Form Follows Flows - The Boston Urban Ring

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Submitted to the Department of Architecture
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ABSTRACT

The formal architectural language of existing public transit can be categorized into one of the following four architectural prototypes: form follows function, the duck, the decorated shed, and the inverted decorated shed. This thesis presents a fifth prototype which involves a kinetic and dynamic approach to design. Coined as, "Form Follows Flows," this approach allows architectural form to be responsive and adaptive to the dynamics of its users and environment. By bridging the disciplines of Urban Planning, Urban Design and Architecture, the thesis investigates design solutions to the issues of urban mobility and complex urban networks (of pedestrians, trains, bicycles, cars, buses, goods, etc.).

The opportunity adopted in this exploration is the Boston Urban Ring Bus Rapid Transit proposal. The project presents major socioeconomic opportunities both at the urban and architectural scale for the City of Cambridge and the Massachusetts Institute of Technology. The design proposal is a mixed-use transit hub, which will layer disparate programs such as a transit station with institutional, residential and commercial uses, thereby generating a 24-7 activated space in the center of the MIT campus. The spatial conditions are informed by the evolving fluxes and flows of users, which change according to time, season and program. Furthermore, the thesis explores the urban implications of architecture that can adequately transform in response to evolving programmatic demands and changes in the surrounding built environment.

This thesis constitutes the final component for the author's completion of the Master of Architecture degree in conjunction to the interdepartmental Urban Design Certificate.

Thesis Supervisor: Rahul Mehrotra
Title: Associate Professor of Architecture

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1. PREMISE - A CITY'S APPROACH TO PUBLIC TRANSIT

Boston Globe Image of the Central Artery Construction in 1954 [Globe File Photo].

BOSTON, WE HAVE A PROBLEM

In 1964, when an issue of the Fortune magazine described the city of Boston as "dying on the vine," [1] the city's response was a desperate measure to re-invent the image of Boston. The result was the Urban Renewal Project in which millions of federal funds were pumped into transforming almost one third of the old city fabric into a new "modern" urban downtown in order to instigate future investments and economic growth. While the social implications of the Urban Renewal, which bulldozed through communities in the West End are debatable, the Urban Renewal successfully served its purpose in re-branding the image of the city of Boston, acting as a catalyst for urban growth during a period of nation-wide recession in the sixties.

The situation of the Greater Boston's public transit authority, Massachusetts Bay Transportation Authority (MBTA) in the 21st century shares various similarities to the situation of the city of Boston in 1964. Since 1988, Boston's MBTA has been the fastest-expanding transit system in the nation while Boston remains among the slowest-growing metropolitan areas in the nation. Furthermore, the state of Massachusetts is the only state to lose population in each of the last two years.[2] With decreasing ridership, MBTA's continued operation under its growing eight billion dollar debt (among the largest of any US transit authority) remains a milestone for urban development.[3]

The Greater City of Boston itself faces a socioeconomic crisis with its growing income disparity and inequality, closely linked to the relationship between racial demographics and geographic allocation of wealth. Boston has become a city with one of the highest income disparities. As the GINI index from Boston Indicators report proves, income disparities between the top and bottom quartile of population has increased drastically since the days of the sixties Urban Renewal.[4] This social phenomenon has resulted in a situation where sales of million-dollar-plus condominiums doubled from 2003 to 2006, while mortgage foreclosure rates rapidly increased in low-income neighborhoods.[5] The urban fragmentation between the low-income neighborhoods and high-end neighborhoods has increased, threatening the health of the city itself.

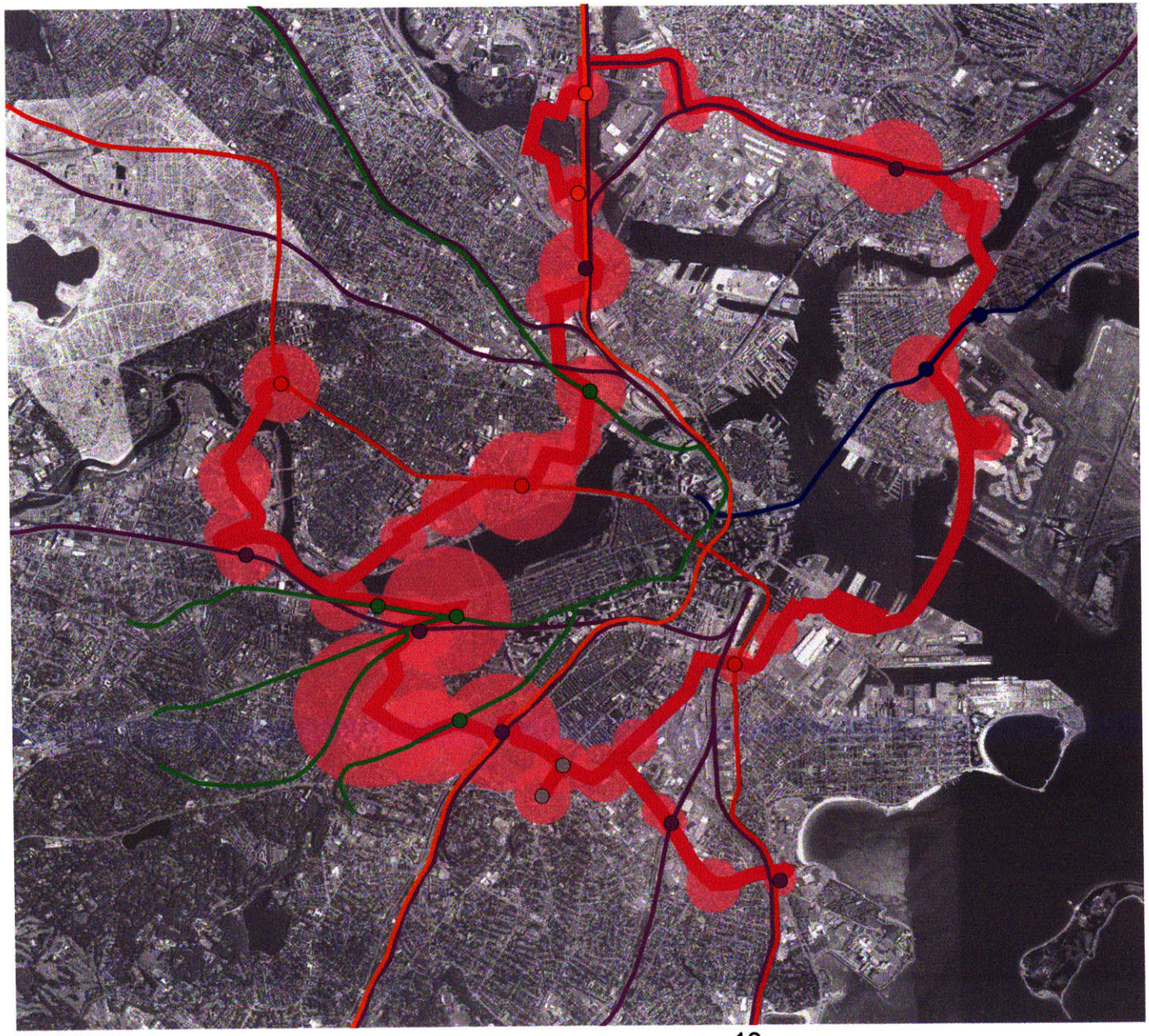
[1] David Kruh, Images of America Scollay Square (Charleston, SC: Arcadia Publishing, 2004), pg 8.
[2] Charles, D. Chieppo, "T Expansion on Wrong Track" The Boston Globe (May 24, 200).
[3] Ibid.
[4] The Boston Foundation, A Summary of the Boston Indicators Report 2002
[5] The Boston Foundation, A Summary of the Boston Indicators Report 2004-2006, pg 38.

THE BOSTON URBAN RING - A SOLUTION?

Today, the implications and the opportunities presented by MBTA's Urban Ring Project seem essential to the survival and future of the city. The Urban Ring Project is essential to re-branding the image of MBTA and regaining ridership. Furthermore, the social implications of providing a circumferential public transit system linking the rapidly growing neighborhoods of Boston, Brookline, Cambridge, Chelsea, Everett and Somerville with major power institutions (as well as employment centers) such as MIT, Harvard, LMA, Dudley, UMass, Airport, and Kendall open up a vast amount of socioeconomic opportunities essential to putting a halt to the growing income disparity.[6] The Project route has been designed to overlap transit catchment areas with economic target zone neighborhoods.

While the Urban Ring Project is essential for the survival of MBTA and the socioeconomic future of the city, the project has greater implications on the debate of mobility in the United States. With concerns of global warming, environmental sustainability and decreasing oil supply, a shift to public transit as a major mode of urban mobility becomes essential to the survival of urban centers. However, the United States lags behind most other developed nations in terms of public transit development. Public transit remains a fairly unpopular mode of transportation, primarily due to the affordable and convenient alternative option of personal vehicles.

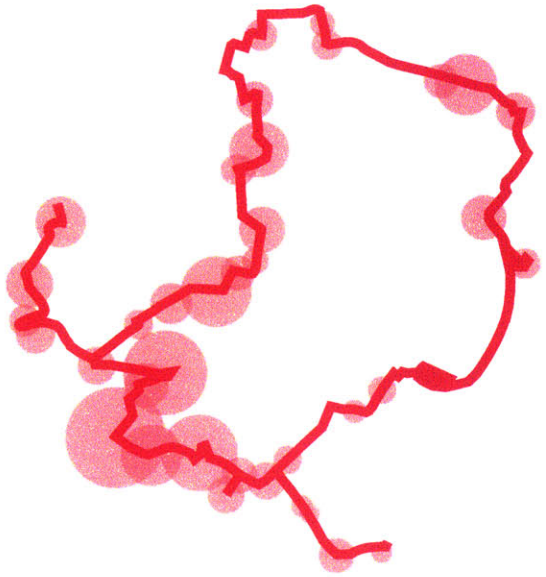
[6] The Urban Ring Homepage: http://theurbanring.com



Proposed Urban Ring Route connecting the neighborhoods of greater Boston.

Information Source: [The Urban Ring Homepage]

PUBLIC TRANSIT FOR THE CITY



RIDERSHIP

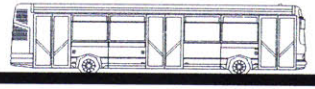
MBTA INTERMODAL CONNECTION

- PROPOSED URBAN RING ROUTE
- RED LINE MBTA
- ORANGE LINE MBTA
- GREEN LINE MBTA
- BLUE LINE MBTA
- COMMUTER RAIL MBTA
- SILVER LINE MBTA

The proposed Boston Urban Ring Project will connect existing major transit nodes with a circumferential bus rapid transit system and there-by alleviating the over-crowding in existing transit lines. Furthermore, the Urban Ring will connect neighborhoods in the greater metropolitan area, proving shorter and more convenient mass transit routes.

MODE SHARE FOR ALL BOSTON TRIPS

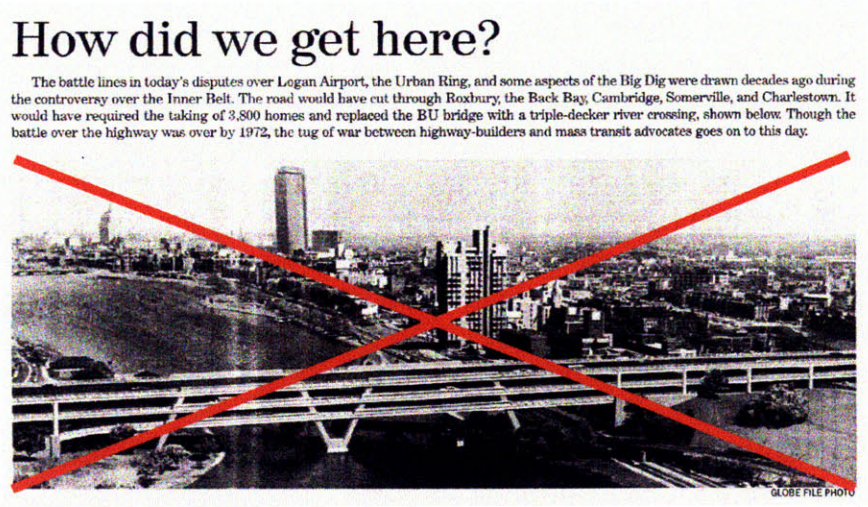
51%
PERSONAL VEHICLE



19%
PUBLIC TRANSIT

30%
PEDESTRIAN

Information Source: [Access Boston 2000-2010]



Globe article on the dispute between highway-builders and mass transit advocates [Globe File Photos].

While Boston's population has grown by approximately 3% since 1990, auto registration has increased by 36%.[7] Boston's solution to the problems of growing automobiles at the turn of the century was rather than improving the public transit system, to hide the "Central Artery," by submerging it underground with the $13.8 Billion Big Dig Project. Yet, in 2008 it is evident that the Big Dig project is merely a temporary solution to the underlying issue of urban mobility.

[7] Access Boston 2000-2010.

TRANSIT - THE FUTURE IMAGE OF A CITY

As Enrique Penalosa, former mayor of Bogota, Columbia explains, "We cannot talk about urban transport until we know what type of a city we want. How do we want to live? Do we want to create a city for humans or a city for automobiles? The important questions are not about engineering, but about ways to live." [8] The TransMilenio project in Bogota, as well as the BRT (Bus Rapid Transit) system in Curitiba, Brazil are among the few of the city-wide public transit systems that have successfully transformed the image of its cities. Both projects originated from a desperate need for affordable public transit in impoverished urban areas during times of economic struggle, and have served as catalysts for urban socioeconomic development.

As Arthur Lubow explains, "(New York City Mayor Michael) Bloomberg's most contentious idea "a congestion tax" on cars entering traffic-clogged districts during peak hours has been working for more than four years in London (and 30 years in Singapore) to increase the numbers of people using public transportation. Interestingly, Curitiba adopted an opposite approach, brandishing a carrot instead of a stick. The city planners suspected that public transportation would attract more users if it was more attractive. And that reasonable assumption turned out to be correct." [9] Today both the Curitiba BRT and TransMilenio is the image of Curitiba and Bogota, serving internationally as successful examples for sustainable public transit projects.

Precedents of successful urban public Bus Rapid Transit in Curitiba, Brazil [Morio/Wikipedia].

[8] Bruce Mau, Massive Change, pg 57.
[9] Arthur Lubow, The New York Times, May 2.

FORM FOLLOWS FLOWS

2. APPROACH - A DESIGNER'S TAKE ON PUBLIC TRANSIT

ARCHITECTURAL FORM AND TRANSIT

In looking at the formal architectural implications of public transit today, it is essential to recognize that almost all public transit forms can be categorized into one of the four types of architectural prototypes: form follows function, the duck, the decorated shed, and the inverted decorated shed.

The most generic transit form is the architectural manifestation of Fordism, where efficiency, productivity, simplification, and standardization become underlying factors in design. Spatial optimization and efficiency of program (form follows function) dominates the design of both stations and the transit vehicle itself.[10]

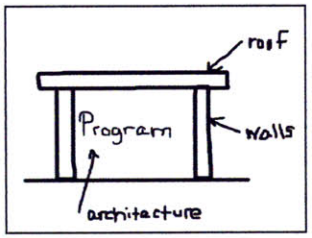
The "Duck" typology coined by architect Robert Venturi is a formal method in which the program of transit directly manifests into the architectural form.[11] An example is the Shibuya train station in Tokyo, Japan, where the form of the station entrance literally mimics that of a train.

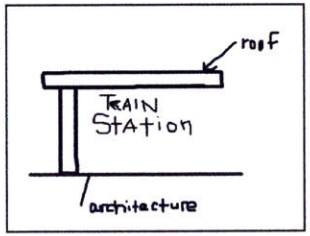
Perhaps the most common formal technique in public transit is the "decorated shed." [12] An example is Otto Wagner's Vienna Stadtbahn (1984-1901), where station designs (such as Karlsplatz) were unified in the Art Nouveau style. Hector Guimard followed soon after with his design for the Paris Metro (1899-1905), in which the lettering of "Métropolitain" (short for the Compagnie du chemin de fer métropolitain de Paris) appeared on the subway entrance heavily ornamented in the Art Nouveau style. Both the Wiener Stadtbahn and Paris Metro use ornamentation and signage for the purpose of unification and creation of the image of its transit services. In these examples, the architectural form is not a functional derivation of the transit system.

The methodology of the "inverted decorated shed" coined by author Anna Klingmann is a further expansion of the concept of the "decorated shed." While the underlying concept remains the same as the "decorated shed," the "inverted decorated shed" carries the decoration to the interior.[13] An example is the Disney Line, in which both exterior and interior of trains are covered with Disney signage, ornamentation and decoration.

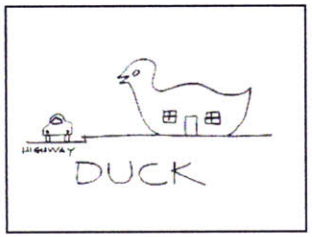
In terms of architectural form, both Curitiba and TransMilenio can be classified as a combination of "form follows function" and the "decorated shed." In Curitiba, architect Sir Norman Foster introduces unified glass tube BRT stops throughout the city. Elevated platforms for the stops functionally enhances the efficiency of the BRT system by easing the enter/exit movement to and from the transit vehicle. However, the cylindrical glass exterior is Foster's architectural touch which raises the BRT stop from merely a "functional shed" to a "decorated shed."

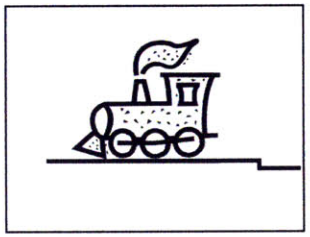
Form Follows Function



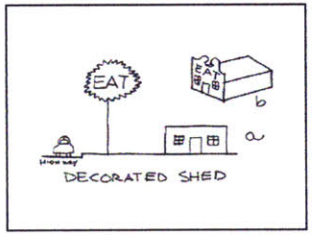


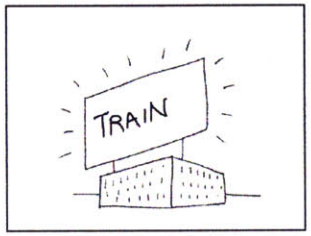
The Duck



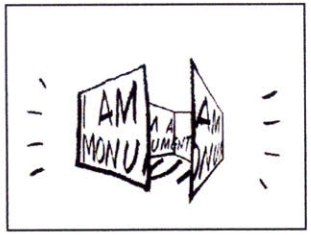


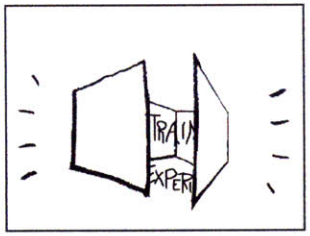
Decorated Shed





Inverted Decorated Shed





[10] David Harvey, "From Fordism to Flexible Accumulation," The Condition of Postmodernity (Oxford, UK: Blackwell, 1989)
[11] Robert Venturi and Denise Scott Brown, "Ugly and Ordinary Architecture or the Decorated Shed," Architectural Forum (November – December 1971)
[12] Ibid.
[13] Anna Klingmann, Brandscapes: Architecture in the Experience Economy (Cambridge, MA: The MIT Press, 2007)
Image Credits : [MBTA], [Venturi, Scott Brown and Associates, Inc.], [Metroparisien], [Anna Klingmann], [Walt Disney Inc.]

