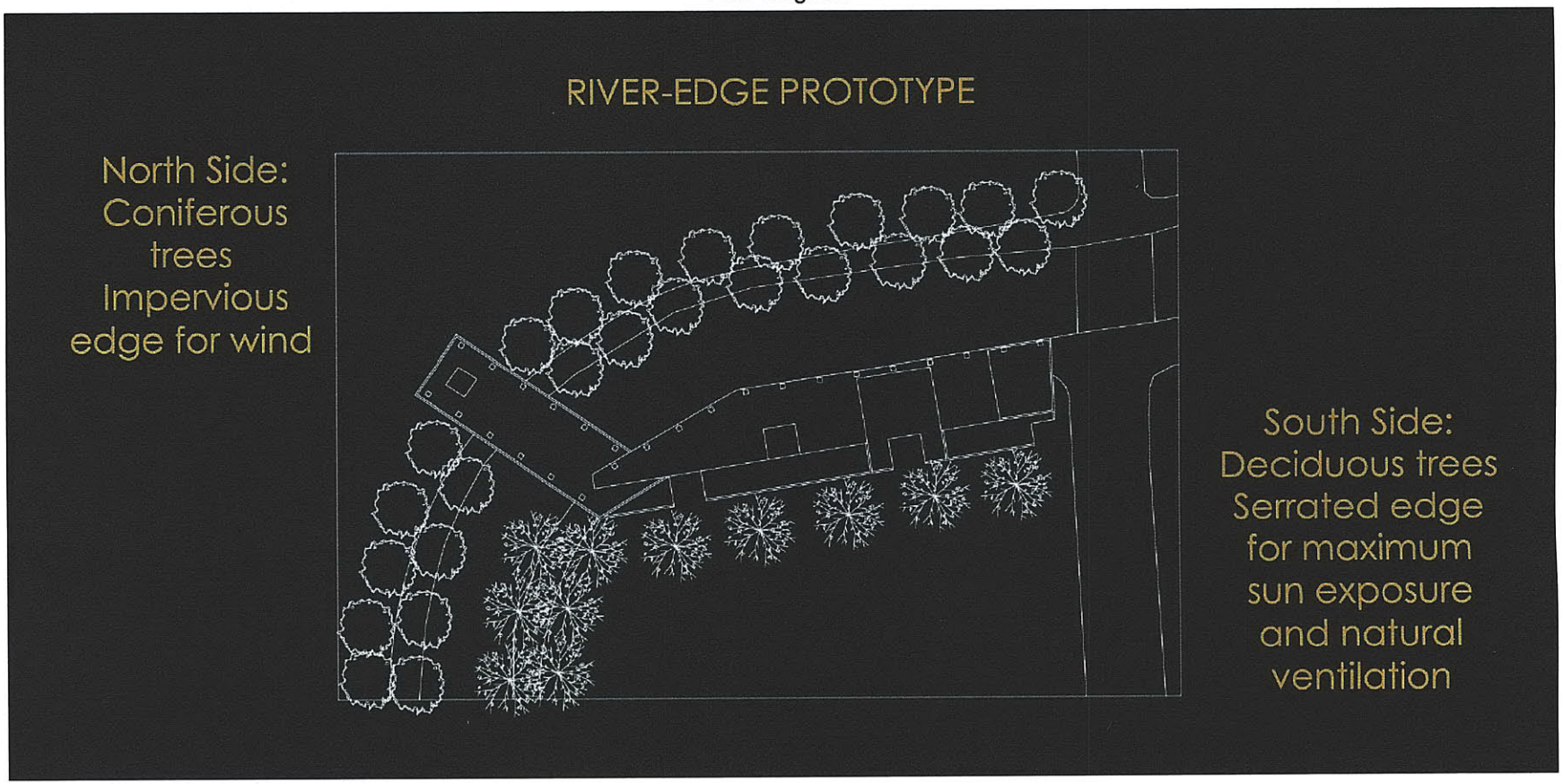
ViewS of river tributary and the river

The first typology is located in a critical area of campus, at the bend of the river. Essentially, it represents an attempt to answer the question: how do different groups of people, people who may not typically have much in common with one another, live together? In this, the river-edge typology, the design goal has been to enlist the river as the point of interconnection between elderly people, children, and working adults. The integration of the river with landscaping (primarily in the form of trees) and pathways serve to provide a nexus for these groups, Moreover, the building itself, being comprised of interlocking buildings, is designed to bring these disparate groups together.