FORM FOLLOWS FLOWS - A NEW TYPOLOGY FOR TRANSIT

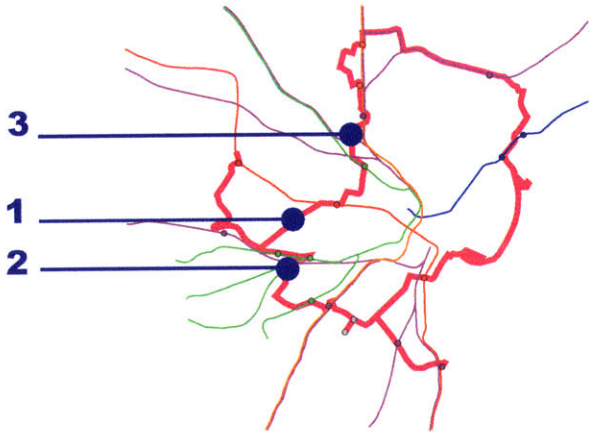
The proposal for this thesis explores yet another typology of architectural form for public transit: form follows flows. This fifth typology is a kinetic and dynamic approach, where architectural form responds to the flows of mobility in the urban fabric and adapts to the kinetics of users. The distinction from the early modernist "form follows function," is that function or program of transit is detached from the traditional idea of single program such as "train station" or "bus stop." The future of urban mobility is heavily dependent on intermodal connectivity, therefore "function" will be considered as a synthesis of dynamic systems of flows -- of pedestrians, trains, bicycles, cars, buses, goods, etc.

Furthermore, the "form follows flows" approach explores the importance of imbedding the BRT network within the existing urban context. In doing so, flexibility of architectural form and adaptability of program becomes essential to accommodate evolving demands and necessities. Rather than simply designing one prototype of stand alone glass box transit stop that will not adapt to the changes in urban built form, the "from follows flows" approach allows Urban Ring stops to adequately transform symbiotically with its surrounding built environment.

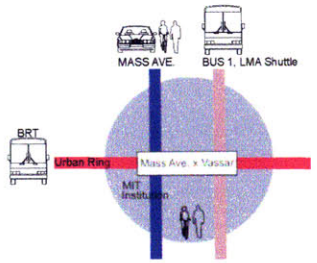
MIT SITE

3. ANALYSIS - URBAN SCALE PLANNING AND DESIGN

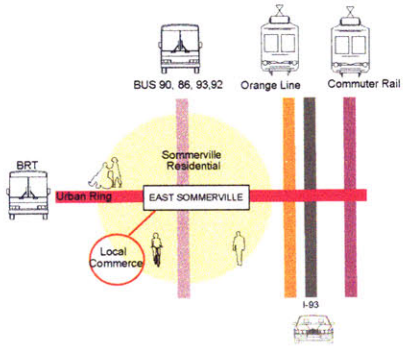
SITE SELECTION PROCESS



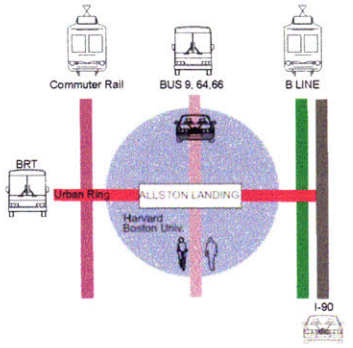
1 MASS AVE VASSAR [MIT]

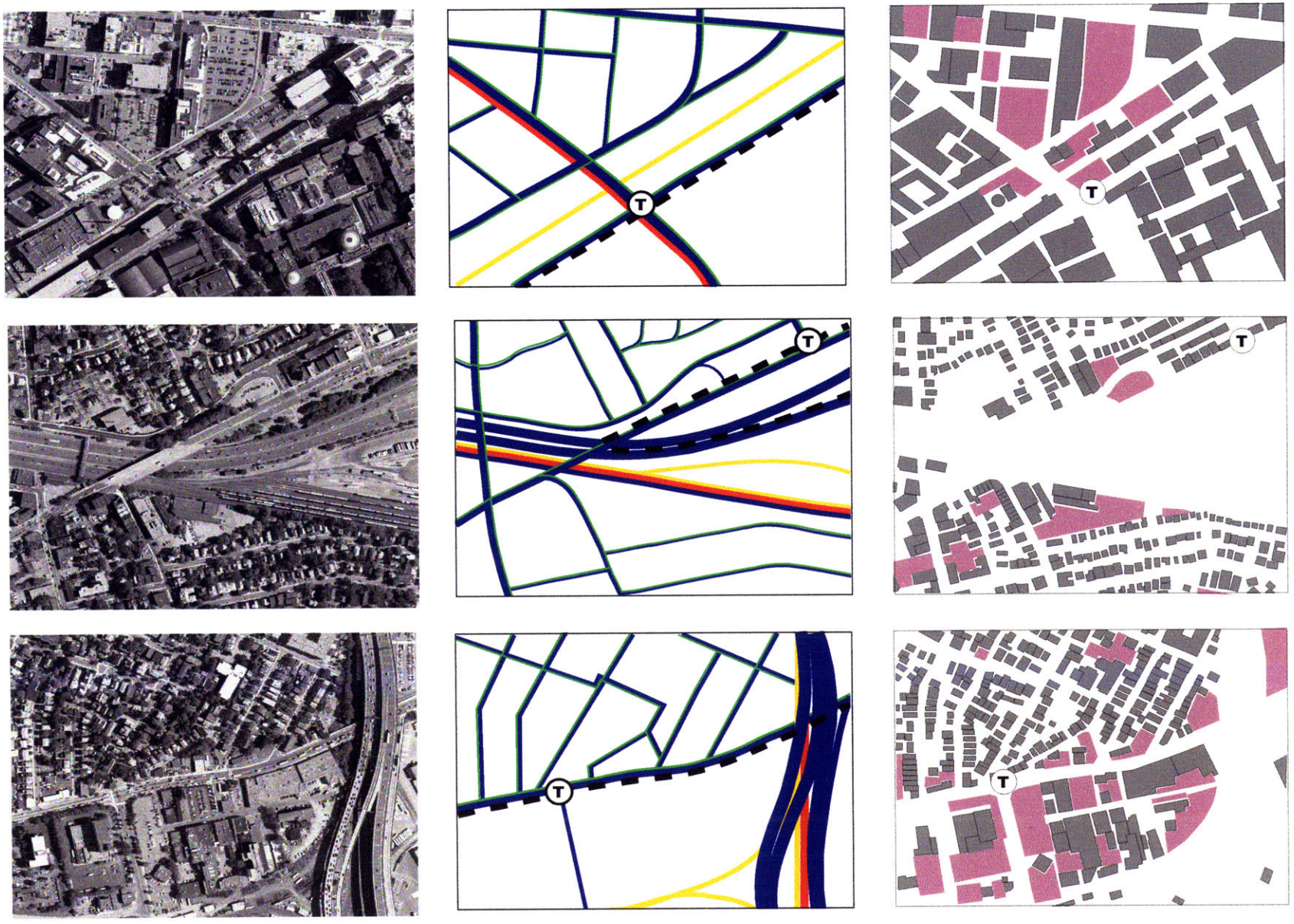


2 ALLSTON LANDING [HARHARD/BU]



3 EAST SOMMERVILLE




VEHICULAR FLOW
TRANSIT FLOW
PEDESTRIAN & BIKE FLOW
OTHER FLOW
BRT ROUTE
BUILT FORM
SURFACE PARKING

Sites

There are three sites selected along MBTA's proposed Urban Ring corridor. Each site is chosen for its unique and complex flows of pedestrian, vehicular, transit and other modes of mobility. Furthermore, each site contains a significant amount of built urban fabric and infrastructure which presents challenges for implementing new transit elements. However, each site also contains under-utilized open spaces (such as deactivated on-grade parking spaces) which provide opportunities for future developments.

Site 1
MIT

The intersection of Massachusetts Avenue and Vassar Street becomes essential when envisioning the future of MIT expansion. A majority of the land north of Massachusetts Avenue on this site is currently allocated to on-grade parking. With an institution-wide shift to transit, these plots owned by MIT will become opportunities for future institutional and commercial developments.

The challenge for this site is dealing with Vassar Street. Vassar is aligned with institutional buildings with laboratories conducting experiments extremely sensitive to vibration, noise, etc. Anticipating a heavy BRT ridership from this location, it becomes important as to where, how and what type of stops are designed on this site.

Vassar Street facing north with separate vehicular, bicycle and pedestrian lane.

Massachusetts Avenue facing northwest with MBTA and MIT shuttles.

Site 2
Allston Landing

This site is selected for its potential to deal with the under-utilized Allston Landing rail yard, currently operated by CSX. For the past few decades, Allston Landing rail yard has been an eyesore for the neighborhood, making the site less than favorable for development incentives. However, with Harvard University's recent land purchases north of the site as well as Boston University's investments into developing Hancock Student Village, plans for further development on this site is on the table. Yet, this site faces many unresolved challenges regarding transit mobility and intermodal accessibility. Some challenges include the issue of air rights of interstate I-90, pedestrian accessibility of the "B" Green Line, intermodal connectivity of Bus routes 9, 64, and 66 to the MBTA Commuter Rail, and the right-of-way of CSX.[14]

An Urban Ring BRT stop in this area introduces yet another layer to the complexity of flows and program on this site. While there are many challenges in dealing with the complexity, the BRT stop is essential for socioeconomic development in this neighborhood. However, it is important to recognize that an unsuccessful urban and architectural intervention in this location will have an extremely harmful impact for future developments in the area. Due to the complex and uncertain nature of the built urban form and flows in this location, the project requires attention to flexibility and adaptability.

Boston University Campus with On-Grade MBTA Green-Line Trolly

[14] Massachusetts Bay Transportation Authority homepage: http://www.mbta

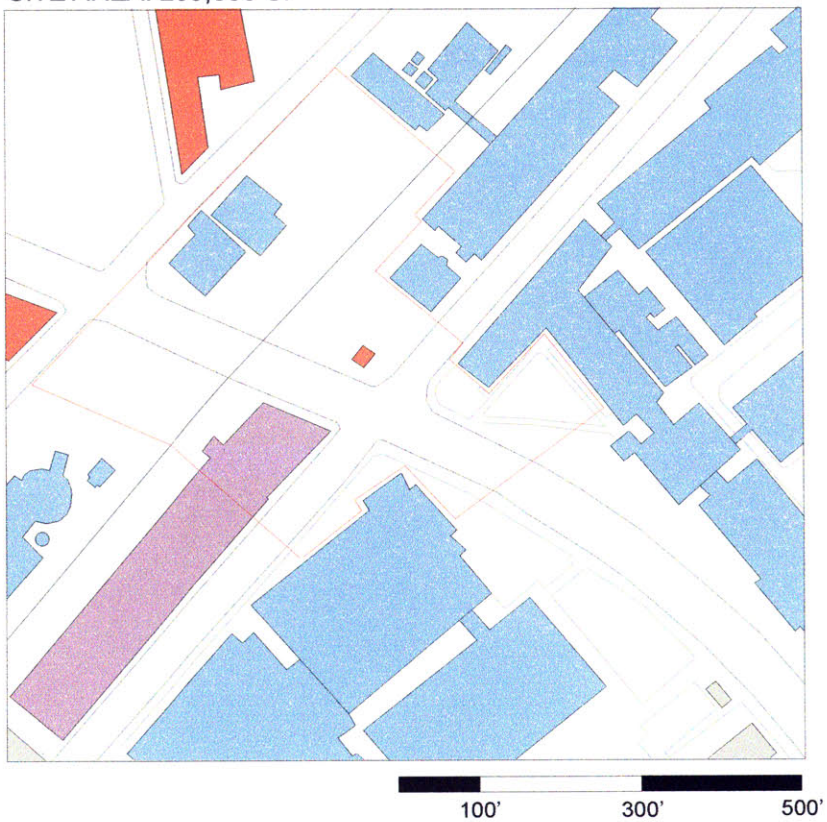
Site 3
East Somerville

This site is selected for its unique proximity to the neighborhood of Sullivan Square and East Somerville. Sullivan Square itself is a major transportation hub, servicing 12 bus routes, the MBTA Orange Line, the MBTA Commuter Rail, and a park and ride facility, all under the interstate I-93 infrastructure. While the intermodal nature of the site raises potential for development, the site has suffered from lack of interest in investments ironically for this precise reason. The space allocated to on-grade parking, vacant former industrial buildings, as well as the underutilized rail yard contribute to the difficulties of this site.[15]

Introducing a BRT stop on this site will bring yet another challenge to this intermodal conglomerate. While the BRT will provide new opportunities of transit, increasing the ridership in this area, if designed poorly, this site will easily become an intermodal nightmare. Thus, the design of the BRT stop becomes extremely important for the success of this site.

[15] Ibid.

SITE AREA: 203,000 SF

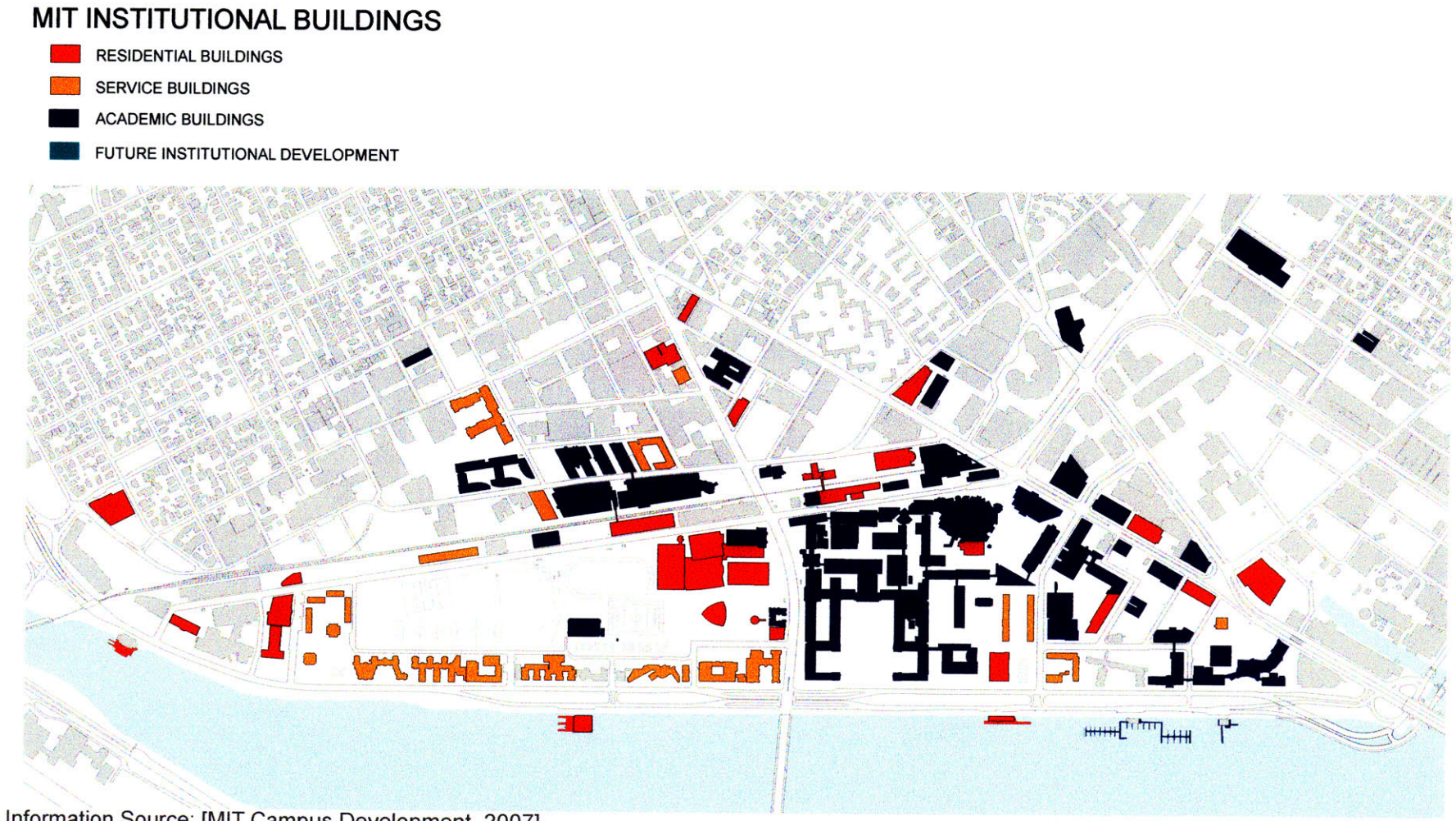


Among the three sites presented above, the MIT site is chosen for further exploration in this thesis due to its strategic location on the MIT Campus, which becomes critical in envisioning the Institute's expansion northward towards to the Osborn Triangle (Indicated on the right page). The site today is primarily used as a surface parking lot. Its program as a parking lot and the CSX tracks act as a physical and psychological barrier, inhibiting pedestrian flow northward on Massachusetts Avenue.

Looking at the diagrams indicating the Institutes's recent trends in real estate ownership and development in Cambridge (indicated in the following pages), it is quite obvious that this site is critical to future campus developments northward. It is essential that anything proposed on this site successfully connects the campuses north and south of the CSX tracks.


SITE
FUTURE INSTITUTIONAL DEVELOPMENT

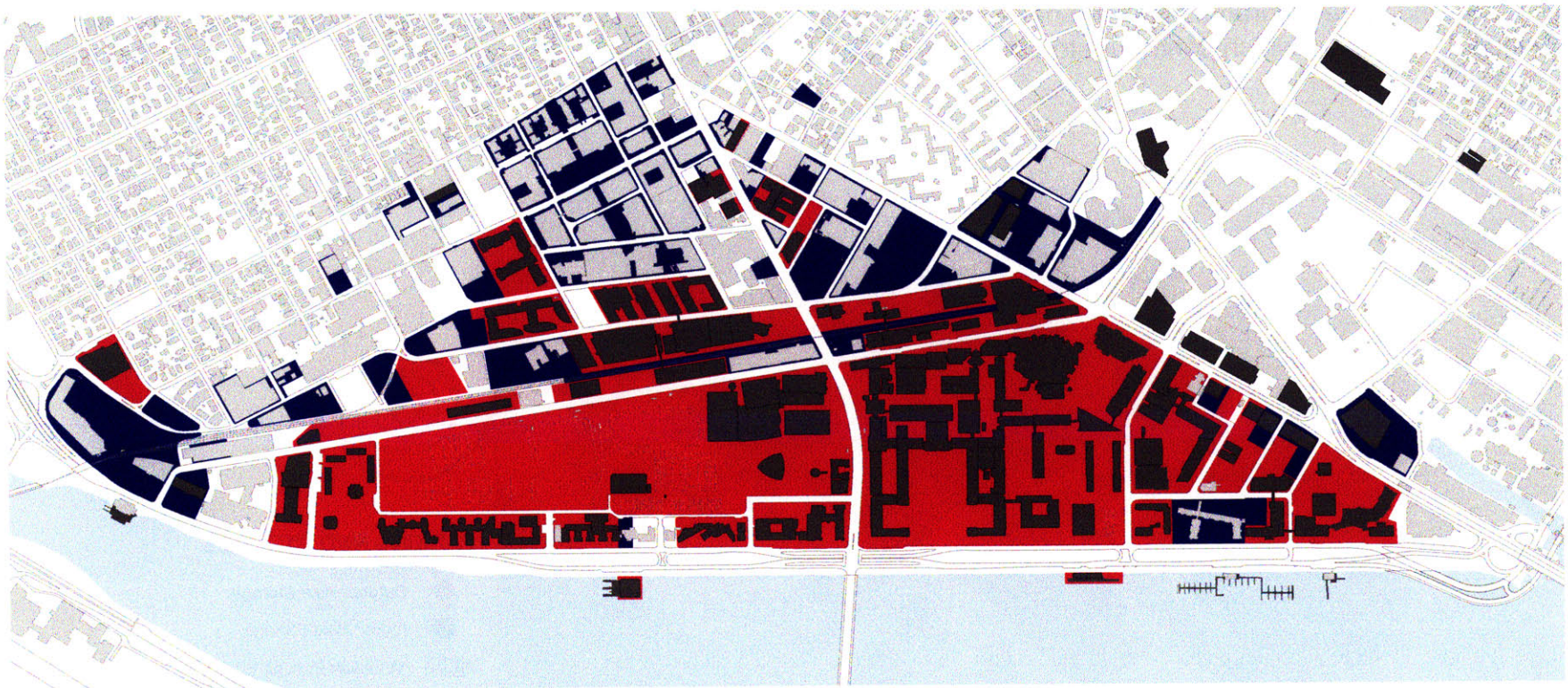
MIT FUTURE DEVELOPMENTS



Information Source: [MIT Campus Development, 2007]

MIT OWNED REAL ESTATE

- ACADEMIC PURPOSE REAL ESTATE
- INVESTMENT PURPOSE REAL ESTATE
- FUTURE INSTITUTIONAL DEVELOPMENT

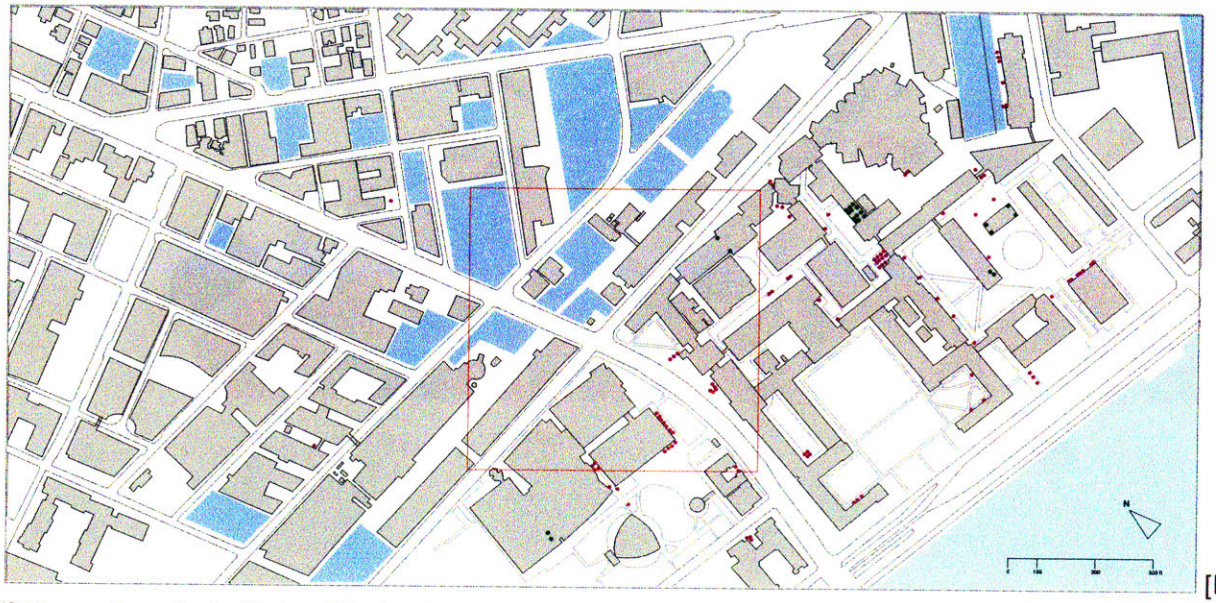


Information Source: [MIT Campus Development, 2007]

EXISTING TRANSIT INFRASTRUCTURE

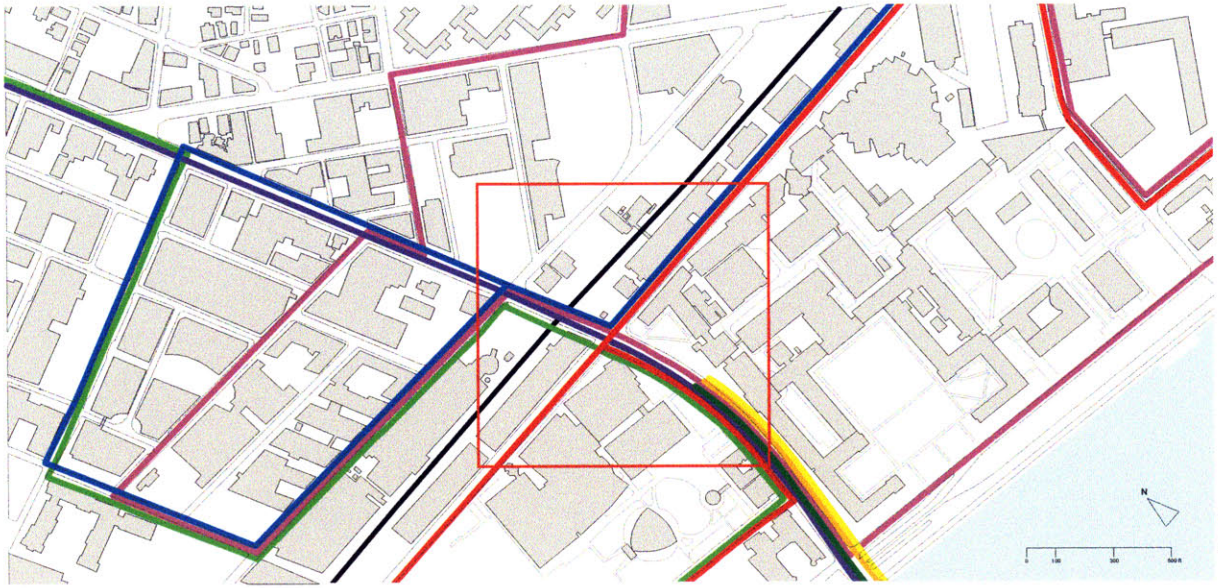
The proposal to design an Urban Ring stop along Albany Street and Massachusetts Avenue can be viewed as an additional layer to the rich network of public and Institutional transit flows already existing on the MIT campus. As a campus located in an urban setting, the Institute has a relatively strong track record in non-personal vehicle commute. In a transportation survey conducted for the Institute's 2006 Annual Town Gown Report, results reveal that an estimated 37% of faculty, staff and students use public transit as the primary mode for campus commute. Furthermore, results from the same survey indicate 31% of the faculty, staff and students either walk or bike as the primary mode for campus commute.[16] The high numerical results from the survey further reveals the existence of an effective and efficient transportation network on campus.

The following three diagrams show the networks of 1. Bicycle storage, 2. Institution operated shuttles, and 3. Public Transit on the MIT Campus, which contribute to the relatively low percentage of vehicular commute.



[Image Information Source: [Rizzo Associates]

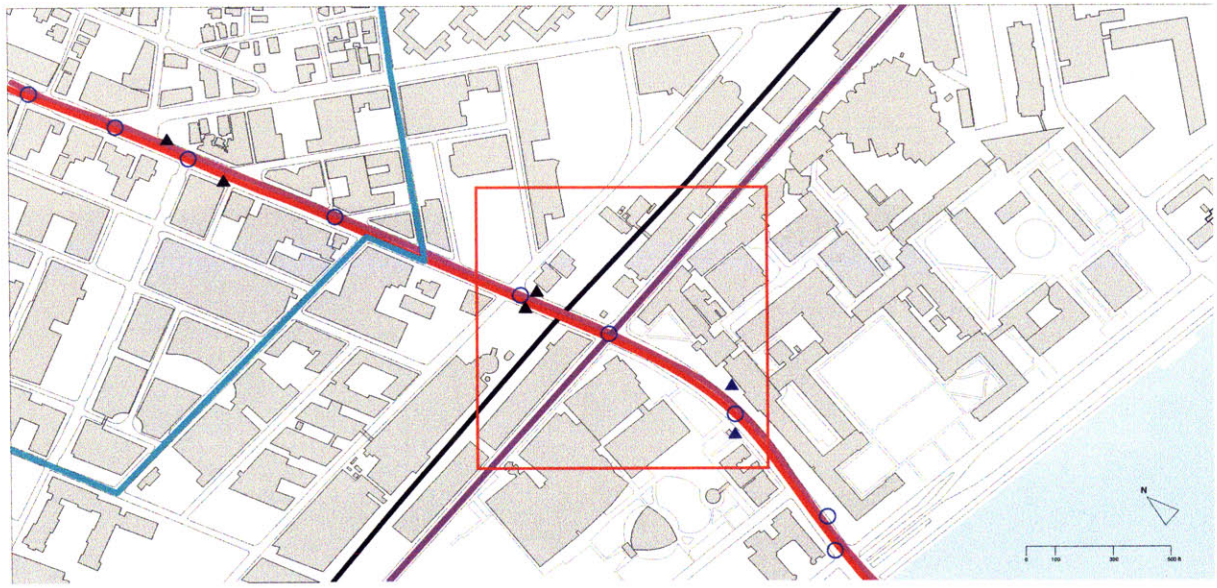
[16] Massachusetts Institute of Technology, 2006 Annual Town Gown Report (Cambridge, MA: 2006), pg 20.



MIT SUTTLE ROUTES

- MIT Shuttle TECH
- MIT Shuttle NW
- M2 Shuttle
- Saferide Shuttle Cambridge East
- Saferide Shuttle Cambridge West
- Saferide Shuttle Boston East
- Saferide Shuttle Boston West
- Boston Daytime
- CSX Right of Way Tracks

Image Information Source: [MIT Annual Town Gown Report, 2006]



TRANSIT ROUTES AND STOPS

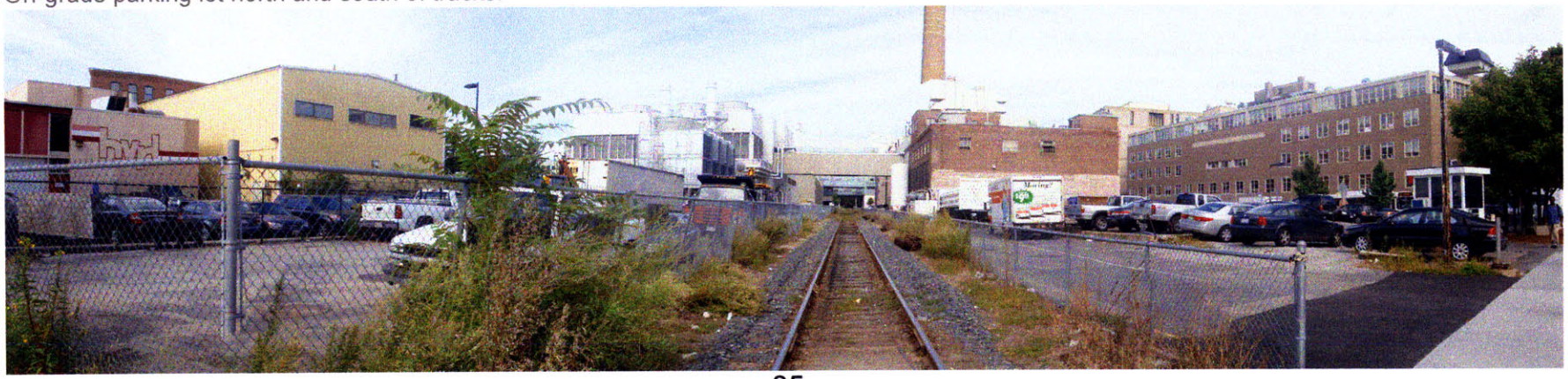
- Cemusa Bus Shelter
- Other Bus Shelter
- MBTA Bus Stop
- MIT Shuttle TECH
- Number 1 Bus Route (7 Days a Week)
- CT1 Bus Route (Weekdays Only)
- CT2 Bus Route (Weekdays Only)
- CSX Right of Way Tracks

Image Information Source: [Community Development Department, City of Cambridge, MA, 2006], [MBTA, 2008]

EXISTING SITE CONDITIONS

Intersection of Massachusetts Avenue and Vassar Street, facing north-west.
View of on-grade parking lot.

View down CSX tracks.
On-grade parking lot north and south of tracks.



FLOW GENERATED PROGRAM

4. ANALYSIS - PROGRAM

USER FLOW DIAGRAM BY PROGRAM

In exploring design strategies for the MIT site, it is essential to recognize the energy of the site. The proposal of the Urban Ring stop along Albany Street introduces a new influx of flows and energy to this site. An estimated 40,000 of new passengers will be be introduced to this site by the new Urban Ring propasl. This number, in addition to the extisting high traffic generated by other MBTA lines such as the Number 1 bus running along Massachusetts Avenue will bring an unprecedented dynamism to this area.[17]

Furthermore, the recent Vassar Streetscape Project conducted by the Institute's Campus Development,[18] has helped increase both pedestrian and bicycle flows along Vassar, heightening the site's potential for becoming a successful transit hub.

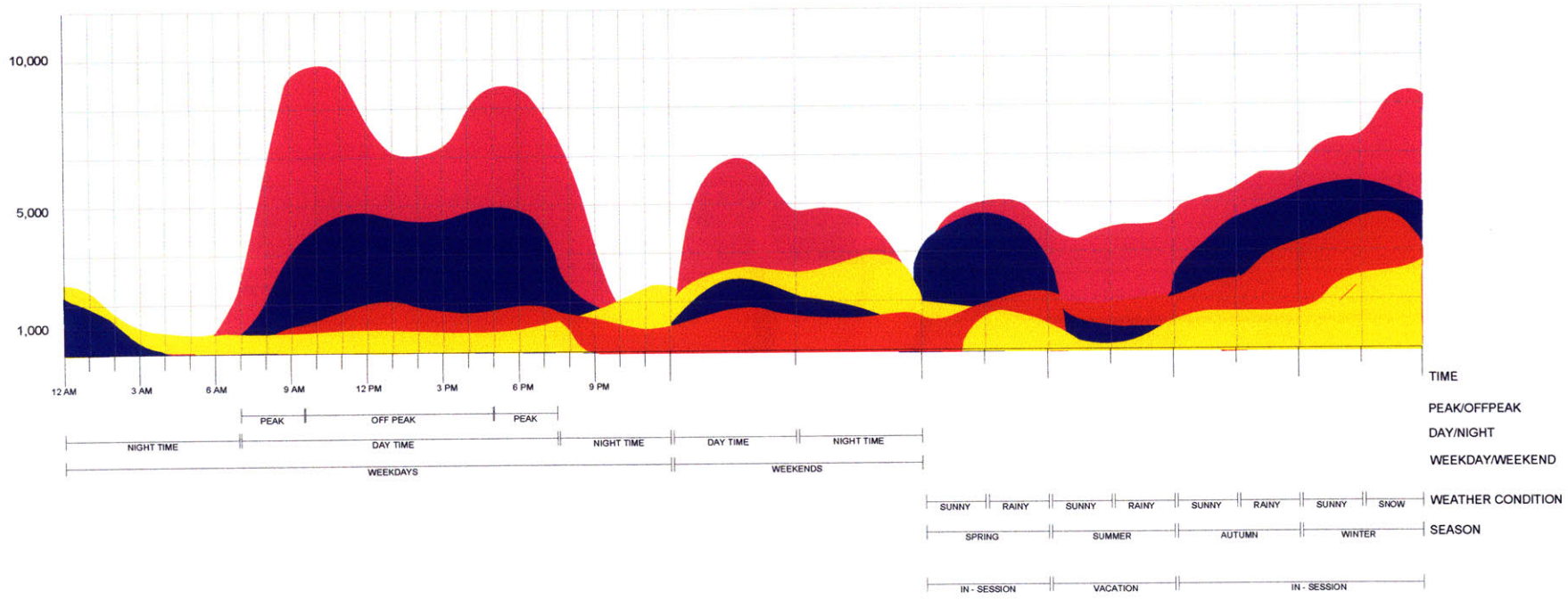
The strength and energy of this site, however derives not only from the flows generated by transit facilities. As indicated in the chart on the right, another major generator of flows is the institutional facilities in the area. The site is located in the center of the campus, connecting the East and West Campus, as well as the North (in the future) and South Campus. Hence naturally, this site becomes a hub for the Institute itself.

By overlaying the transit flows generated by the urban ring, along with institutional flows, this site is already quite dynamic. However it is essential to consider the impact of the element of time in this location. Due of the nature of transit and Academia, the flows generated by these programs tend to focus during the weekday. This phenomena presents a challenge in both Urban and Architectural design. Since transit and institutional programs do not generate night-time flows, the sight may suffer a lack of activity during the evening. This condition, from an Urban context is undesirable because it is not only an under-utilization of space, but furthermore presents issues of safety and security.