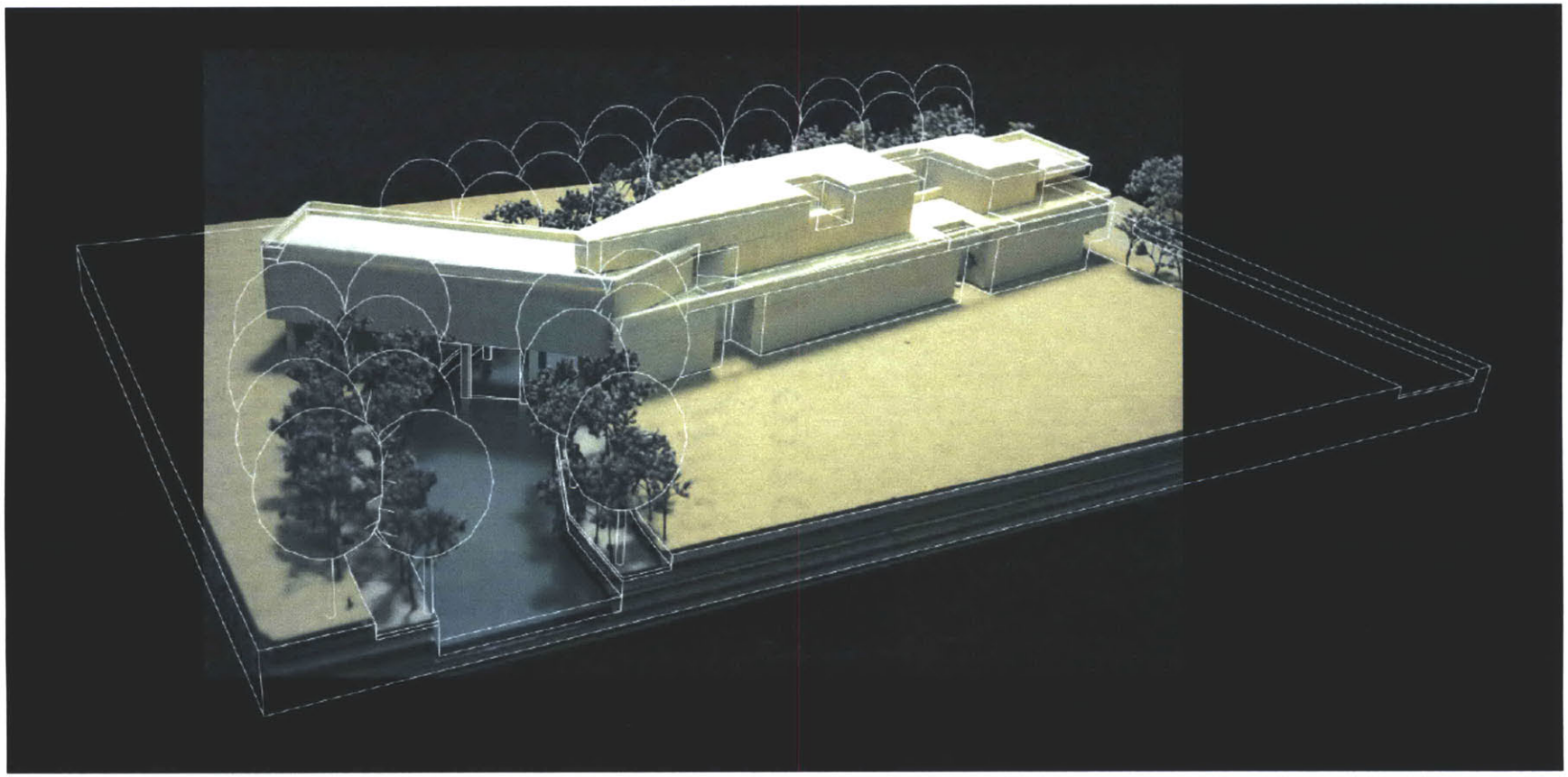


River-edge typology

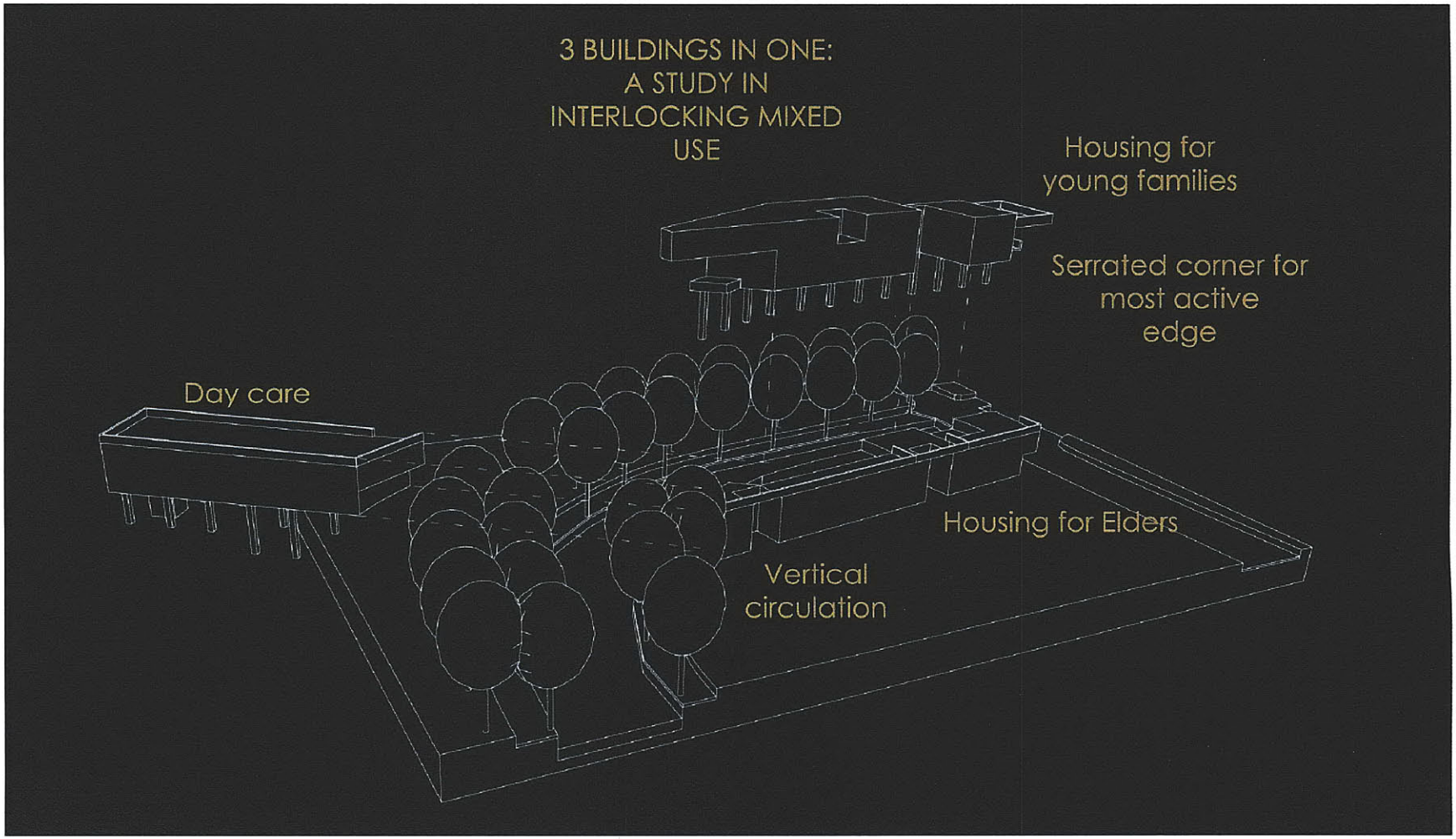
Plan diagram

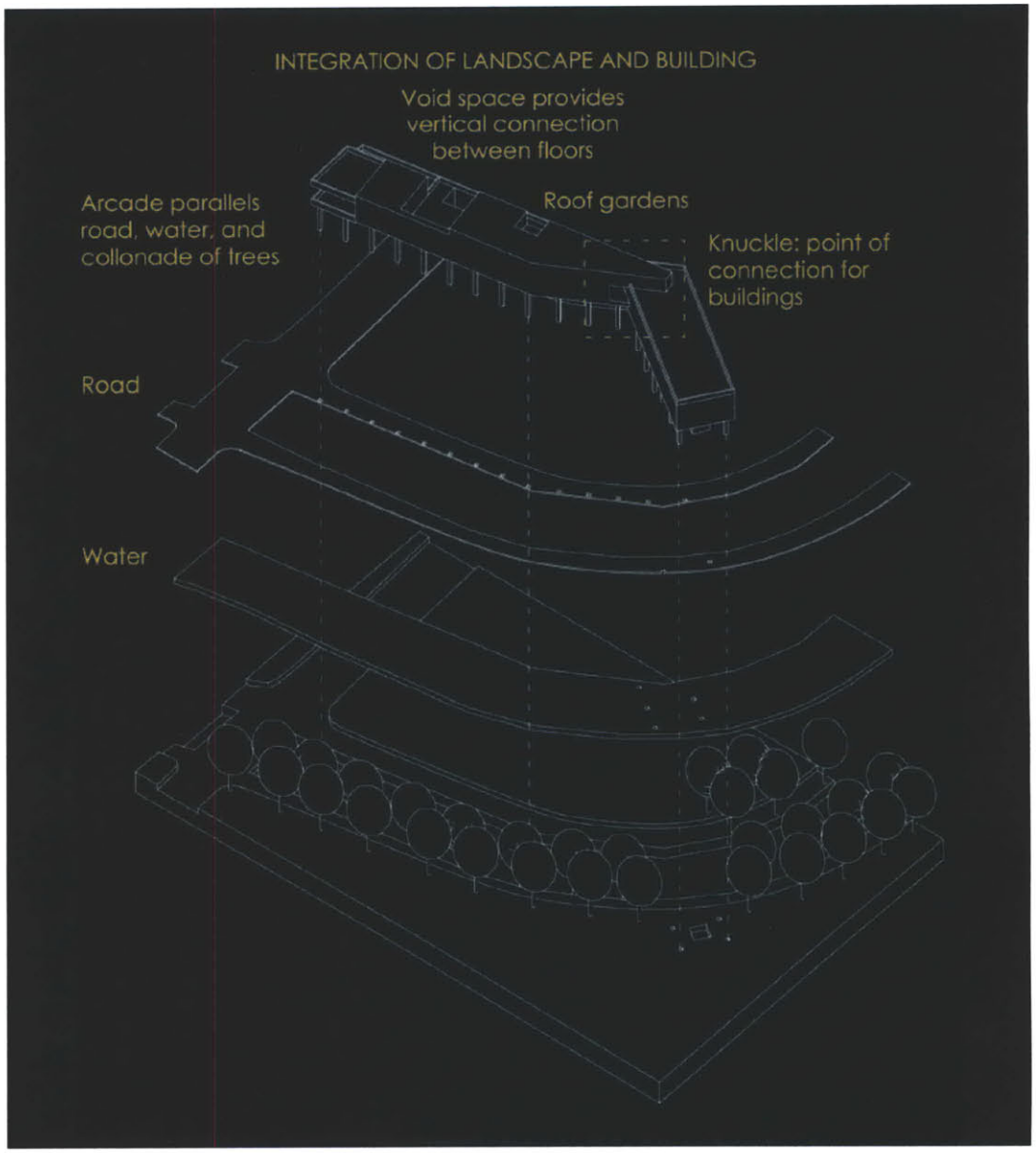


Transposed model & axonometric

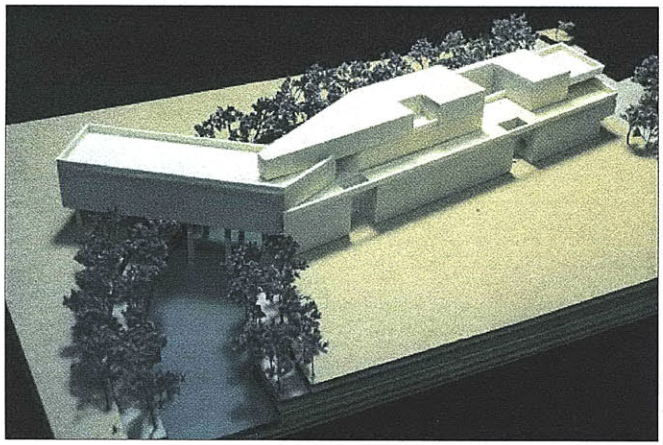


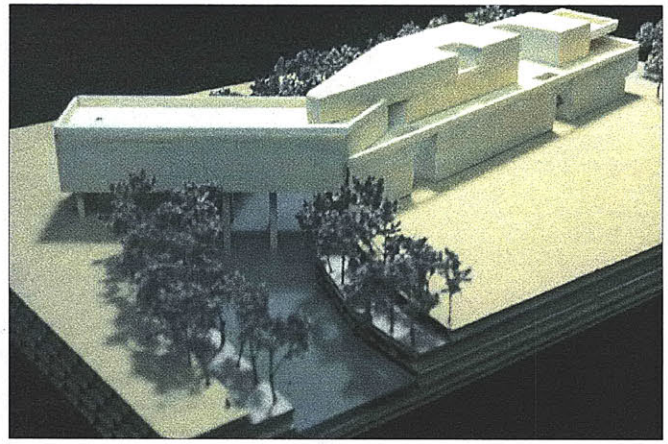
Axonometric diagram



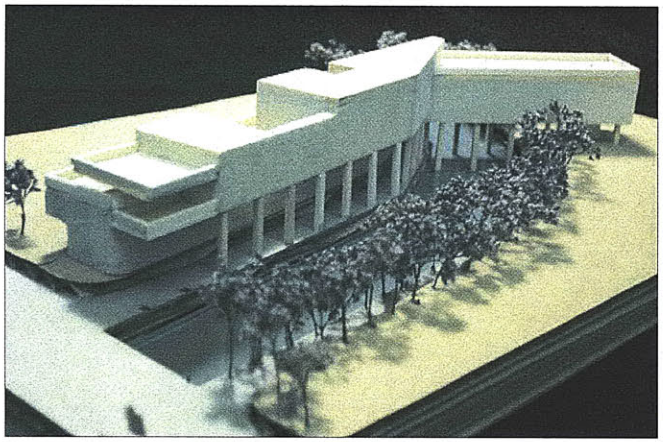


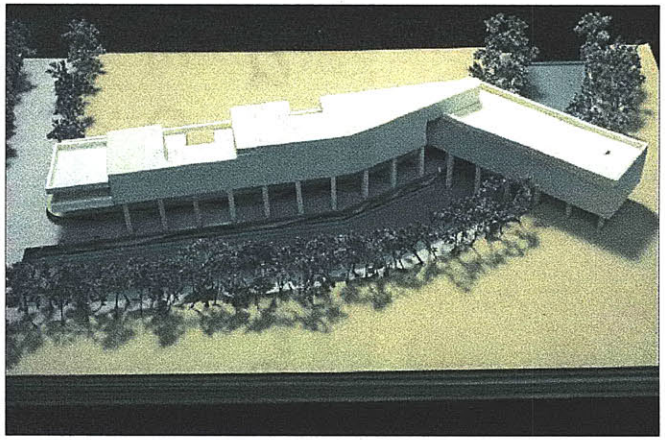
Axonometric diagram



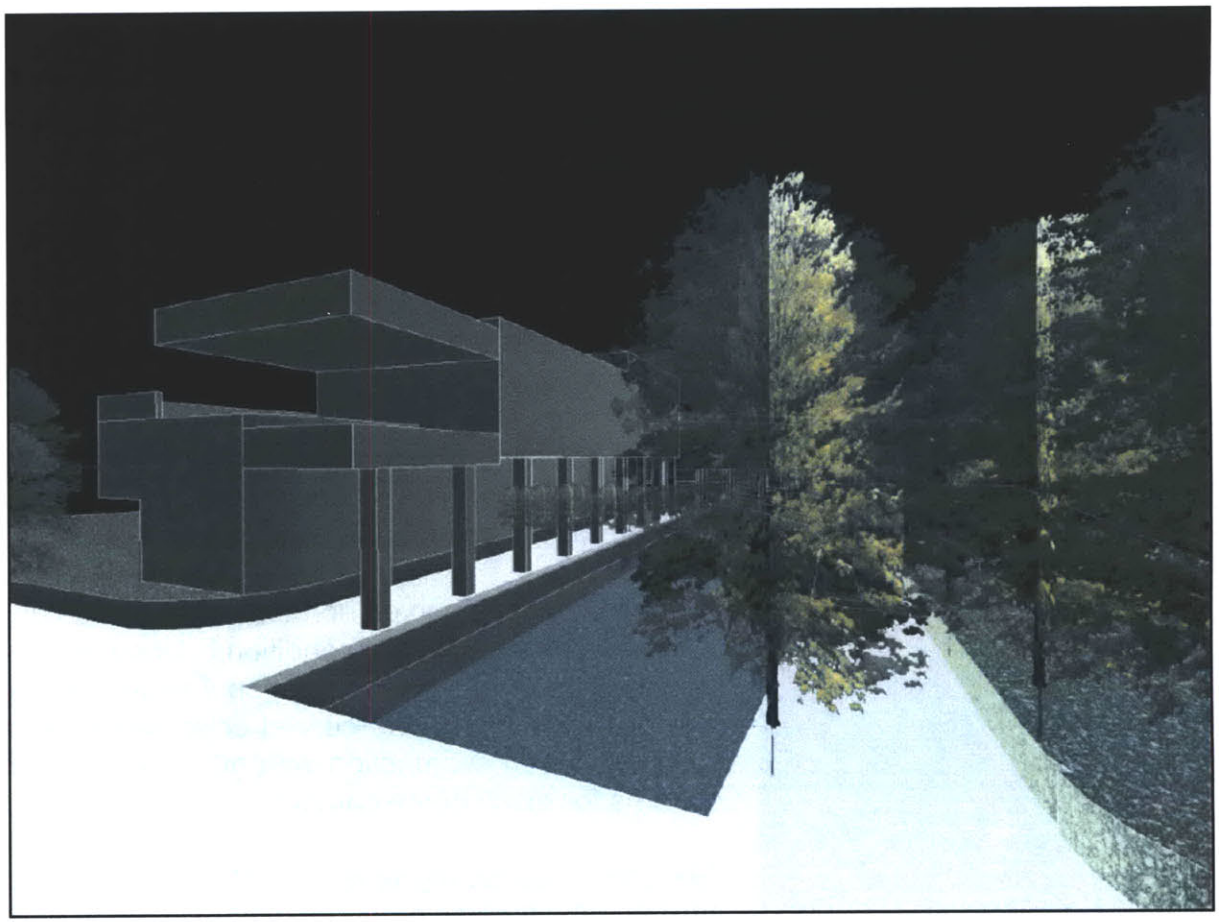


2 views from southwest

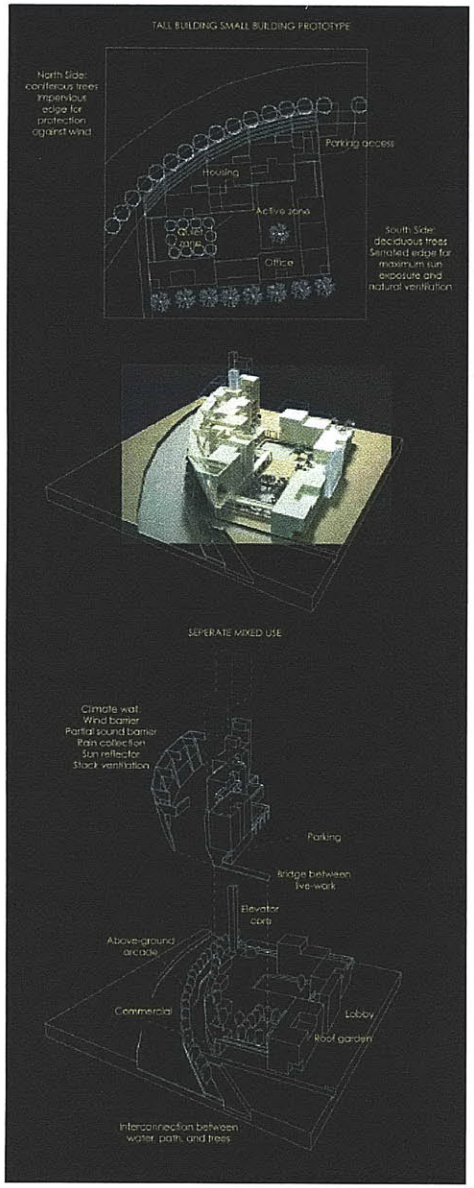




Views from southwest & south



Perspective view from southwest



The second typology is for a live-work condition. It is located on the northern edge of campus. The northern buildings are medium-rise housing units and the southern buildings are offices. There is also a commercial zone on the ground floor