In order to create a space which operates 24-7, a third program is introduced to the site. The residential program generates a another type of flow, which is active during the evening, when students return from the institutional activities. While the volume of the residential flux may not necessarily be in the same magnitude of the transit user flows, the duration of use can be predicted to be longer.

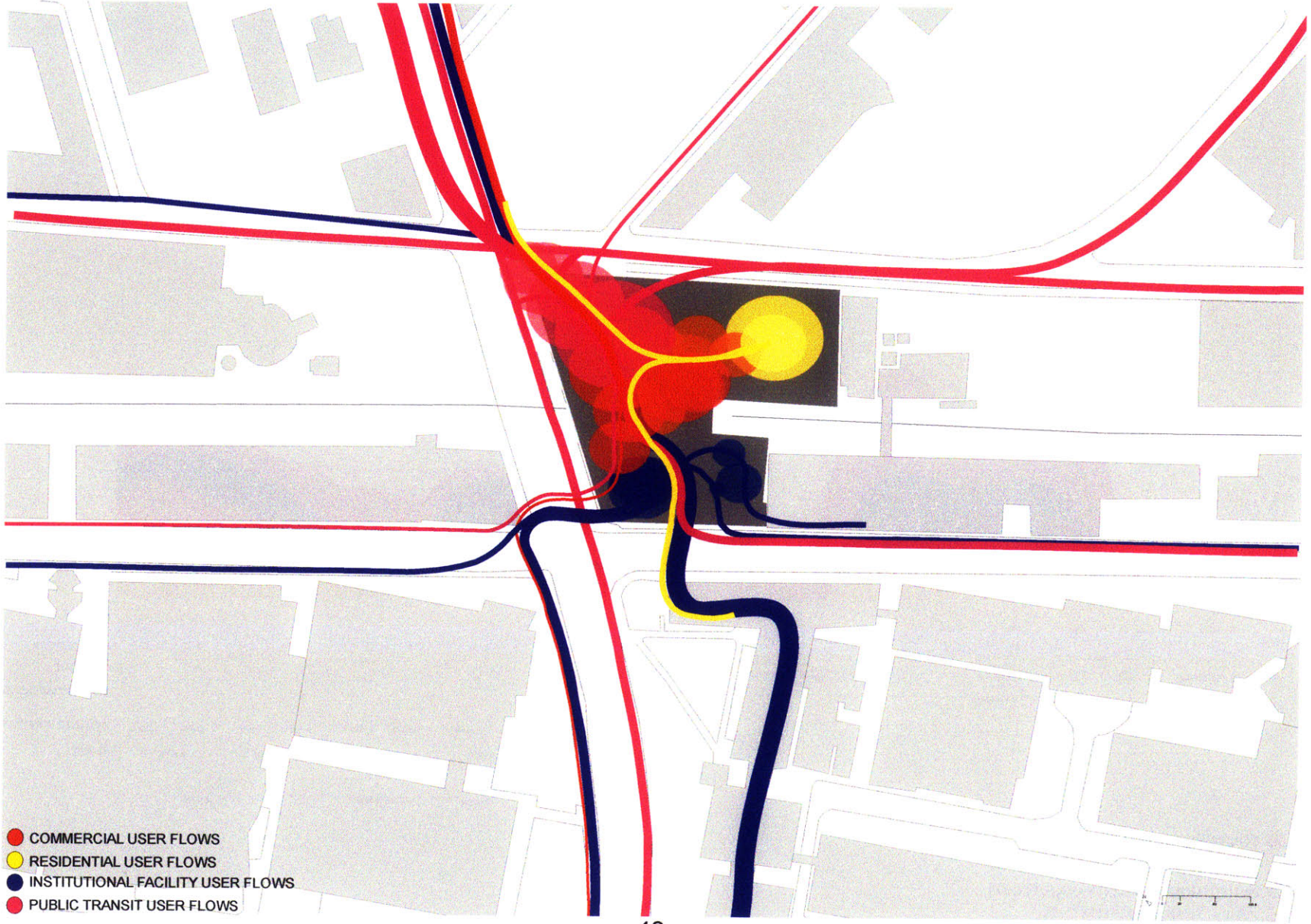
The chart on the right summarizes the different flows crossed with the element of time. As evident from the chart, the four flows allow the site to be constantly occupied and in use.

[17] The Urban Ring Homepage: http://theurbanring.com
[18] Massachusetts Institute of Technology, Campus Development Presentation 2006.

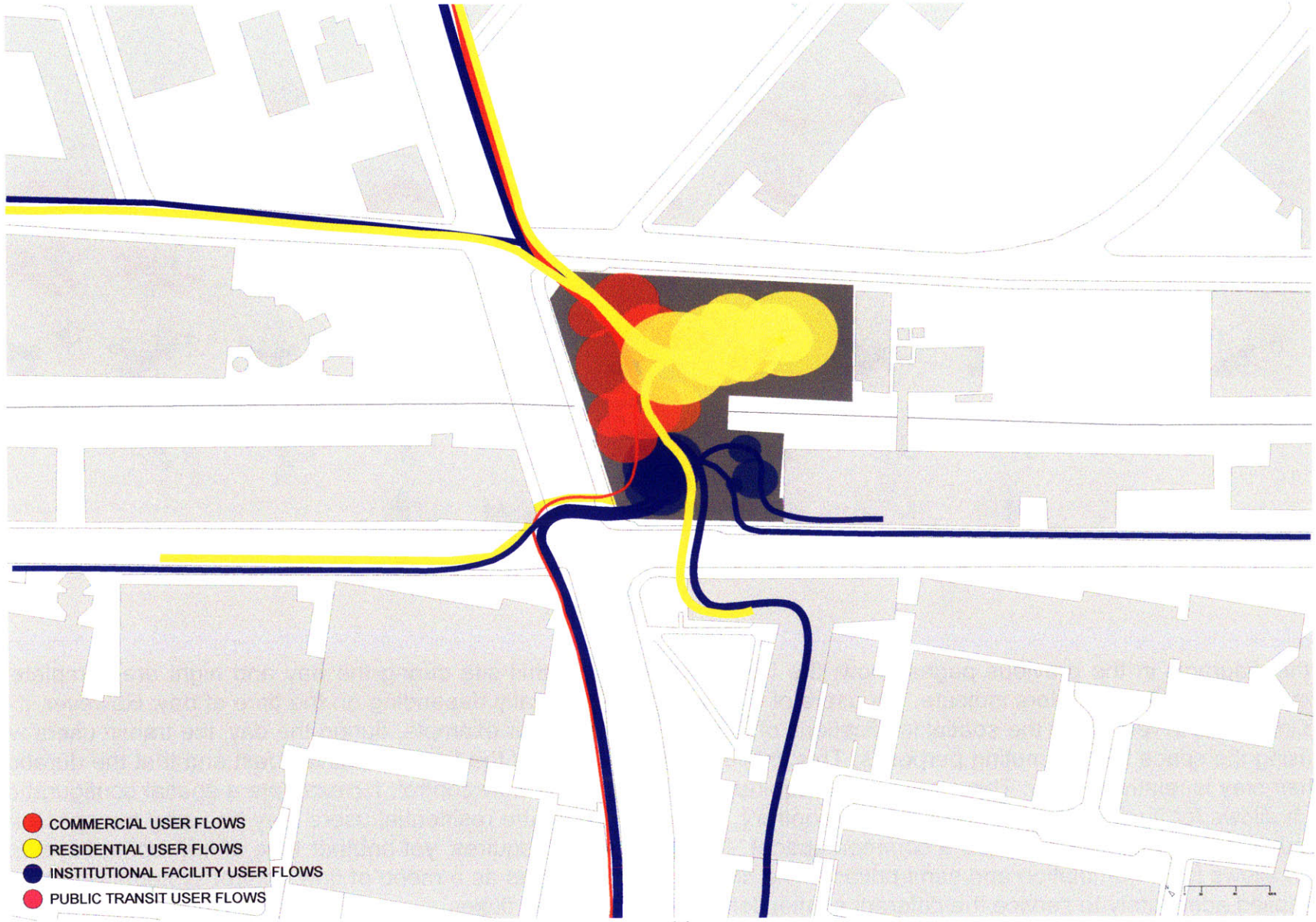


COMMERCIAL USER FLOWS
RESIDENTIAL USER FLOWS
INSTITUTIONAL FACILITY USER FLOWS
PUBLIC TRANSIT USER FLOWS

SITE FLOWS - DAY TIME



SITE FLOWS - NIGHT TIME



FLOW CONTROL SYSTEMS

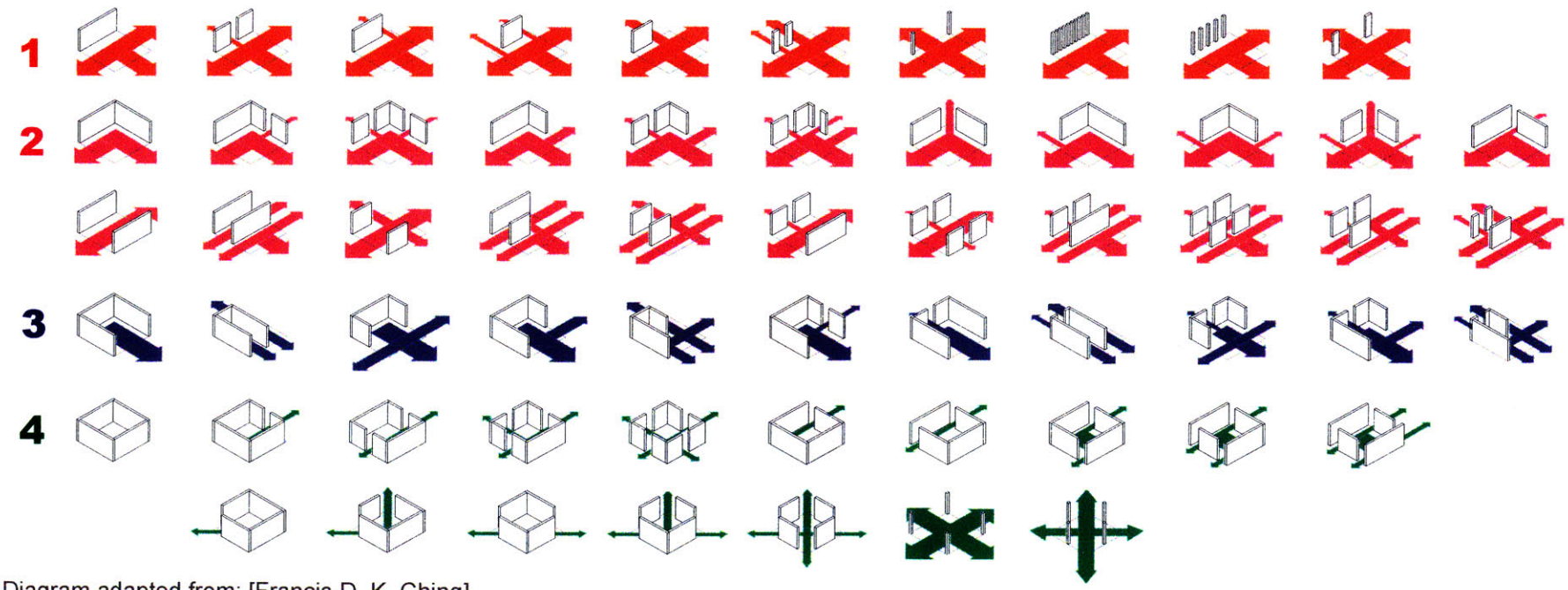
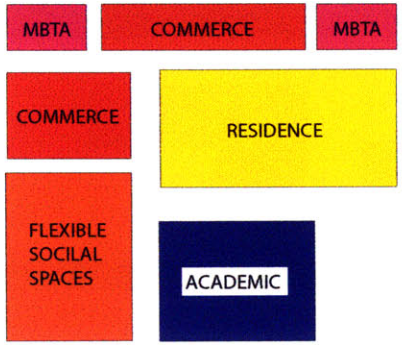


Diagram adapted from: [Francis D. K. Ching]

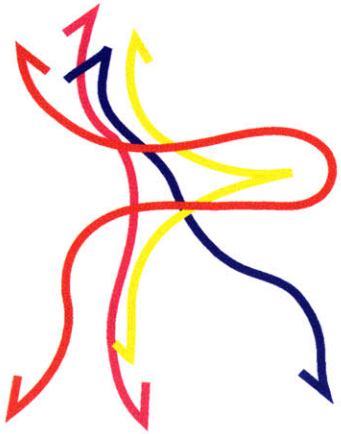
As the diagrams in the previous pages show, the flows generated on this site during the day and night are completely distinct. As the different colors indicate, the users of the spaces differ greatly depending on the time of day. However, it is also important to recognize the spatial implications of these differences. For example, during the day, the transit users will be using the space for commuting purposes. This implies that the speed of the flow is relatively fast and that the duration of their stay is relatively slow. This type of flow requires a distinct type of flow control, for example a spatial configuration which allows for fluidity and continuity. On the contrary, during the night, the residential users may be using the space for the purpose of group assembly (as a common space). This type of flow requires, yet another type of flow control system, which allows for accumulation and semi-privacy. The diagram above serves as a menu of flow control systems which can be applied adequately to service the different spatial demands of flows and fluxes.

CONCEPT AND STRATEGY

PROGRAM

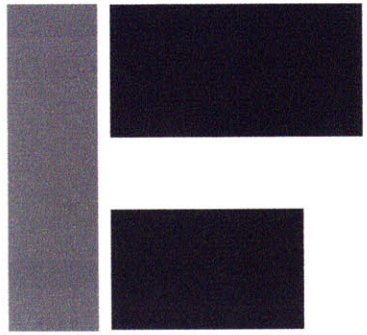


USER FLOWS



COMMERCIAL
RESIDENTIAL
PUBLIC TRANSIT
ACADEMIC

FLEXIBILITY v. RIGIDITY



FLEXIBLE / SOFT SPACES
RIGID / HARD SPACES

WITH FLEXIBILITY v. RIGIDITY,
ISSUES OF HARD v. SOFT SPACES
RIGIDITY OF PROGRAMS,
DEGREE OF SECURITY NECESSARY,
PERMEABILITY
ARE ALSO CONSIDERED

After assessing the criticality of program, flows, time, as well as the spatial implications of different flow controls, it is important to derive a design strategy to accomodate all these issues. Hence, the exploration of flexibility and rigidity in architectural form, brings this project back to its thesis, "form follows flows." Due to the fact that the user flows and the programs servicing these flows change by time, naturally, the architectural spaces encompassing these flows and programs need to be able to accomodate these changes.

PROGRAM

RESIDENTIAL PROGRAMS

RESIDENTIAL UNITS
X 240 UNITS

PUBLIC WC
X 1 OR 2 PER FL

LAUNDRY ROOM

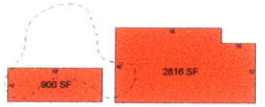
SECURITY

FOOD SERVICES

COMMON SPACE
X 1 OR 2 PER FL

LOBBY

BIKE STORAGE



MULTIPURPOSE ROOM

INSTITUTIONAL / ACADEMIC PROGRAMS

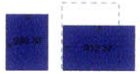
LARGE LECTURE HALL

PUBLIC WC
X 1 OR 2 PER FL

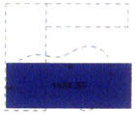
OFFICE UNITS

LAB SPACE

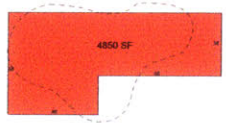
FOOD SERVICES



CONFERENCE ROOM

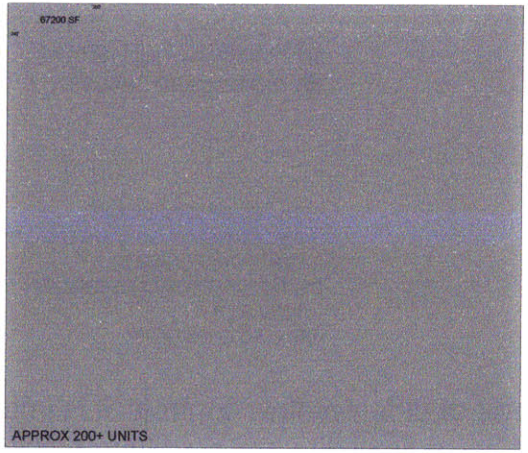


STUDY LIBRARY



COOP

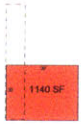
TRANSIT PROGRAMS



PARKING

STATION

DAY CARE



RETAIL

RIGID PROGRAMS
HARD SPACES

FLEXIBLE PROGRAMS
SOFT SPACES

The diagram on the left taxonomizes the spatial requirements of the programs essential to this building.

The disparate programs of residential, institutional, and transit are stacked on this site in addition to the retail and auxiliary social programs that service the first three.

Furthermore, the programs are grouped into hard (rigid) and soft (flexible) spaces depending on the nature of activities conducted in these spaces as well its mechanical and structural requirements.

KINETIC DESIGN SYSTEMS

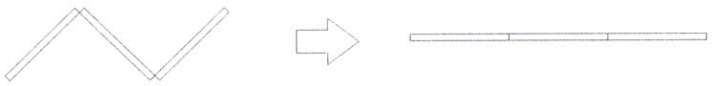
5. ANALYSIS - THE MECHANISM

KINETIC DESIGN SYSTEMS

The following is a menu of kinetic systems or structural mechanisms which will be used in this thesis for the exploration of flexibility in architectural form. The first four elements, indicated as Hard Kinetic Systems, will be used for spatial reconfiguration at the architectural level. The remaining elements, indicated as Soft Kinetic Systems, are implied for spatial refurnishing of such reconfigured spaces. Since the nature of the use of the latter systems imply an interior design level of detail, these systems are not explored in this thesis.

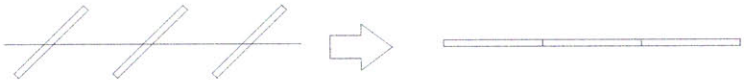
HARD KINETIC SYSTEMS
FOR SPACE RECONFIGURATION

FOLD



SLIDE

PIVOT

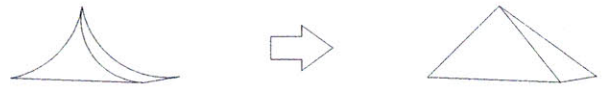


ROLL

Image Credits: [BEHF Architeckten], [Shigeru Ban Architects], [Steven Holl Architects]

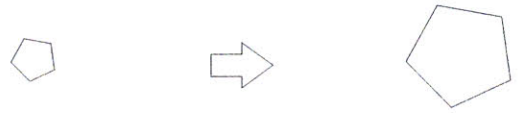
SOFT KINETIC SYSTEMS
FOR SPACE REFURNISHING

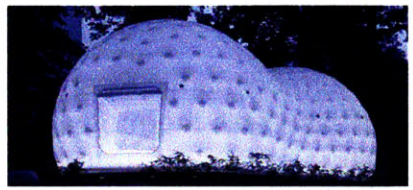
TENSILE



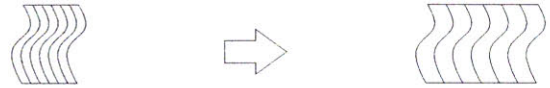
ASSEMBLY

INFLATE

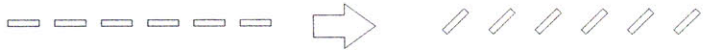




CURTAIN



LOUVRE



GEODESIC

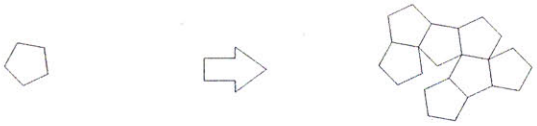
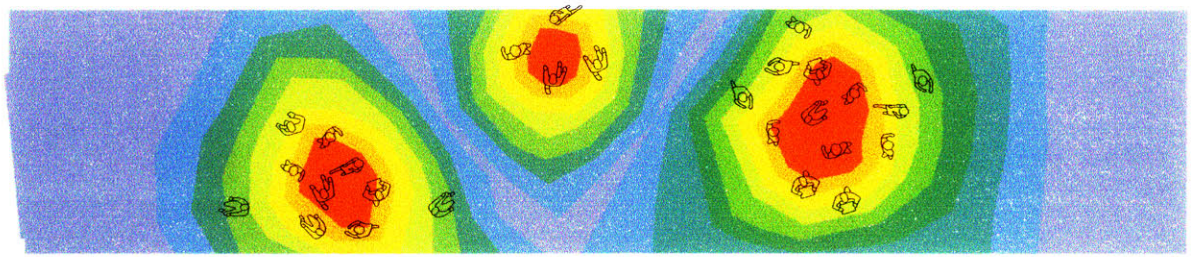


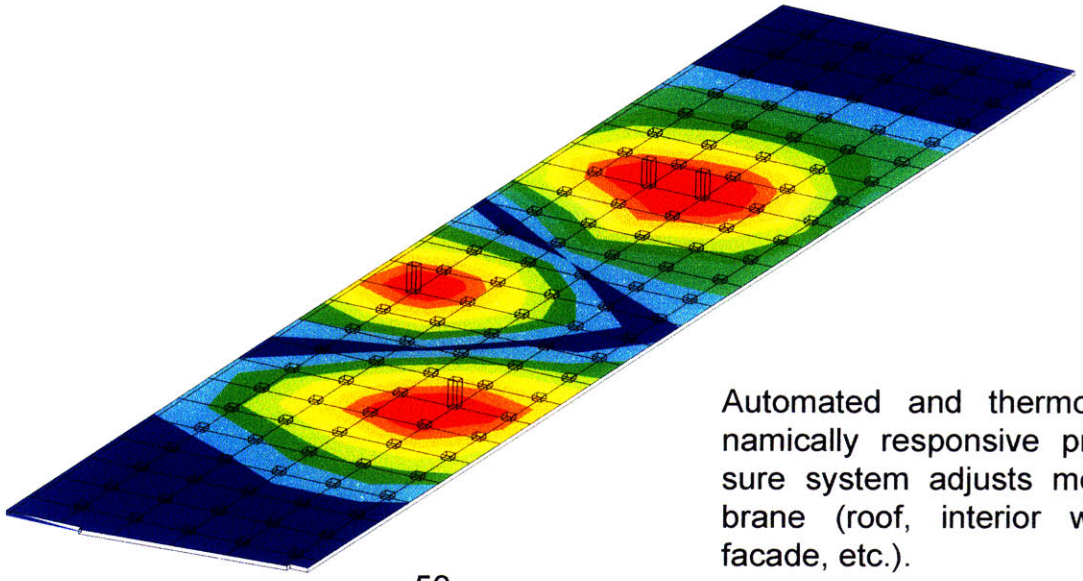
Image Credits: [Frei Otto], [Shigeru Ban Architects], Kuma Kengo & Associates]

OTHER KINETIC MECHANISMS

AUTOMATED RESPONSIVE SURFACES

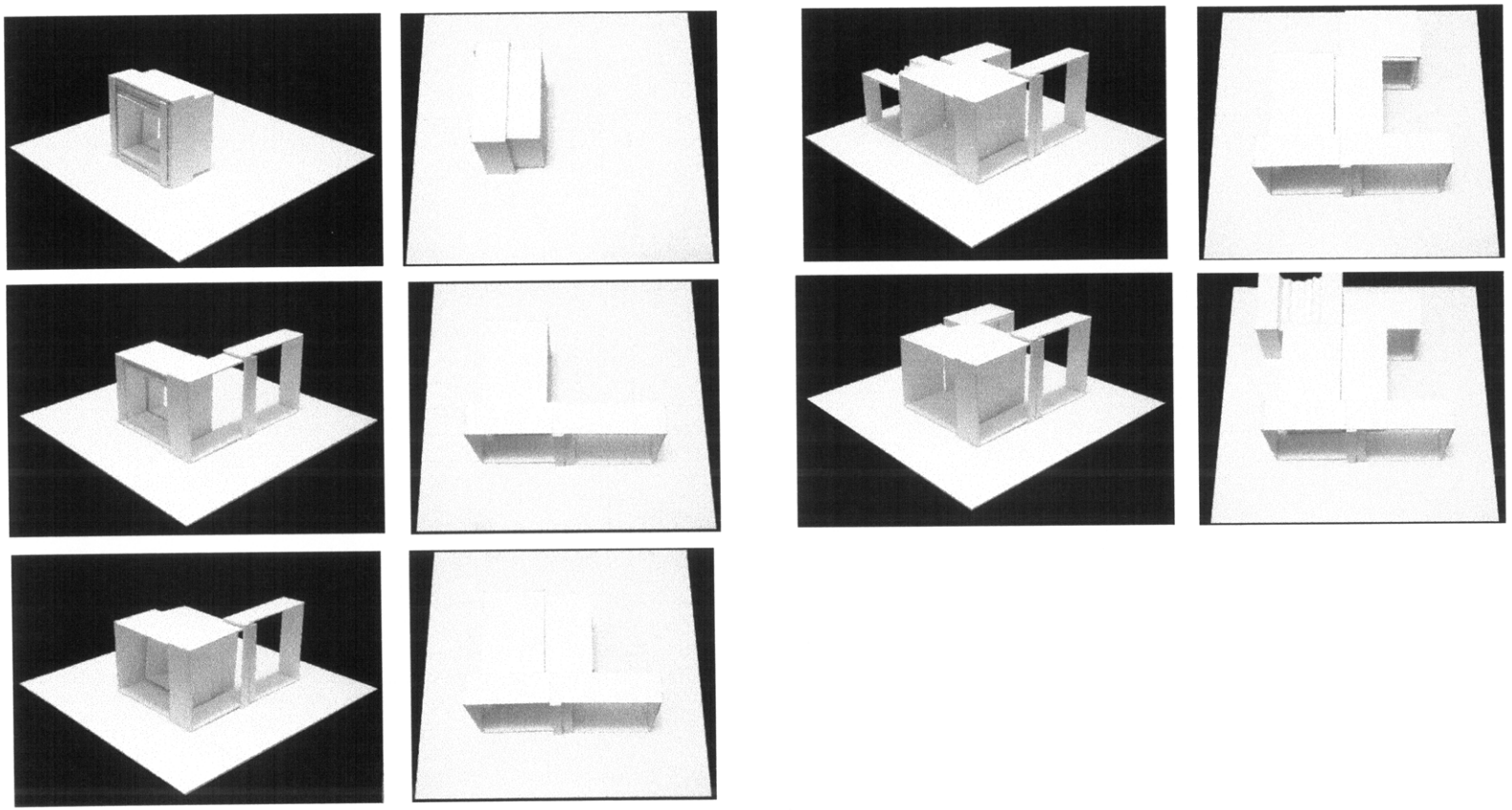


Thermodynamic Response to Flows and Motions of People
Measurable thermodynamic gradient based on body temperature of masses (groups) of people inhabiting the programmable space



Automated and thermodynamically responsive pressure system adjusts membrane (roof, interior wall, facade, etc.).

FLEXIBLE AND PRE-FABRICATION MECHANISM



While the following mechanisms of thermodynamically automated responsive surfaces and pre-fabrication are explored as a strategy for flexible architecture, these mechanisms are not implemented in the final design and thesis.

ARCHITECTURAL DESIGN

6. PRODUCT - THE SYNTHESIS

CONCEPT DIAGRAMS

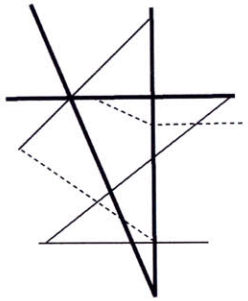
The underlying design elements which serve as the backbone of the building on the site are the three main arteries, or promenades which act as a three dimensional main street. The three arteries are based on user desire lines , connecting institutional buildings from one another, as well as to the transit facilities. The three arteries, located on three separate floors create a three story "ground floor" which is open to the public. The three arteries intersect each other at three distinct nodes, at which vertical circulation occurs.

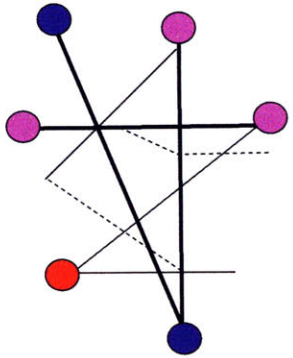
FLOWS

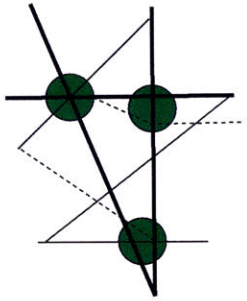
CONNECTIONS

NODES

CONCEPT





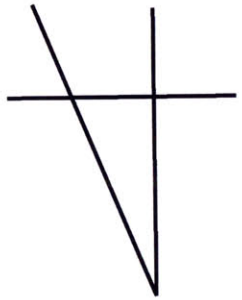


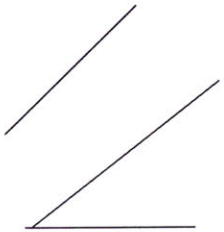
PRIMARY

SECONDARY

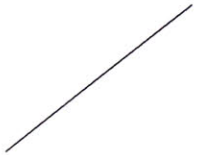
TERCIARY

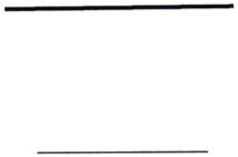
HEIRARCHY

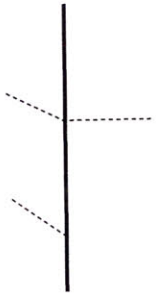




FLOORS







B1

1F

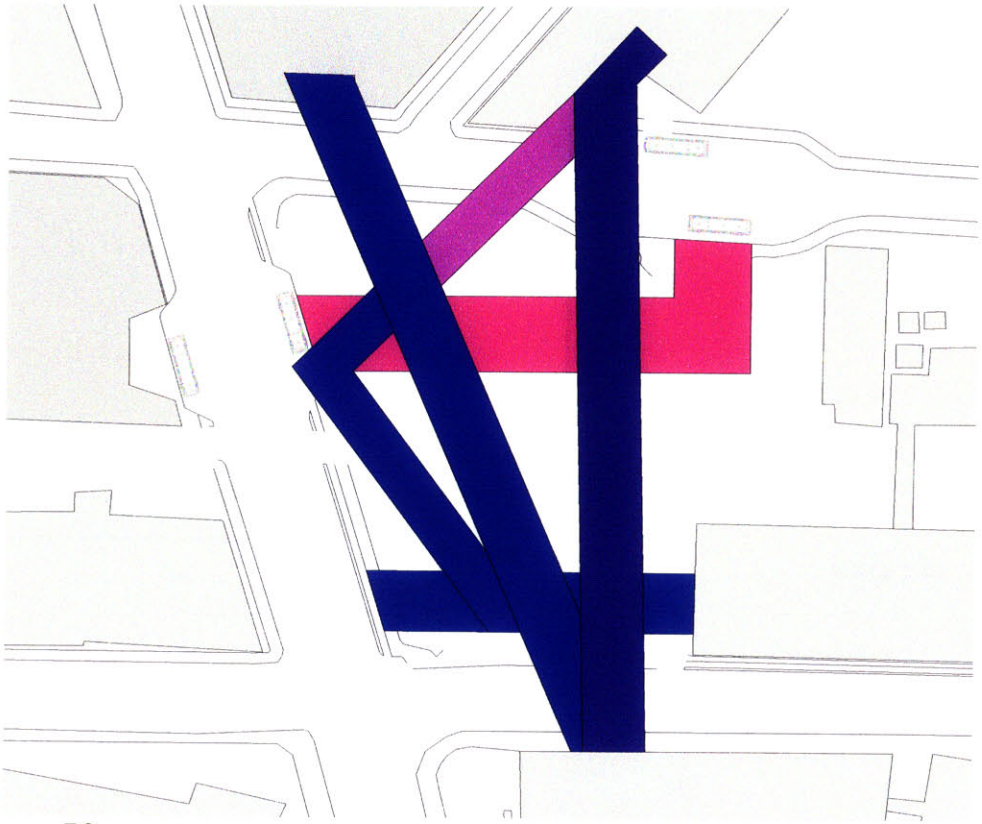
2F

3F

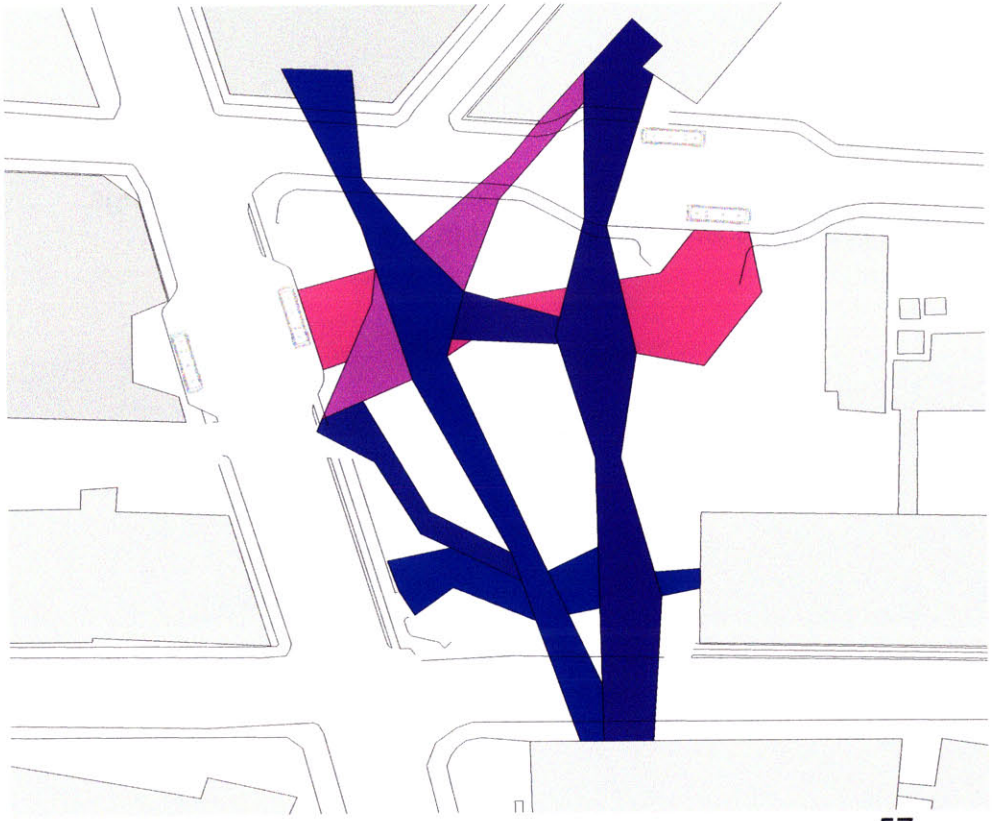
FLOW DIAGRAM I

COLOR KEY

- TRANSIT
- INSTITUTIONAL
- RETAIL
- COMMUNITY / SOCIAL



FLOW DIAGRAM II

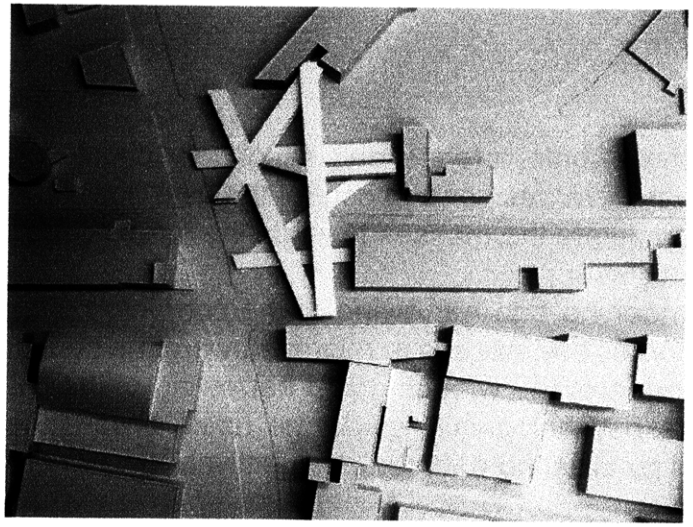


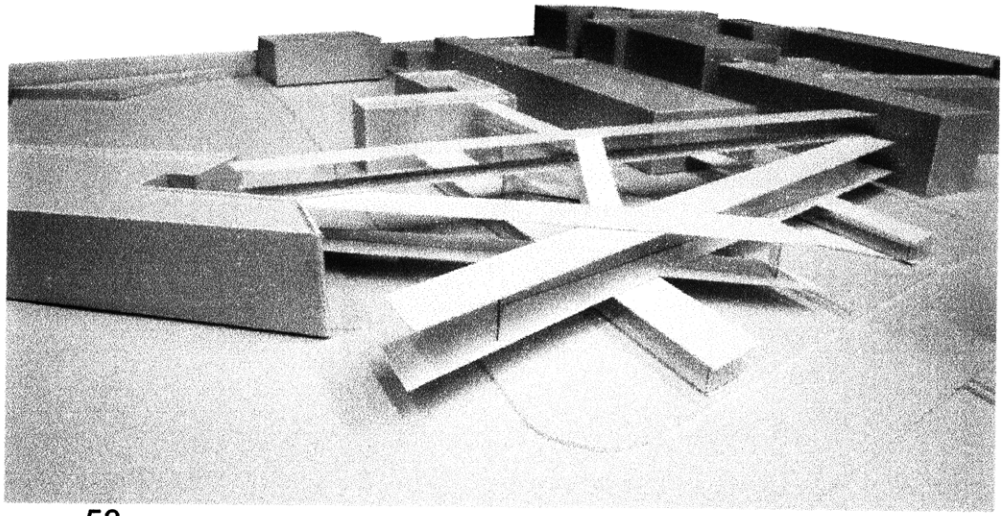
The three main arteries and secondary circulation pathways are designed to control the user flows and to accumulate the masses towards the three nodes.