of the housing structure and below this, car parking. The basic challenge is to design for the complicated privacy issues involved in a configuration with numerous programs. The general strategy is to separate housing from office. The void in between serves as a buffer zone between the two programs and is articulated by a diversity of public spaces. Above ground bridges serve to connect the two programs. Housing is elevated above ground, and a wall on the northern edge facilitates noise reduction and privacy from the urban edge of the city.

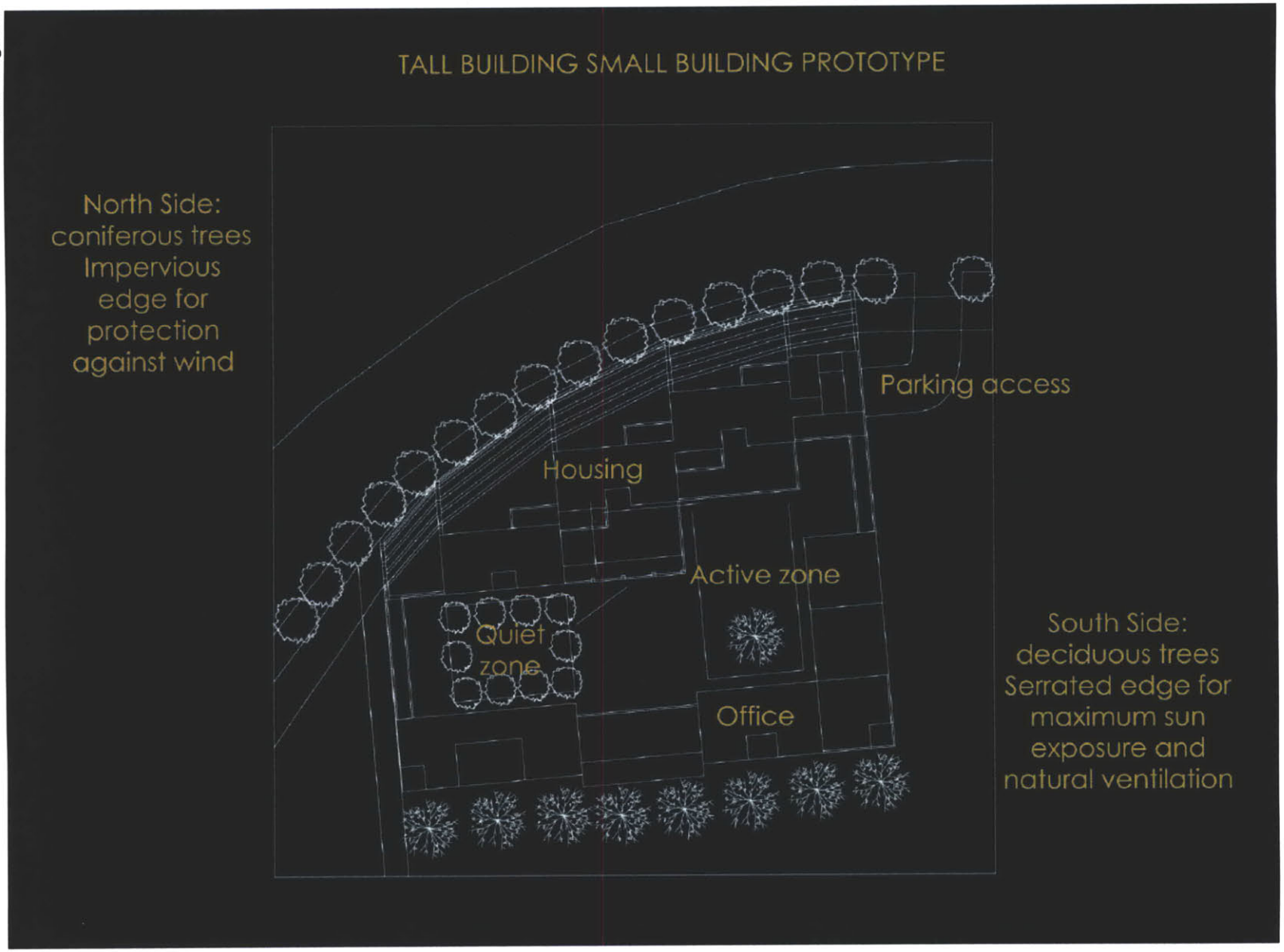
Another critical condition that is explored here is the juxtaposition of a tall building with a shorter building. The rationale here is use the taller buildings in the north to shield the southern buildings from the harsh winter winds.