The widening and narrowing of the corridors physically forces the masses to migrate toward the nodes. Furthermore, the widening and narrowing of the coridors psychologically guide the users toward the nodes by creating a forced perspectival.

FLOW DIAGRAM 3D MODEL

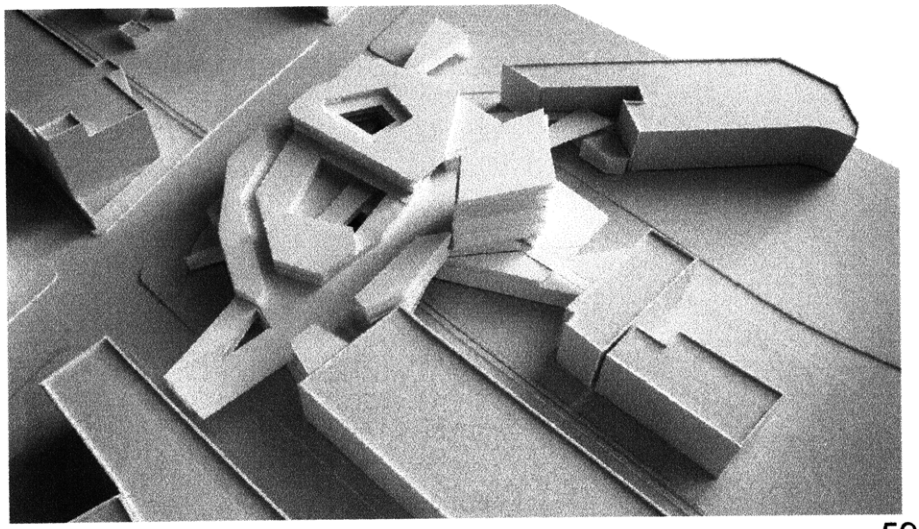
The models below show the three dimensional circulation systems and how the arteries connect to existing buildings. Here, the circulation is shown as a mass, and the surrounding programs are void (not built in the model).

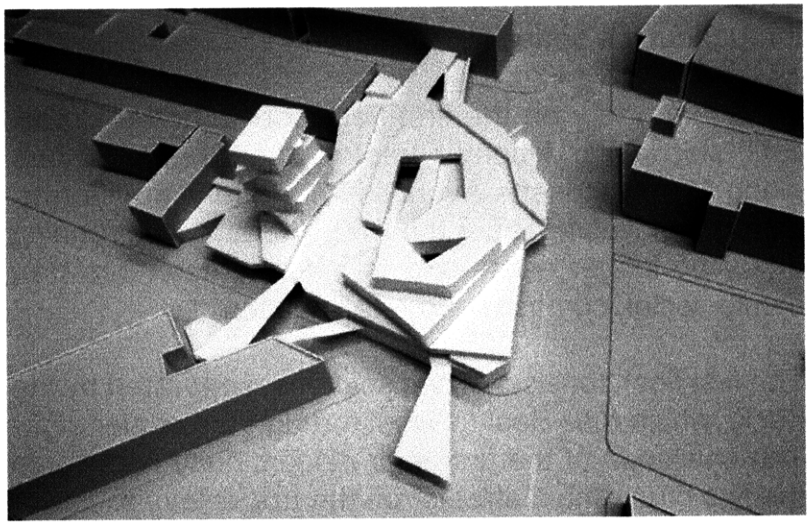




PROCESS MODELS

The sketch process models below is an inverted interpretation of the 3D flow diagram model shown on the previous page. Here the program and spaces are indicated as mass while the circulation is indicated by void.





FIRST FLOOR KINETIC SYSTEM

The Hard Kinetic Systems are implemented on the first floor in order to reconfigure spaces adequate for the flexible programs.

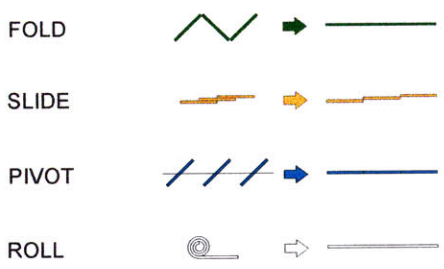
The mechanisms of folding (indicated in green), sliding (indicated in orange), and pivot (indicated in cyan) are applied to partition spaces for distinct programs, which change over the course of the day.

The day and night time plans in the following pages show how the spaces are reconfigured by these Hard Kinetic Systems. Furthermore, the plans show how the masses flow throughout the spaces.

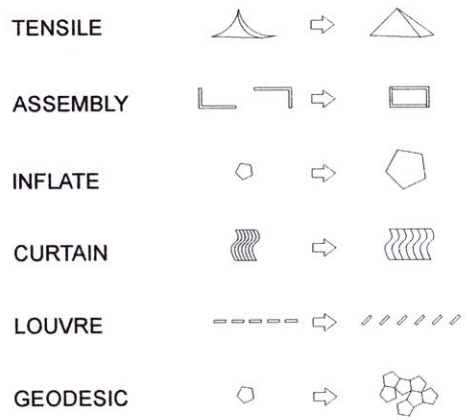
The main artery on the first floor connects the Urban Ring BRT stop along Albany Street to the Number 1 bus stop along Massachusetts Avenue. This artery transforms itself during the evening, after the BRT and bus stop running. The artery no longer exists and transforms itself into programmable social, common and retail spaces.

The first floor consists of two sections, separated by the CSX tracks which runs East to West through the center of the site. The challenge of the first floor discontinuity is overcome by the two other "main streets" on the upper levels.

HARD SYSTEMS [RECONFIGURE]



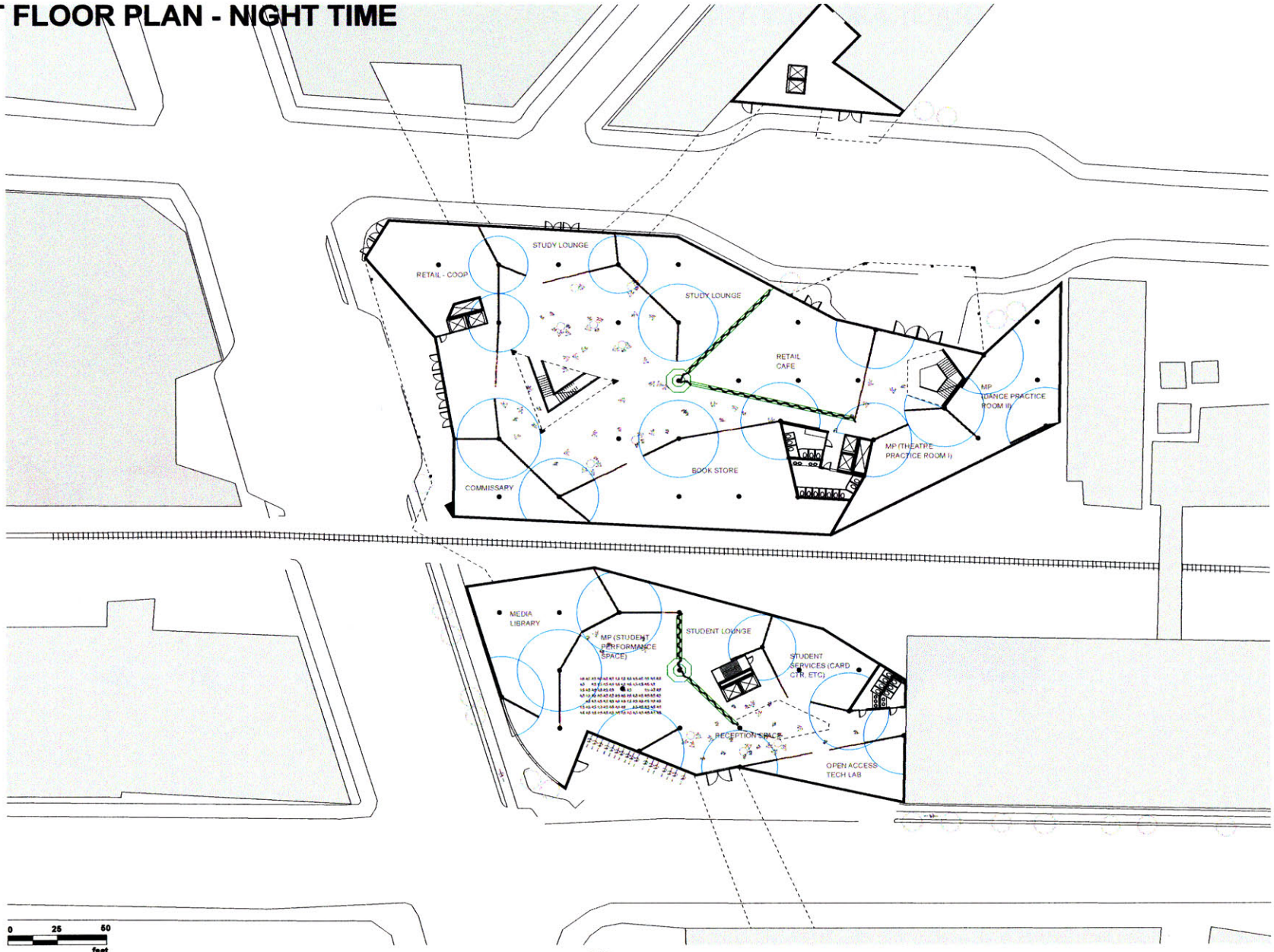
SOFT SYSTEMS [REFURNISH]




MASSACHUSETTS
AVENUE
ALBANY STREET
STUDY LOUNGE
RETAIL/ CUCP
STUDY LOUNGE
RETAIL
CAFE
COMMISSARY
BOOK STORE
MEDIA
LIBRARY
STUDENT LOUNGE
RECEPTION SPACE
OPEN ACCESS
TECH LAB
VASSAR STREET
0
25
50
feet

FIRST FLOOR PLAN - DAY TIME

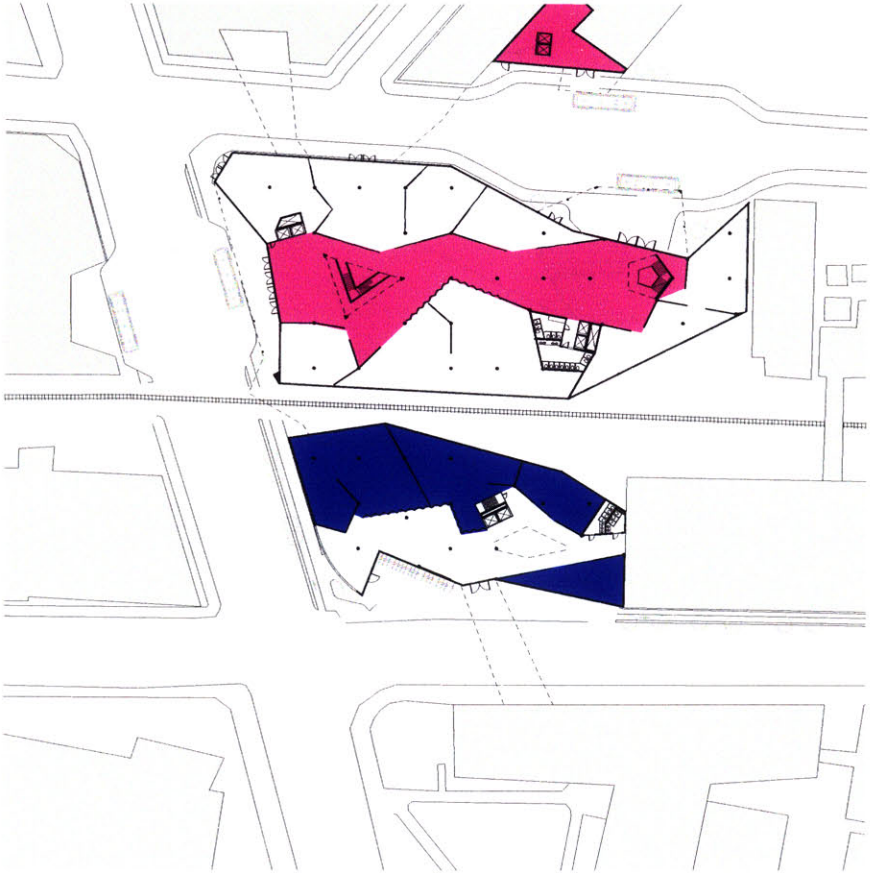
FIRST FLOOR PLAN - NIGHT TIME

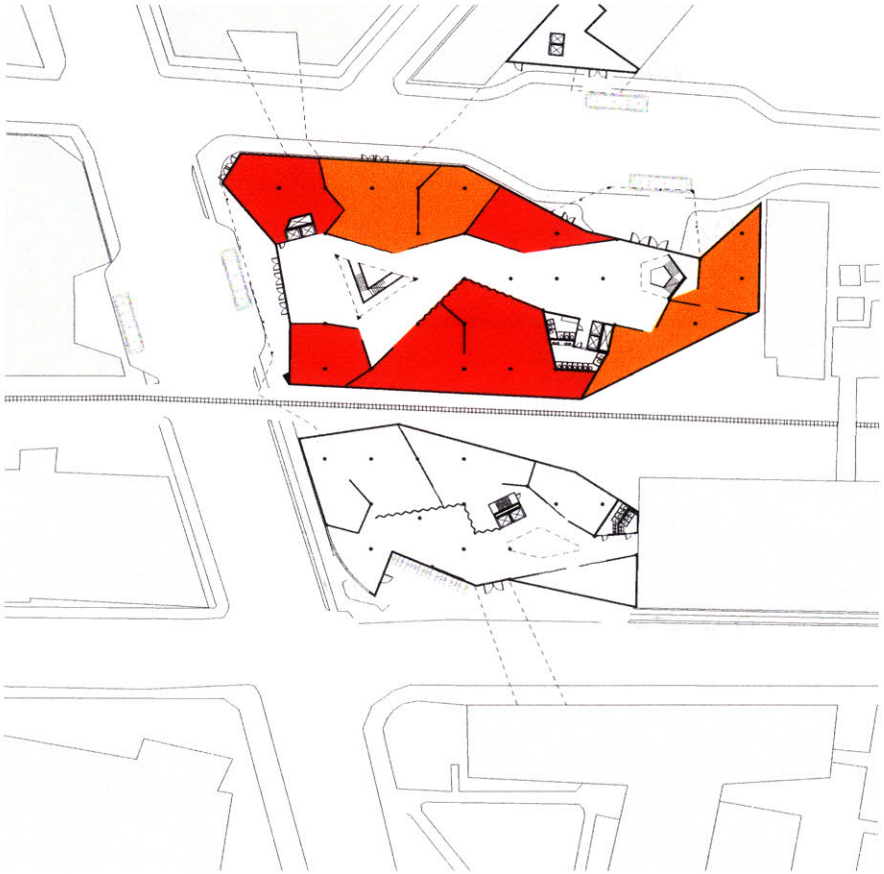


FIRST FLOOR PLAN DIAGRAM - DAY TIME

COLOR KEY

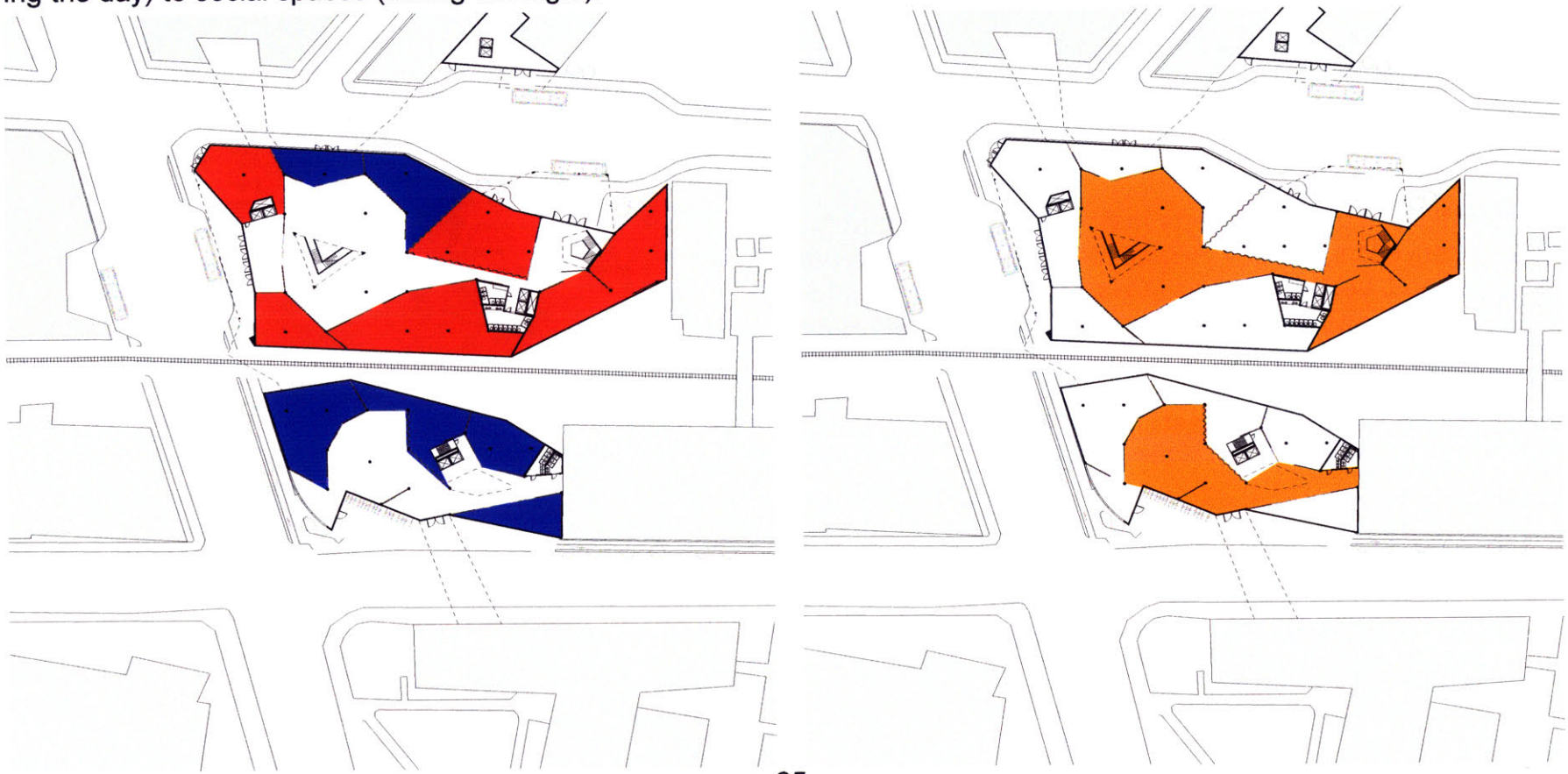
- TRANSIT
- INSTITUTIONAL
- RETAIL
- COMMUNITY / SOCIAL





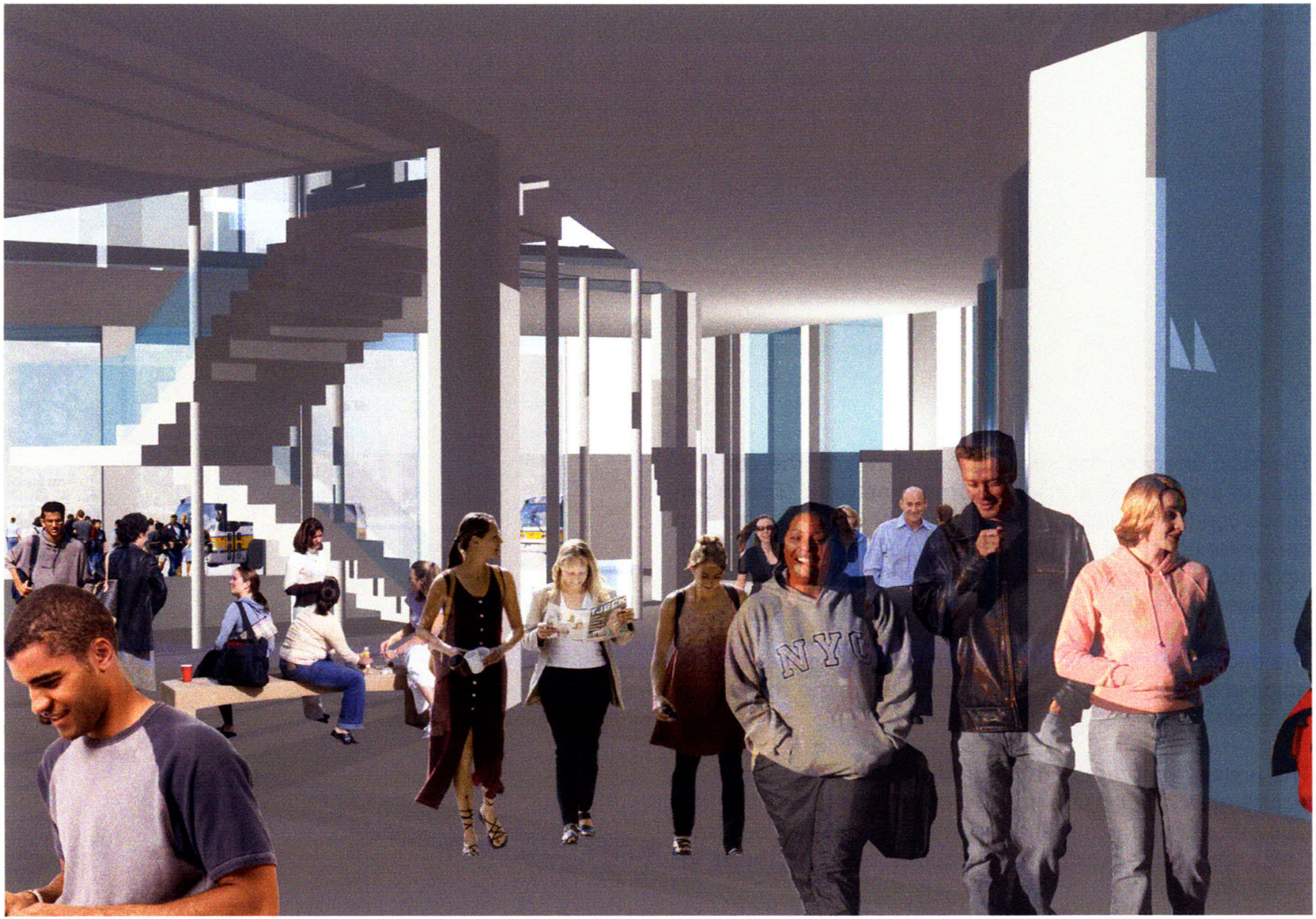
FIRST FLOOR PLAN DIAGRAM - NIGHT TIME

The major programmatic difference between the day and night time on the first floor is the main artery which transforms from a transit circulation passage (during the day) to social spaces (during the night).



RENDERING - FIRST FLOOR PROMENADE

The first floor "main street" acts mainly as a promenade for transit users during the day. People may be transferring from the Number 1 bus stop along Massachusetts Avenue (depicted in the background of the rendering) to the Urban Ring BRT stop along Albany Street. In other cases, they may be faculty or students commuting to the Institute or simply using the transit system to get to East Cambridge.

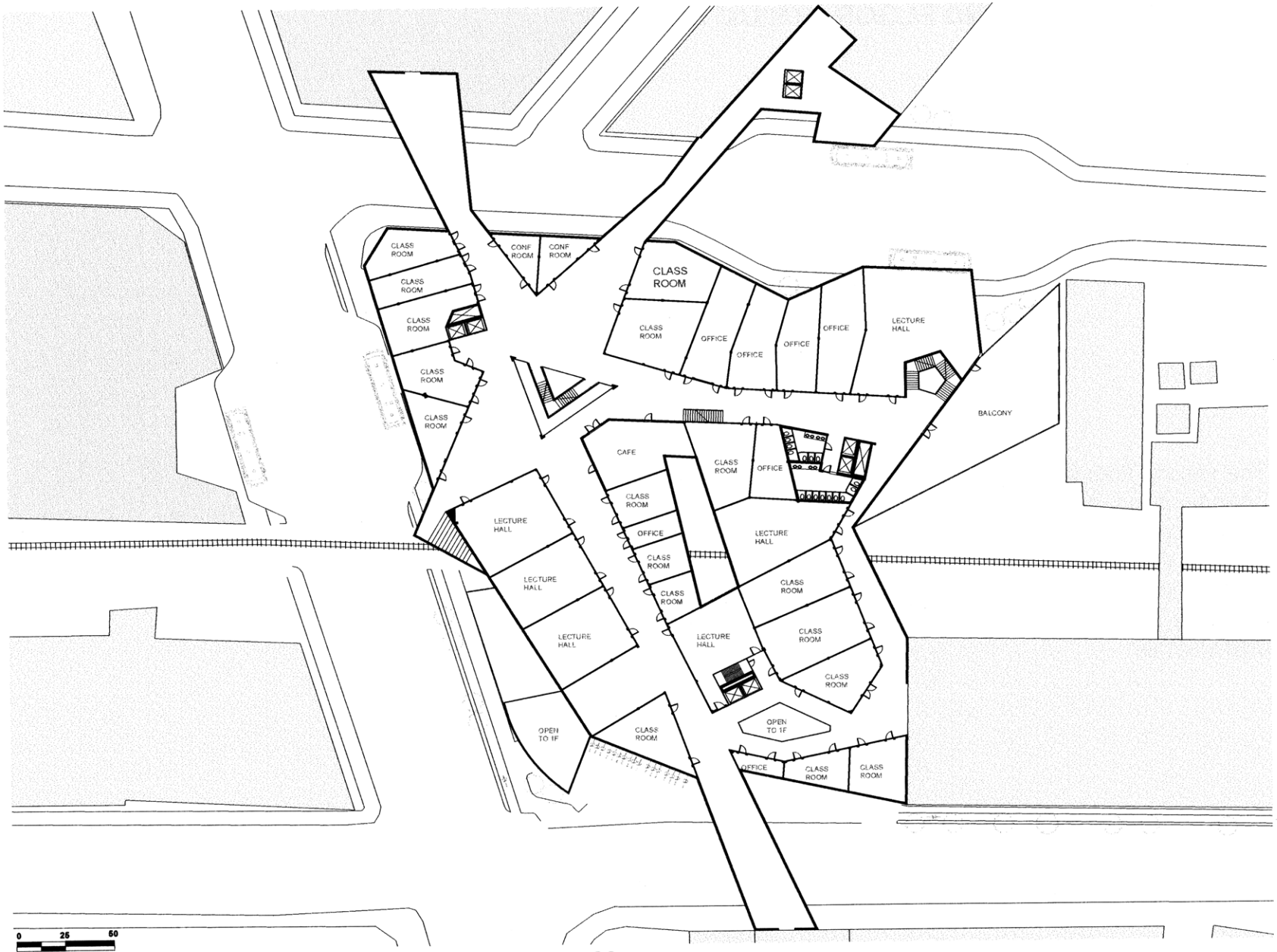

NYC

SECOND FLOOR PLAN

The main artery on the second floor allows for the continuation of the Institute's Infinite Corridor network. The promenade connects Building 35 along Vassar Street (located on the center bottom of the plan) to the future institutional building to be situated on the corner of Albany Street and Massachusetts Avenue.

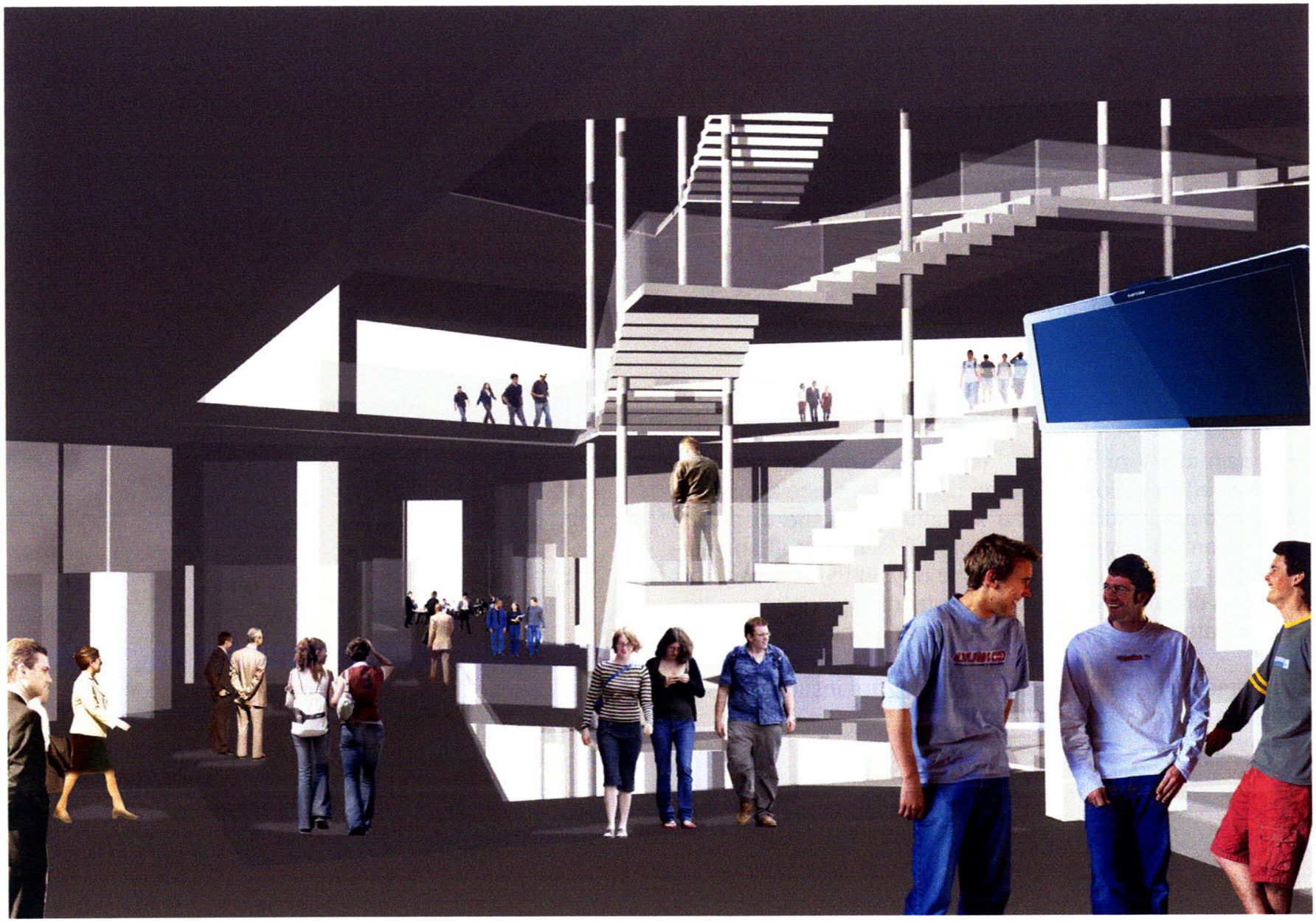
The secondary circulations all merge at the northern node, which is a large atrium space opening up to the roof above the seventh floor.

The primary programs on the second floor are institutional lecture halls and classrooms, which can be converted into study rooms and conference rooms according to demand. Cafes are located proximal to the nodes, servicing these "internal plazas."


CLASS ROOM
CONF ROOM
CONF ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
CLASS ROOM
OFFICE
OFFICE
OFFICE
OFFICE
LECTURE HALL
BALCONY
CAFE
CLASS ROOM
OFFICE
CLASS ROOM
OFFICE
LECTURE HALL
CLASS ROOM
CLASS ROOM
LECTURE HALL
LECTURE HALL
LECTURE HALL
CLASS ROOM
CLASS ROOM
CLASS ROOM
OPEN TO 1F
OPEN TO 1F
OFFICE
CLASS ROOM
CLASS ROOM
0
25
50
feet

RENDERING - SECOND FLOOR ATRIUM SPACE

The second floor atrium space services a mix of transit and institutional users. During the winter, the interior "main street" on the second floor, which connects the first floor transit stops to the greater MIT Infinite Corridor network, becomes an ideal way to get to destinations throughout the campus and East Cambridge without exposing oneself to the outside cold weather.



THIRD FLOOR PLAN

The main artery on the third floor is the outdoor walkway running vertically North to South of the site. Once again, the above ground circulation is a continuation of the Institute's Infinite Corridor network. Flows of MIT faculty, staff and students can be anticipated during the day. In the evening, this serves as one of the main approach leading to the residential tower located on the North-West corner of the site.

The primary programs on the third floor are institutional lecture halls, classrooms and offices.

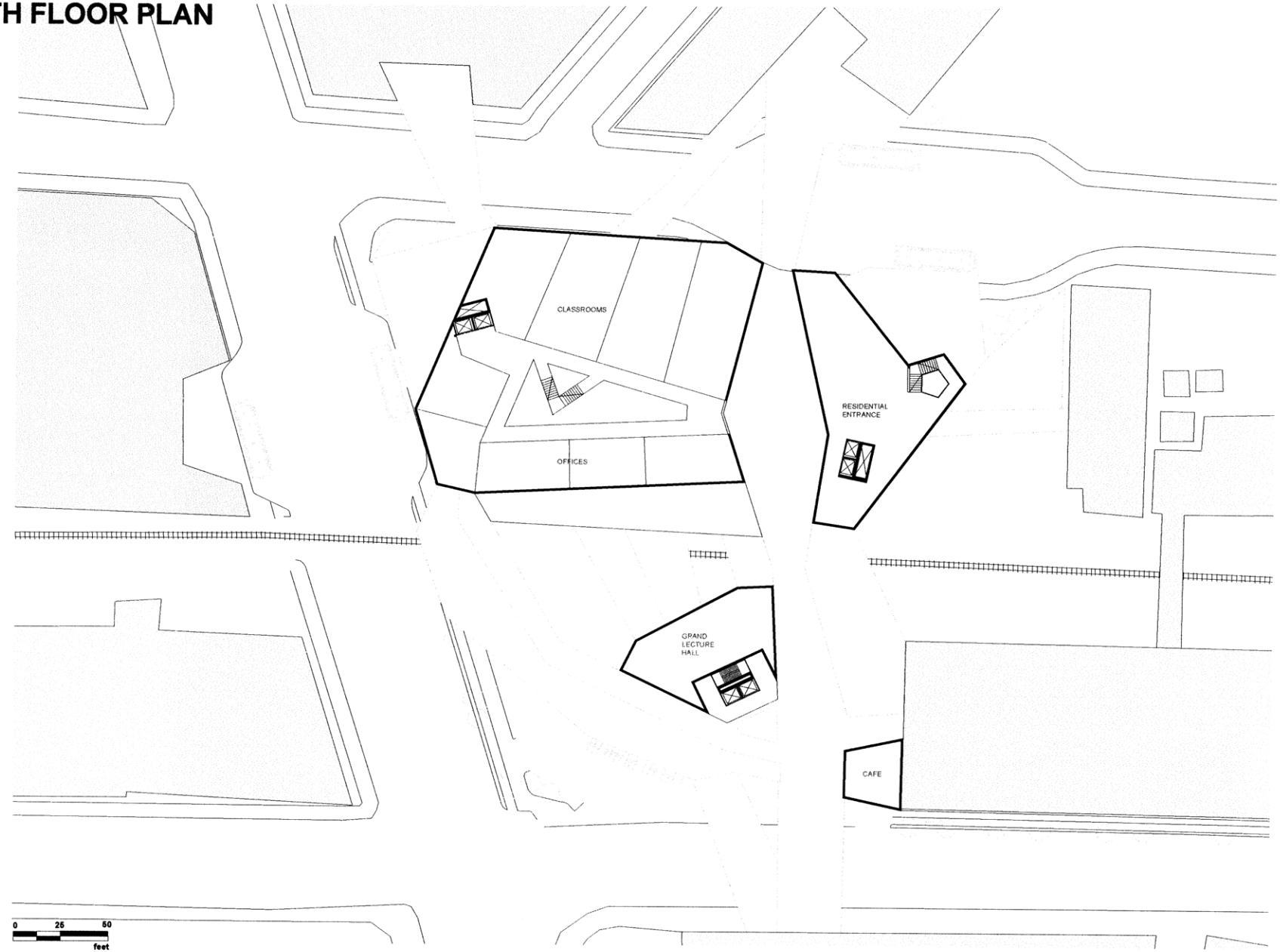

BALCONY
LIBRARY
LECTURE HALL
LECTURE HALL
BALCONY
OPEN TO 2F
GRAND LECTURE HALL
OPEN TO 1F
OPEN TO 1F
CAFE
EXTERIOR COORIDOR
0
25
50
feet