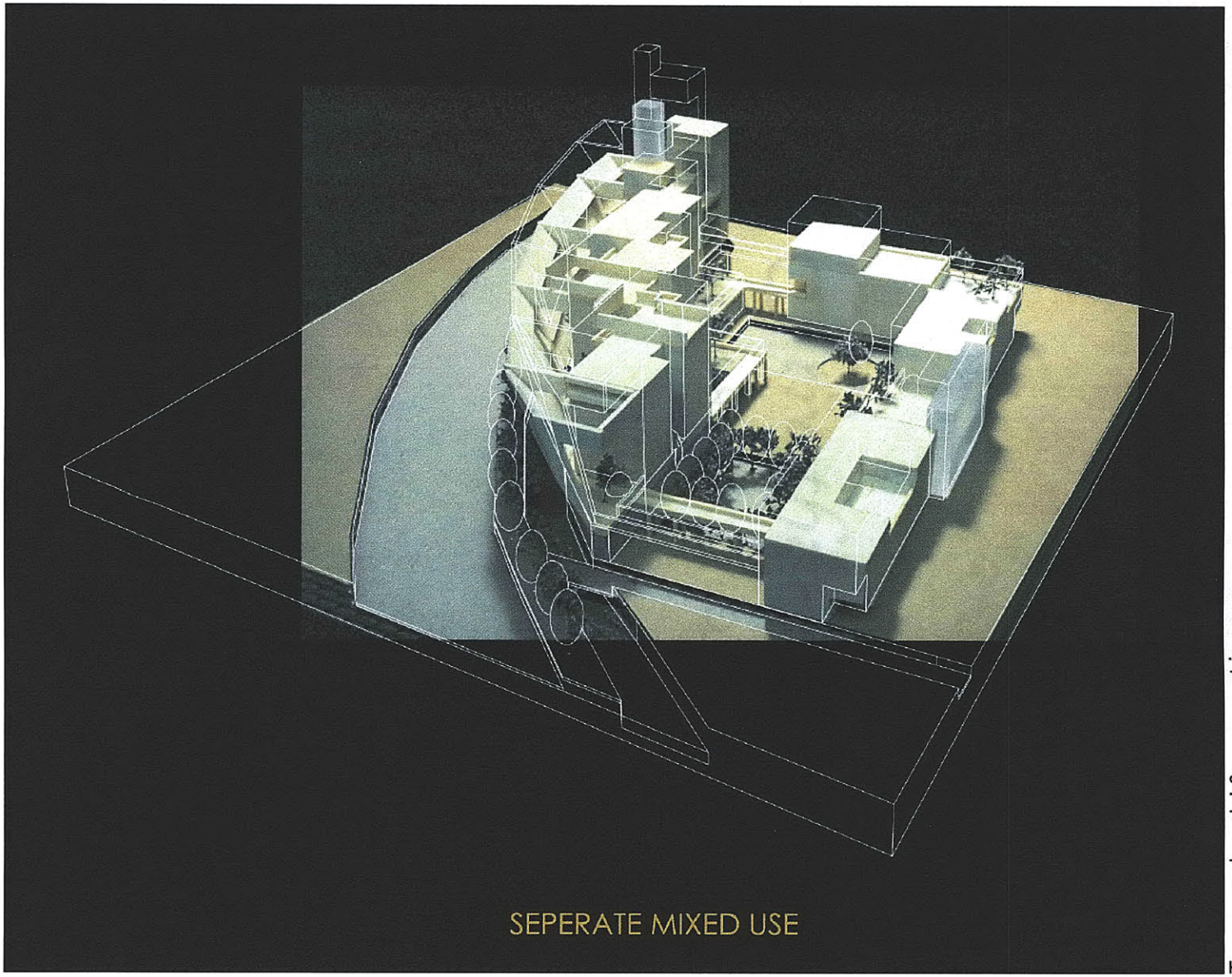
The rationale for a curved northern edge and an orthogonal southern edge is to respond to both urban and climatic conditions. Urbanistically, the curved edge takes the curve of the city road, and the the orthogonal edge takes after the configuration of the campus interior. Climatically, the curved edge serves to redirect the winter winds around the building, and in conjunction with other configurations of this type, redirects the winds patterns for much of the campus.

Aside from redirecting winter winds, the curved northern wall also deflects the southern sun, thereby increasing sun exposure. There is also a strategy for rain collection into the river below. Moreover, there is also the possibility for stack ventilation in the cavity between the wall and the building.

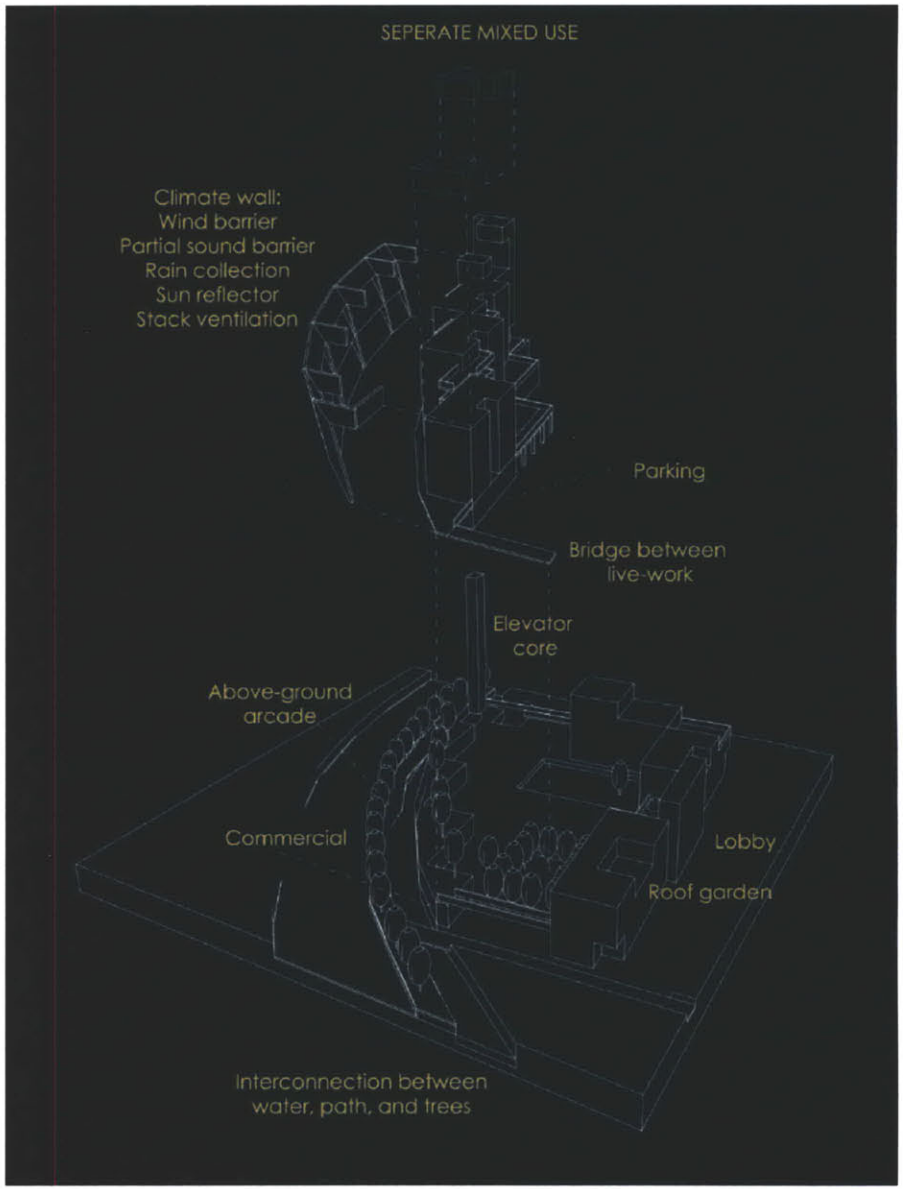
Live-work typology

Plan diagram

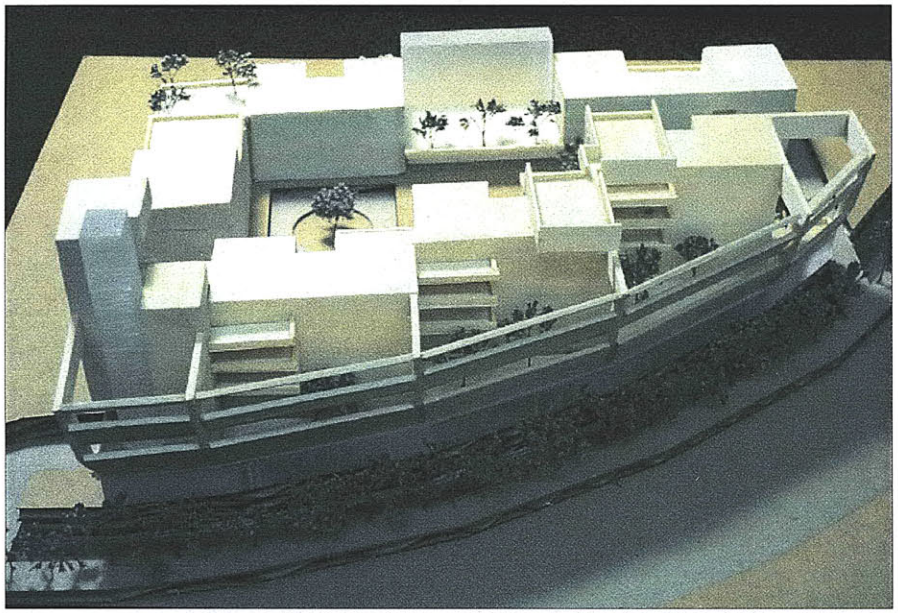




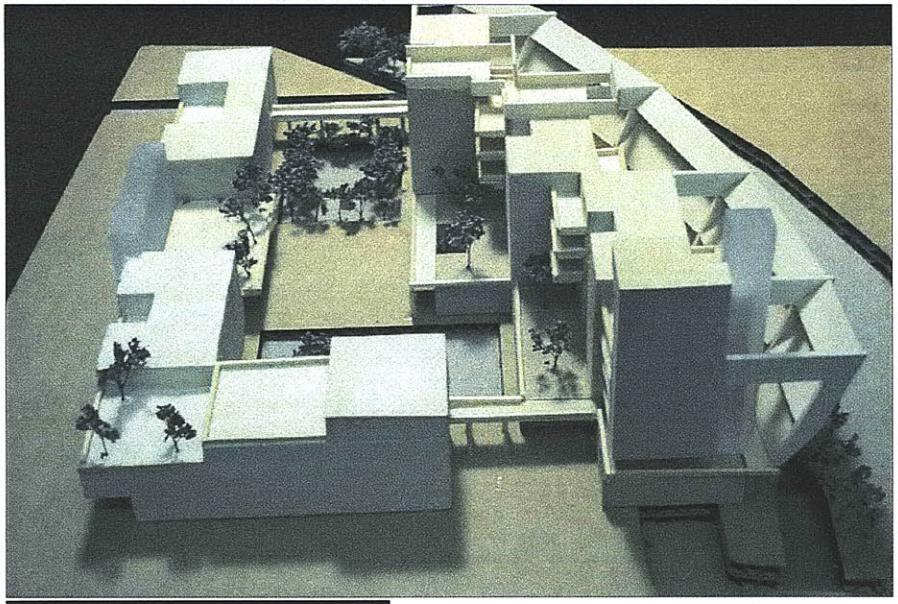
Transposed model & axonometric



Axonometric diagram

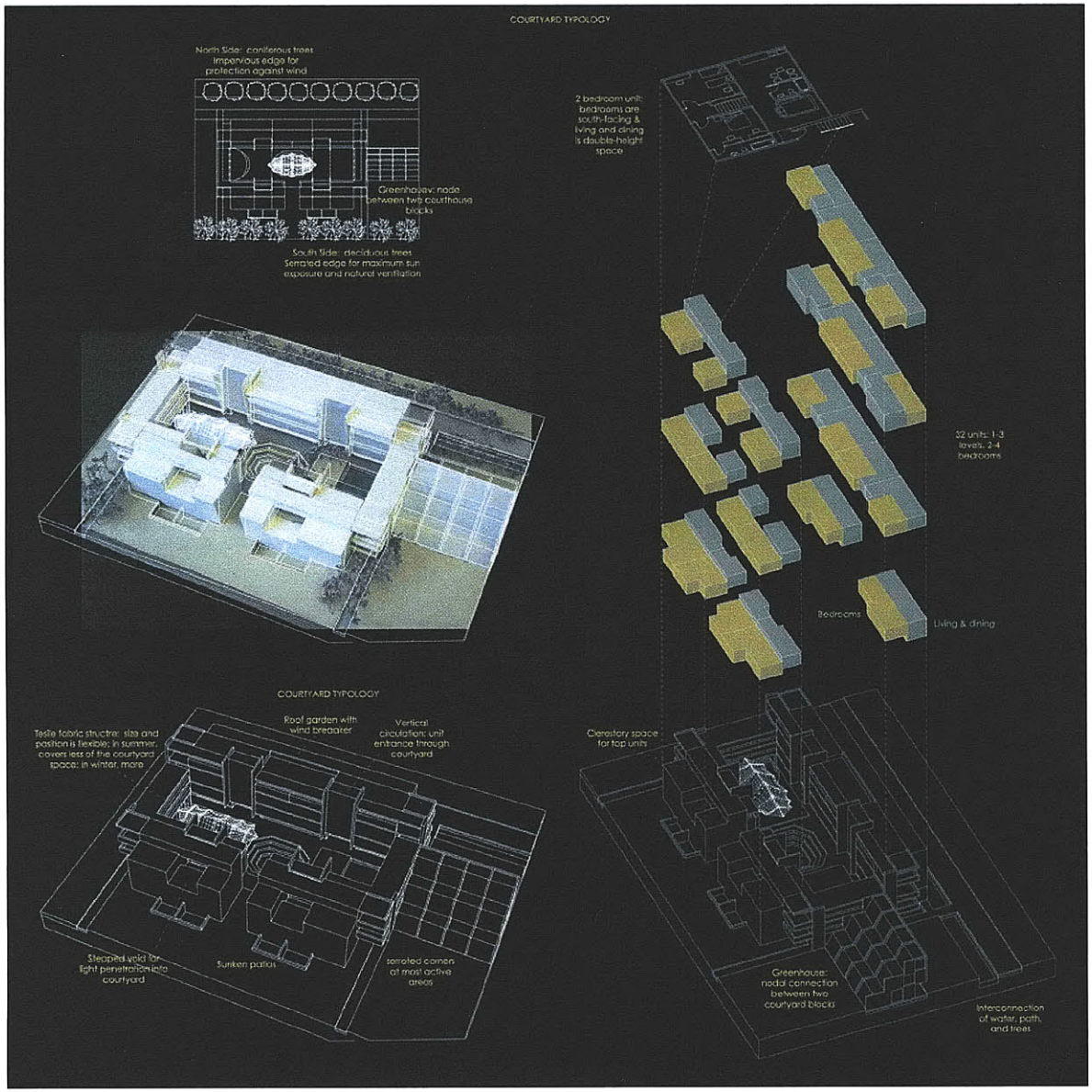


View of model from north



View of model from east

Perspective view from northeast



Courtyard typology

The third typology explores in detail the courtyard condition. It is located on the the eastern edge of campus, and its integration of pathways, roads, and water is intended to connect the campus with the rest of the city. Between two courtyard types is a greenhouse that serves as a node for communal activity.

One of the central ideas of this typology is the design of a fabric tensile canopy to be erected in the courtyard. This canopy would be larger in the winter and smaller in the summer, and its location would be determined by the users.

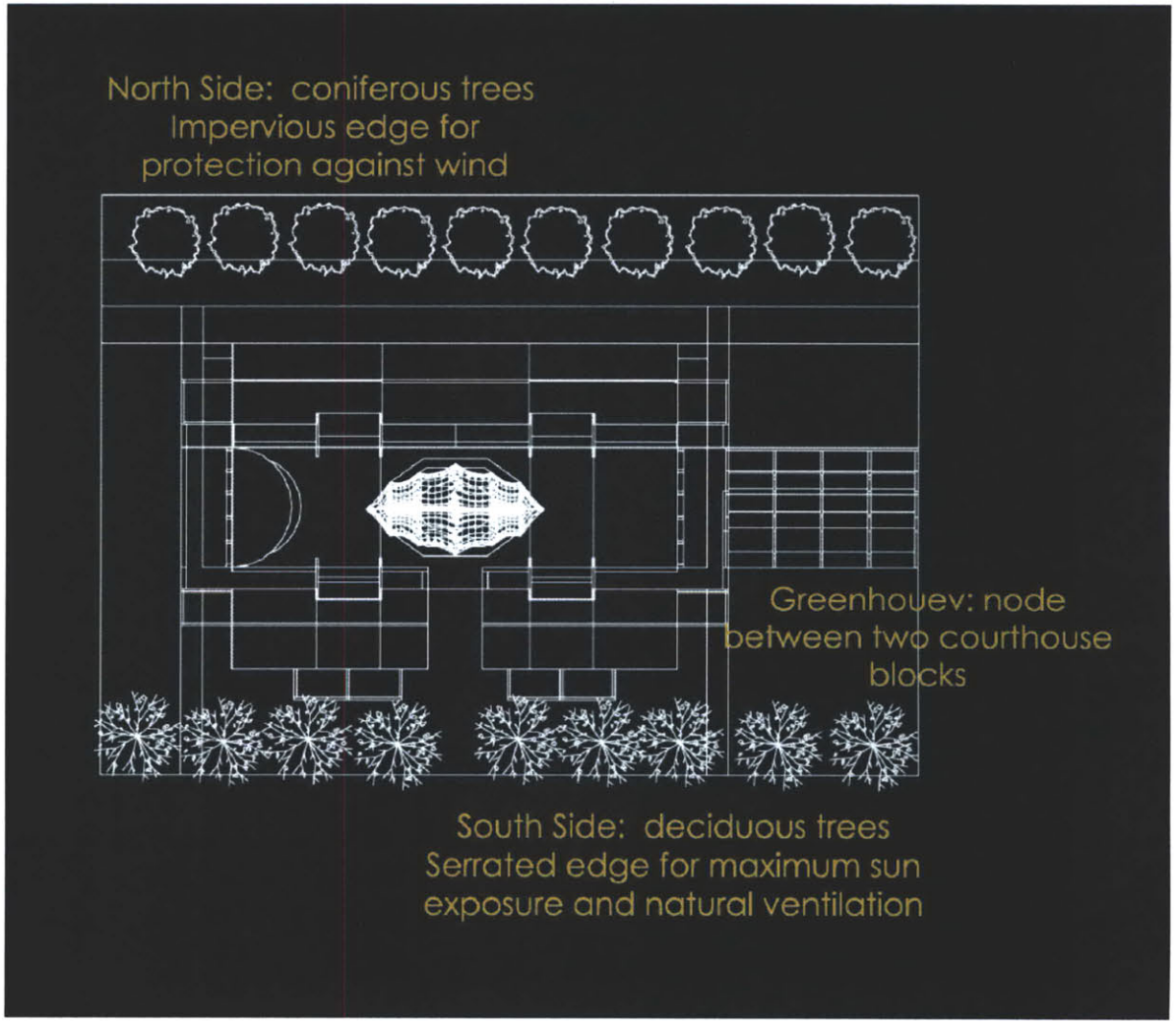
In addition to activating the pathways, water is held in the form of retention pools for the purposes of conservation.

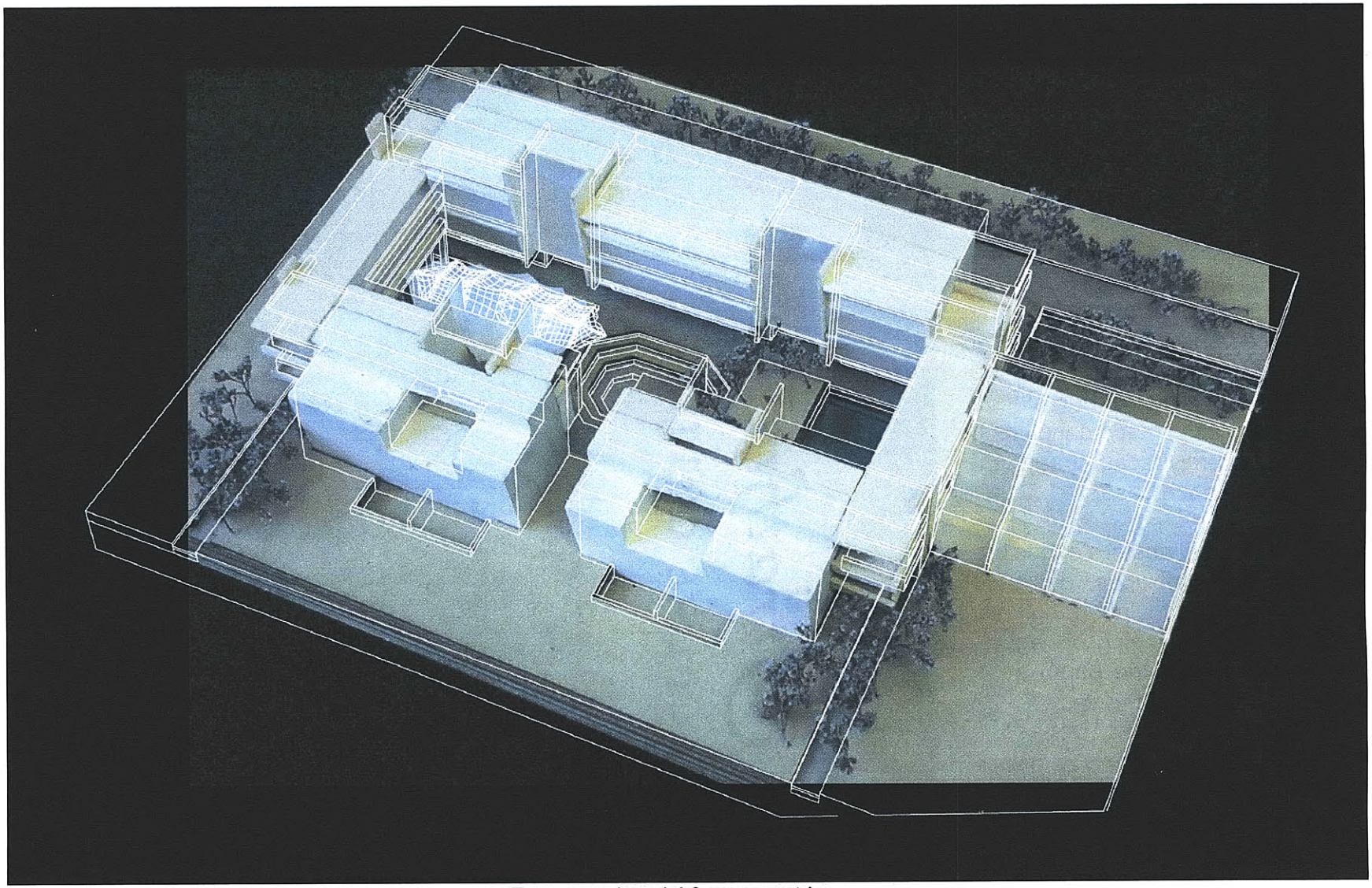
The 4 story northern block blocks the wind from the rest of the block. A commercial is located at the ground level and alongside the axis created by the north side lane of trees, water, and pathway. The 3 story southern block is penetrated by void spaces and allows for optimal sun exposure. Each facade of the north and south blocks encounters a unique set of climatic conditions, and consequently facade treatment is different in each case.

The eastern and western edges are semi-enclosed terraces, designed to accomodate circulation, balcony space, and the hanging of vegetation to screen out the harsh east-west sun and protect privacy.

The units are comprised of a mixture of single level apartments and duplexes. Entrances are through the courtyard.

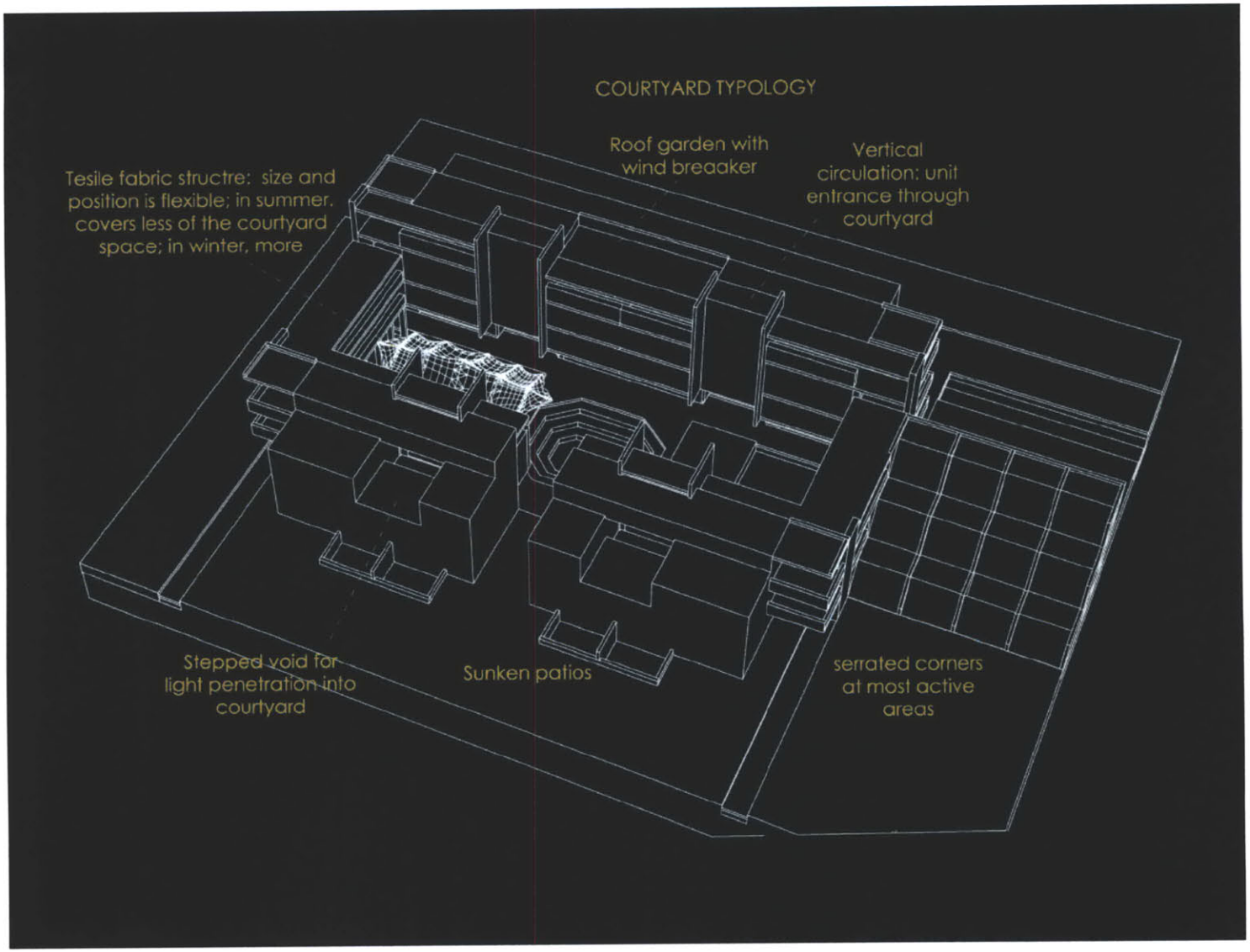
Plan diagram

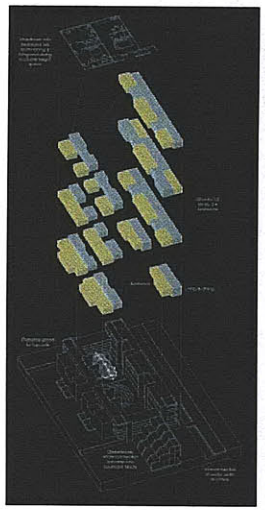


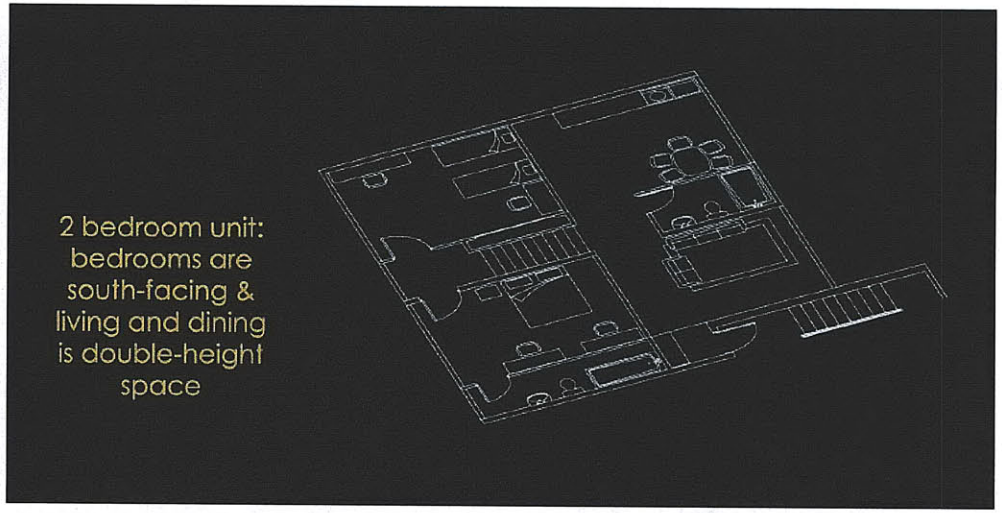


Transposed model & axonometric

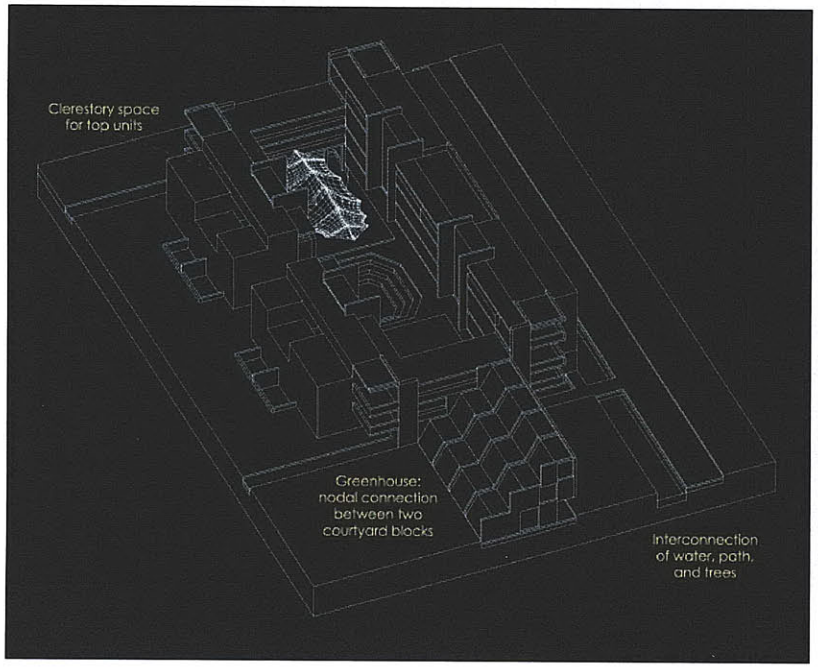
Axonometric diagram

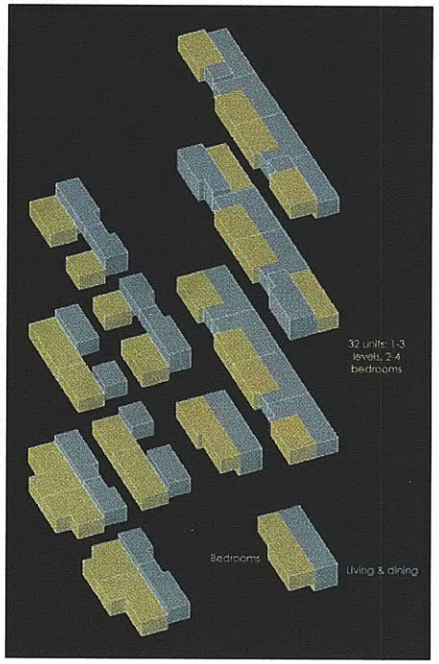


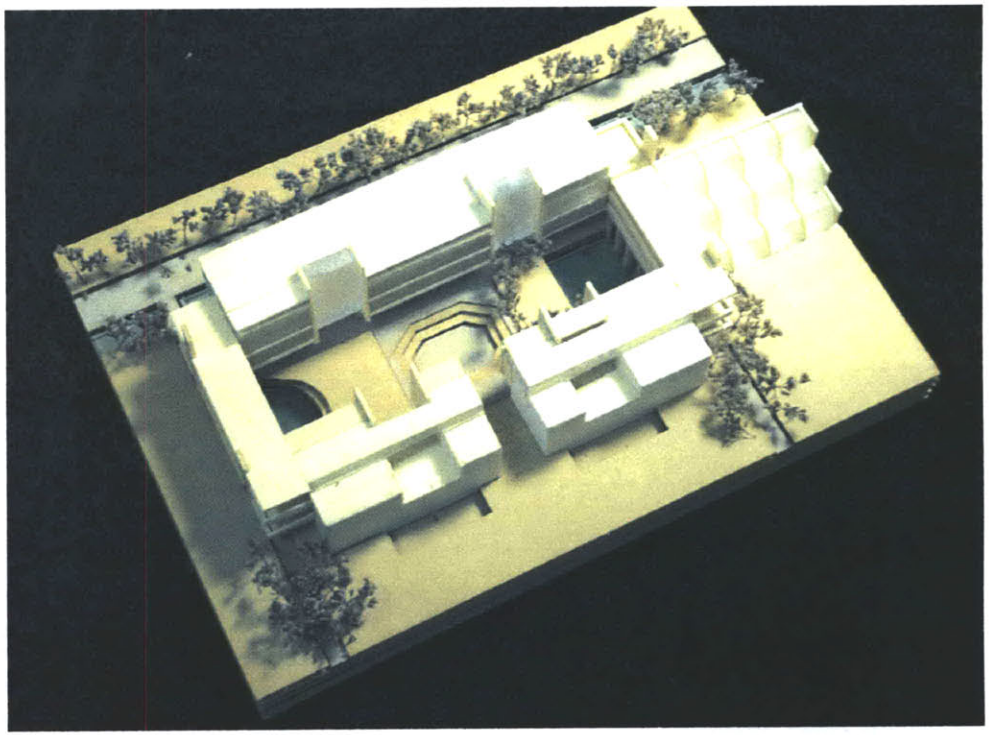




Illustrations [clockwise]:
Exploded axon diagram
Typical unit plan
Unit distribution
Axonometric diagram

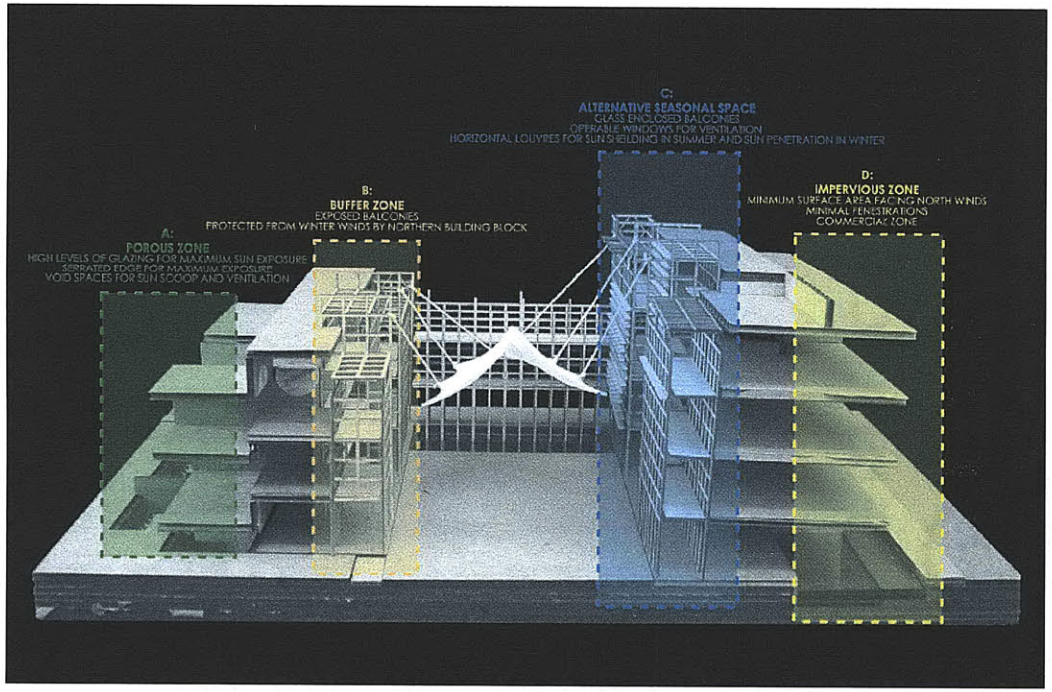






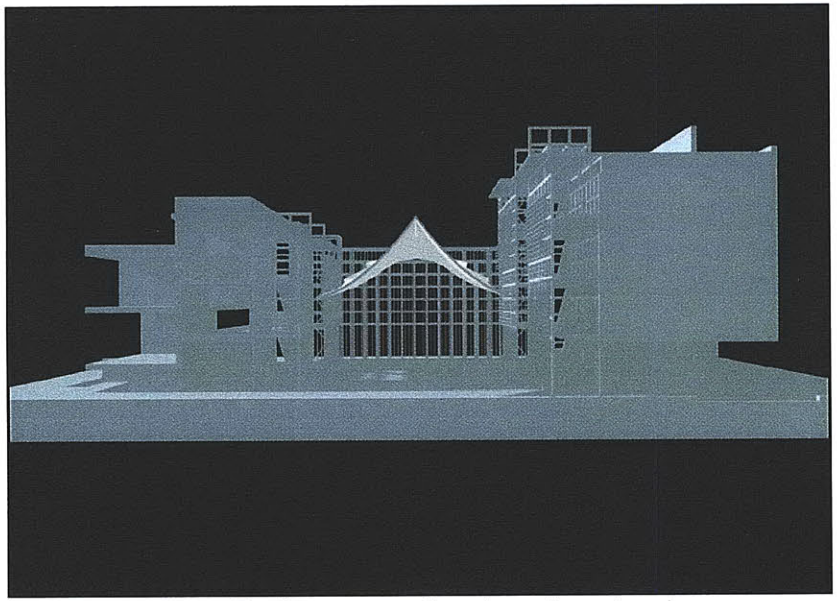
Bird's-eye view of model

East elevation

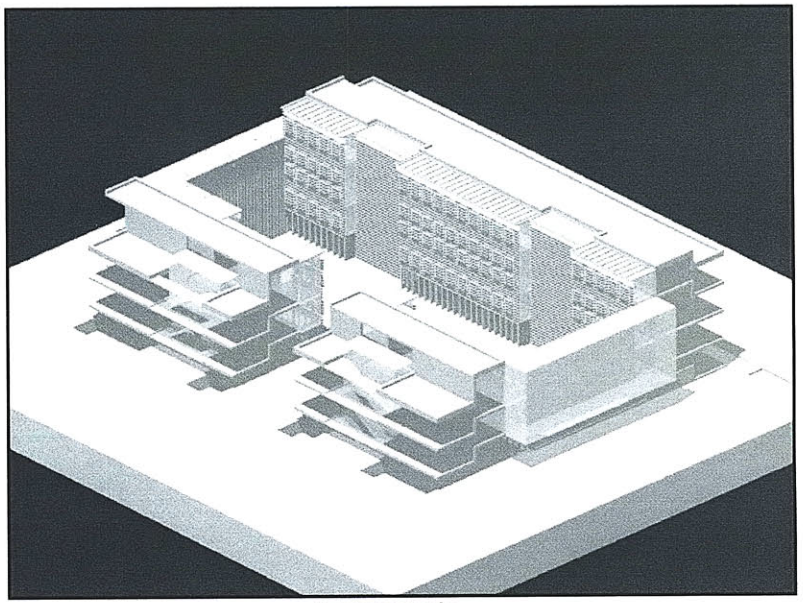


4 climate zones

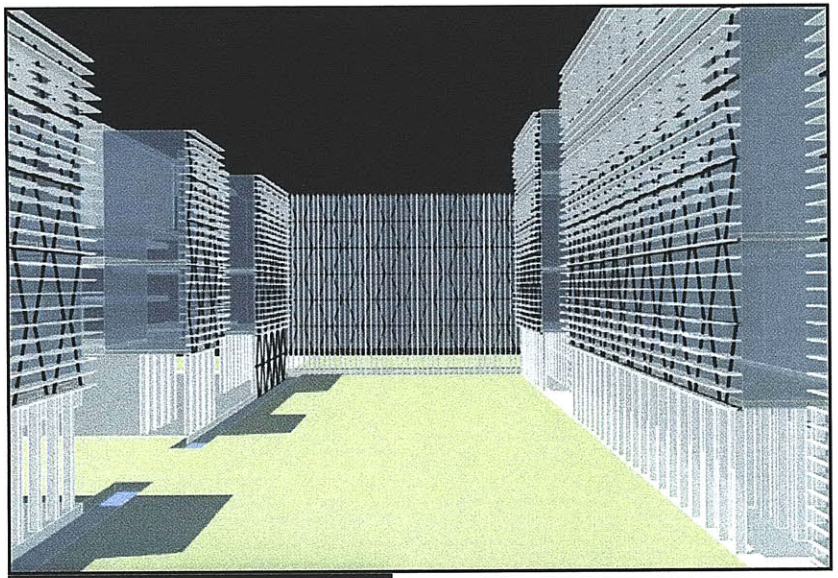
Concept diagram of relationship between building and canopy



Section perspective view of courtyard

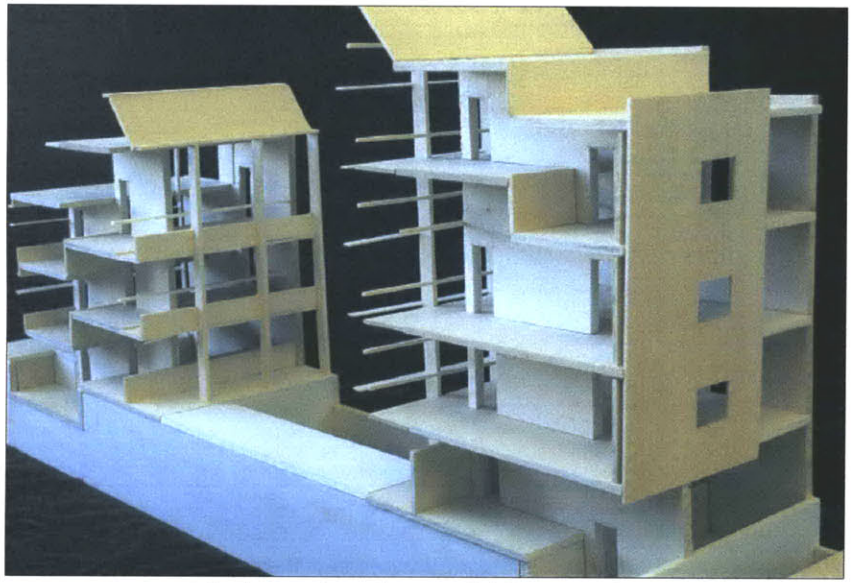


Axonometric

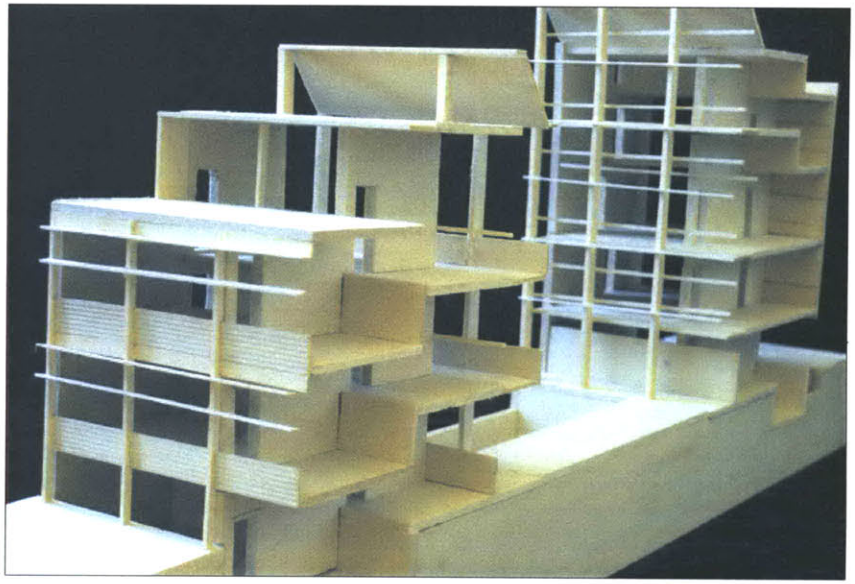


Perspective view of courtyard

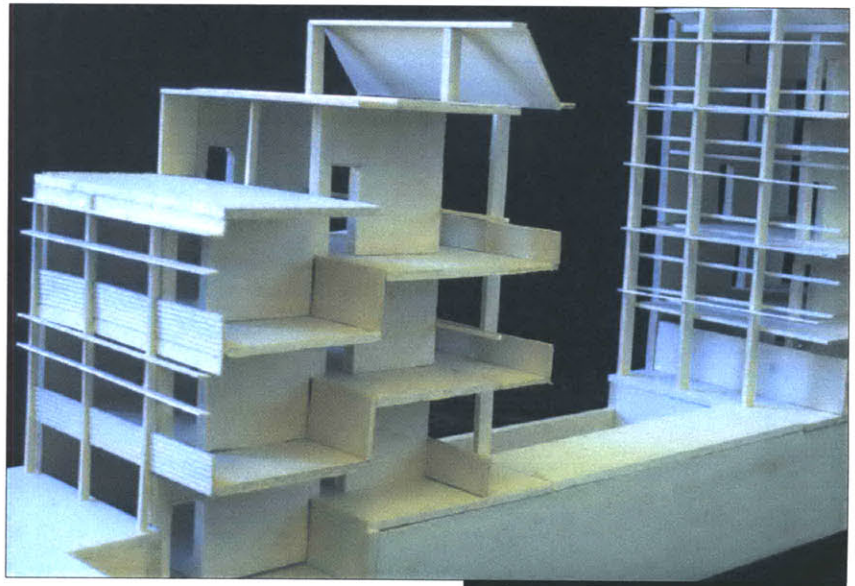
3 T Y P E S COURTYARD TYPOLOGY



2 views of section model from northeast



2 views of section model from southeast



3 TYPES

Final Review

Acknowledgements

This book is dedicated to my wife, Jay-- the raison de' etre for persisting,
despite the insanity of it all.

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Illustrations

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