RENDERING - THIRD FLOOR OUTDOOR WALKWAY

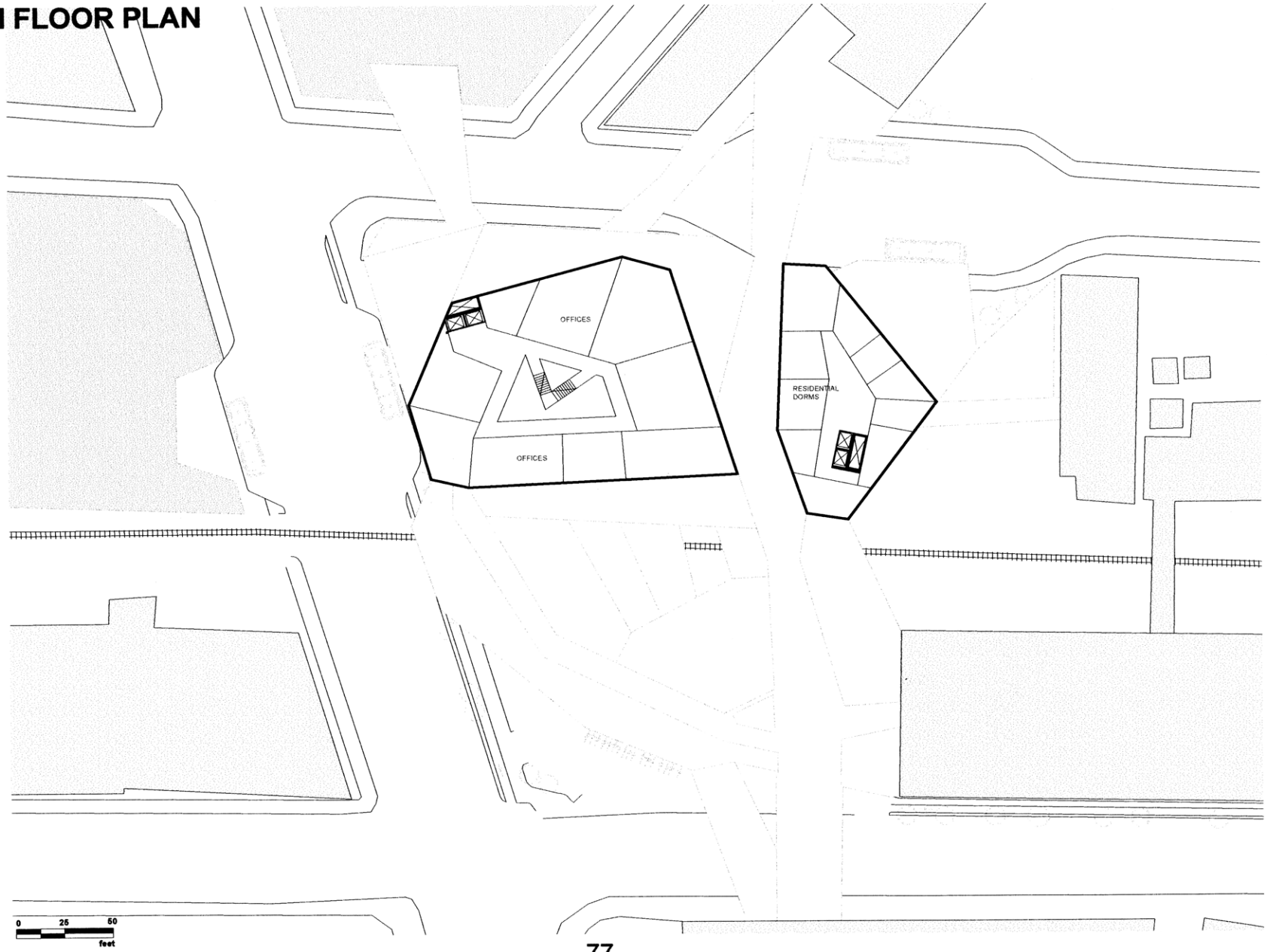
This rendering is a view of what one will see walking out of Building 35 onto the third floor outdoor walkway. On the right side, there is a four story (in counting from the third floor walkway) cafe, with the 14 story residential tower in the background.

The walkway will be filled with MIT faculty, staff and students during the day, similar to the Infinite Corridor along Building 10.

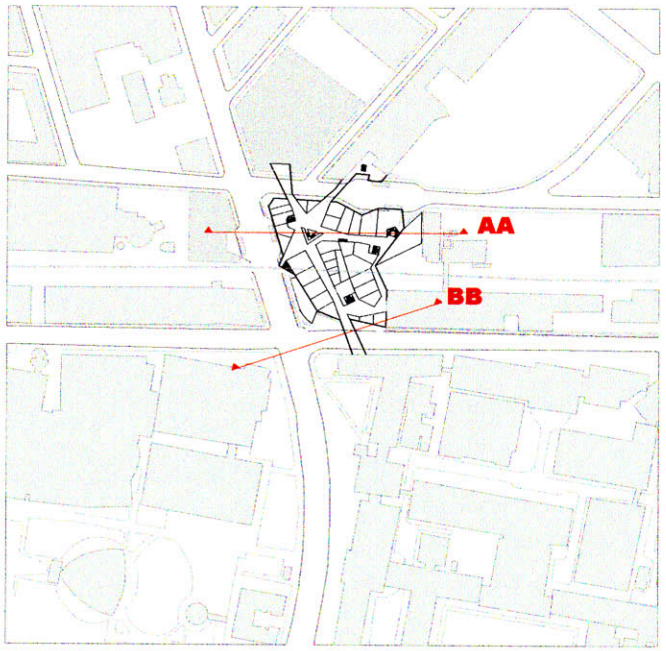
4-5TH FLOOR PLAN

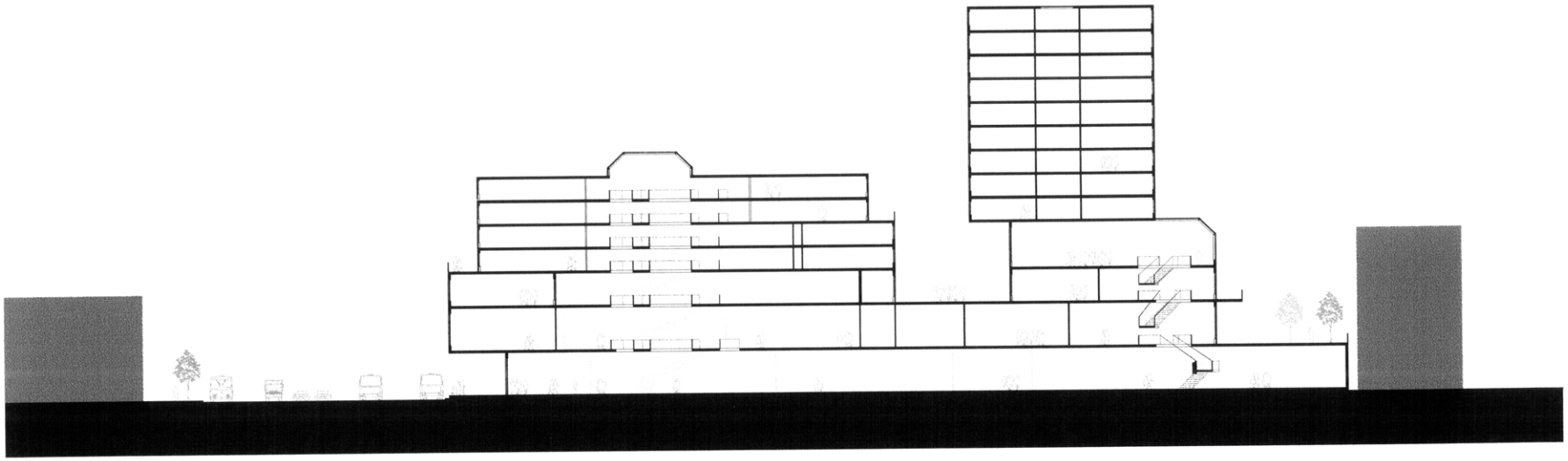


6-7TH FLOOR PLAN

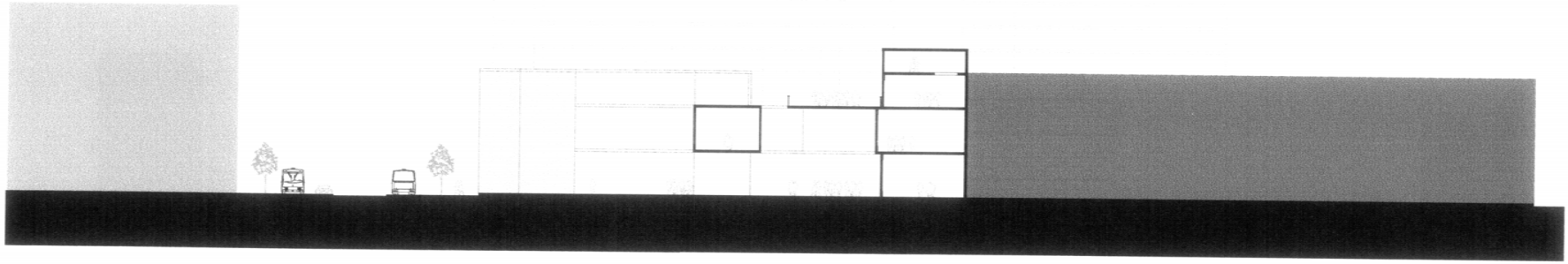


SECTIONS





SECTION A [64' : 1" SCALE]

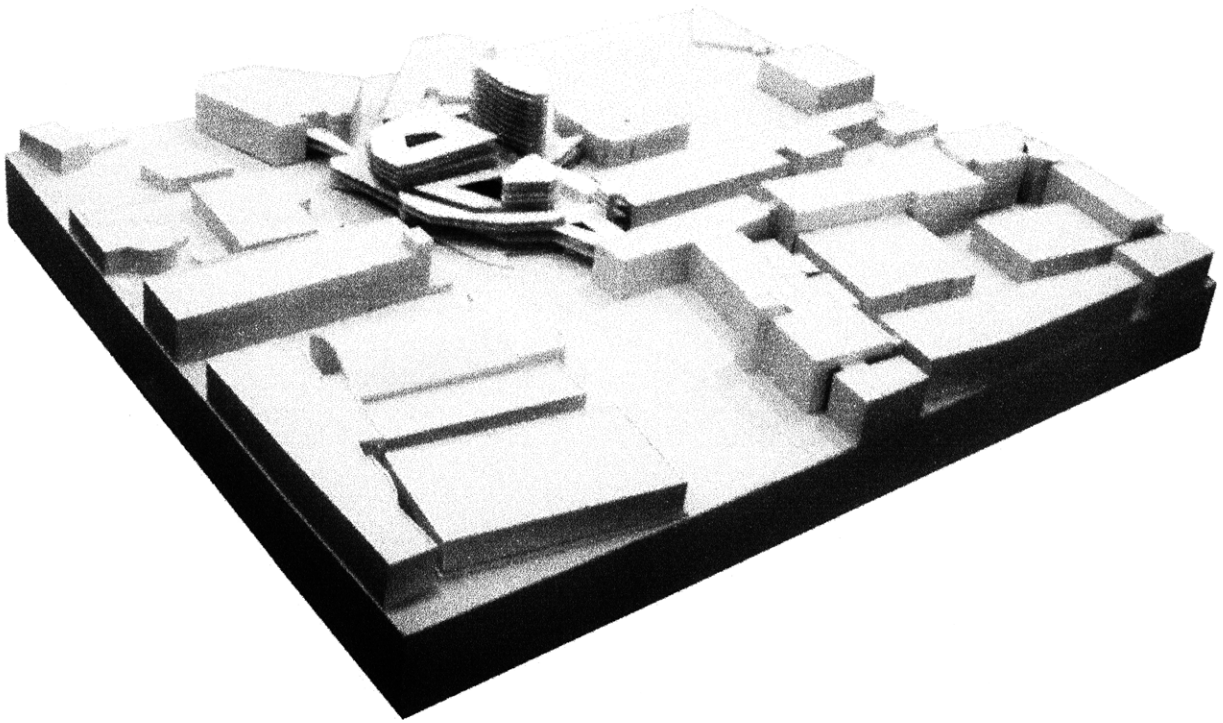


SECTION B [64' : 1" SCALE]

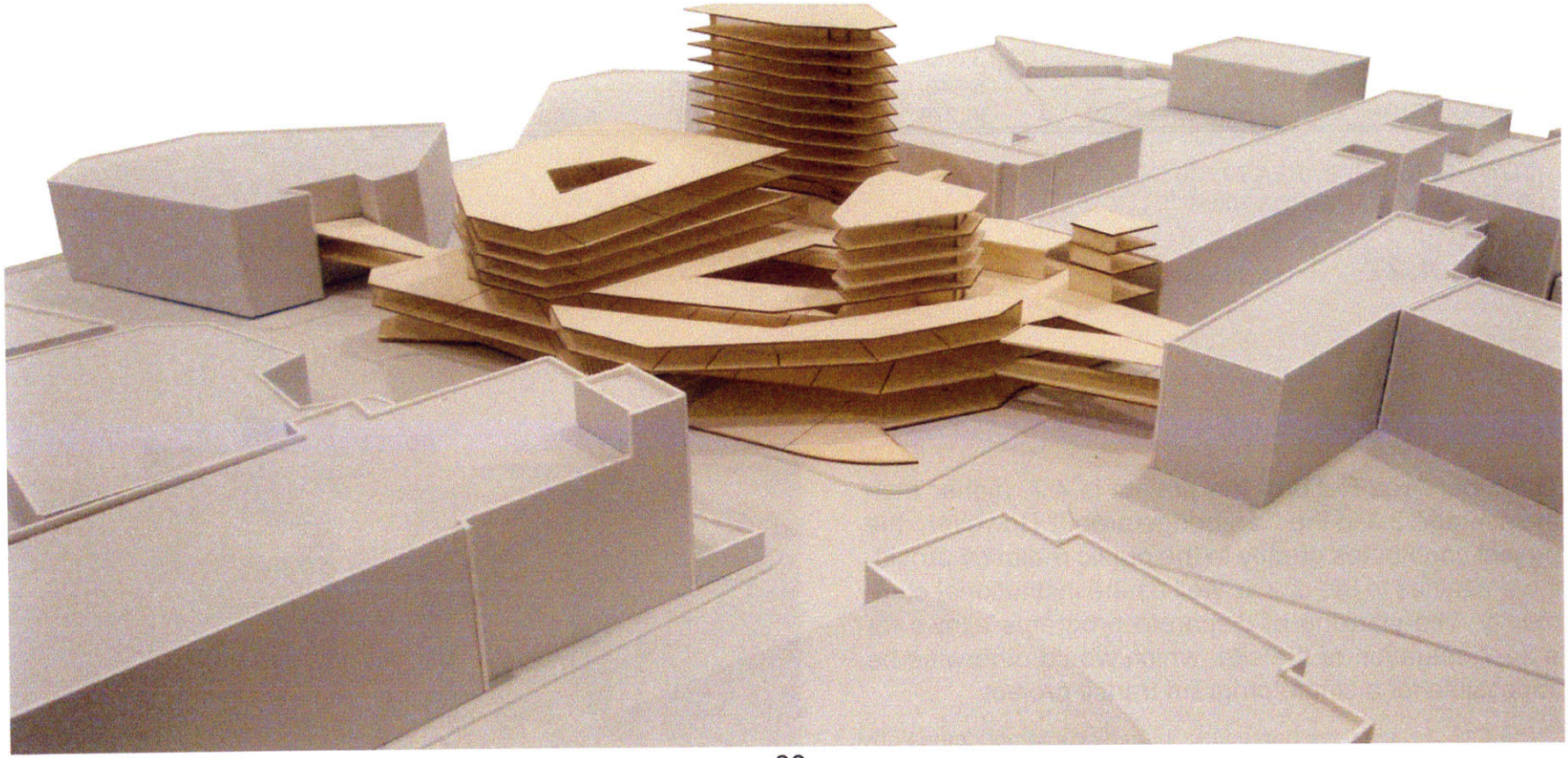
URBAN IMPLICATIONS

7. PRODUCT - BACK TO URBAN SCALE

THE BUILDING ON SITE



The site model explores the project's urban scale impact on the site. The distinct architectural form separates the project from the rest of the existing built environment. Yet the staggering of the tower components and the connective passages to the institutional buildings allow the building to be part of the urban fabric.



FAR SPECIFICATIONS

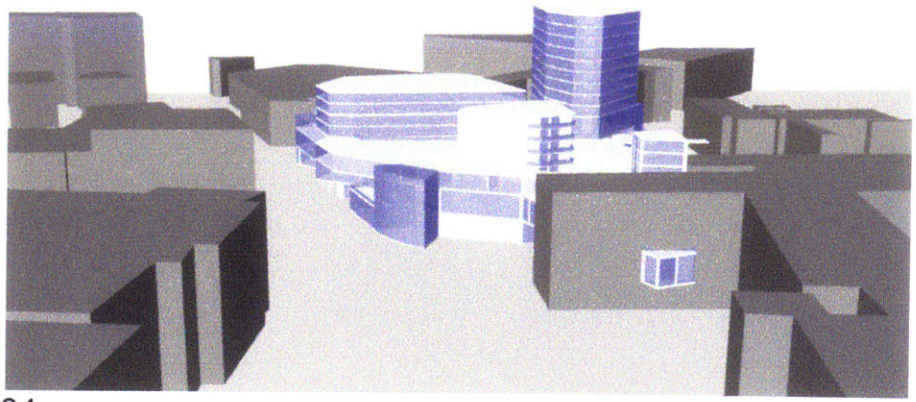
	FLOOR					
	1	2	3	4	5	6+
TOTAL AREA	58,520	78,360	76,970	32,920	32,920	59,040
RESIDENTIAL	-	-	-	6,560	-	48,600
INSTITUTIONAL	1,550	34,520	32,420	16,870	16,870	-
MBTA	6,290	-	-	-	-	-
COMMUNITY	24,090	-	-	-	-	-
RETAIL	9,000	1,440	810	810	810	-
SERVICE CORE	3,230	2,790	2,260	1,820	1,530	2,610
OPEN AIR	-	3,800	10,290	1,580	7,850	-
BALCONY	-	5,540	3,200	2,950	-	-
CIRCULATION	14,360	30,270	27,990	2,330	5,860	7,830

TOTAL BUILDABLE AREA 79,300 SF
TOTAL FLOOR AREA 338,700SF

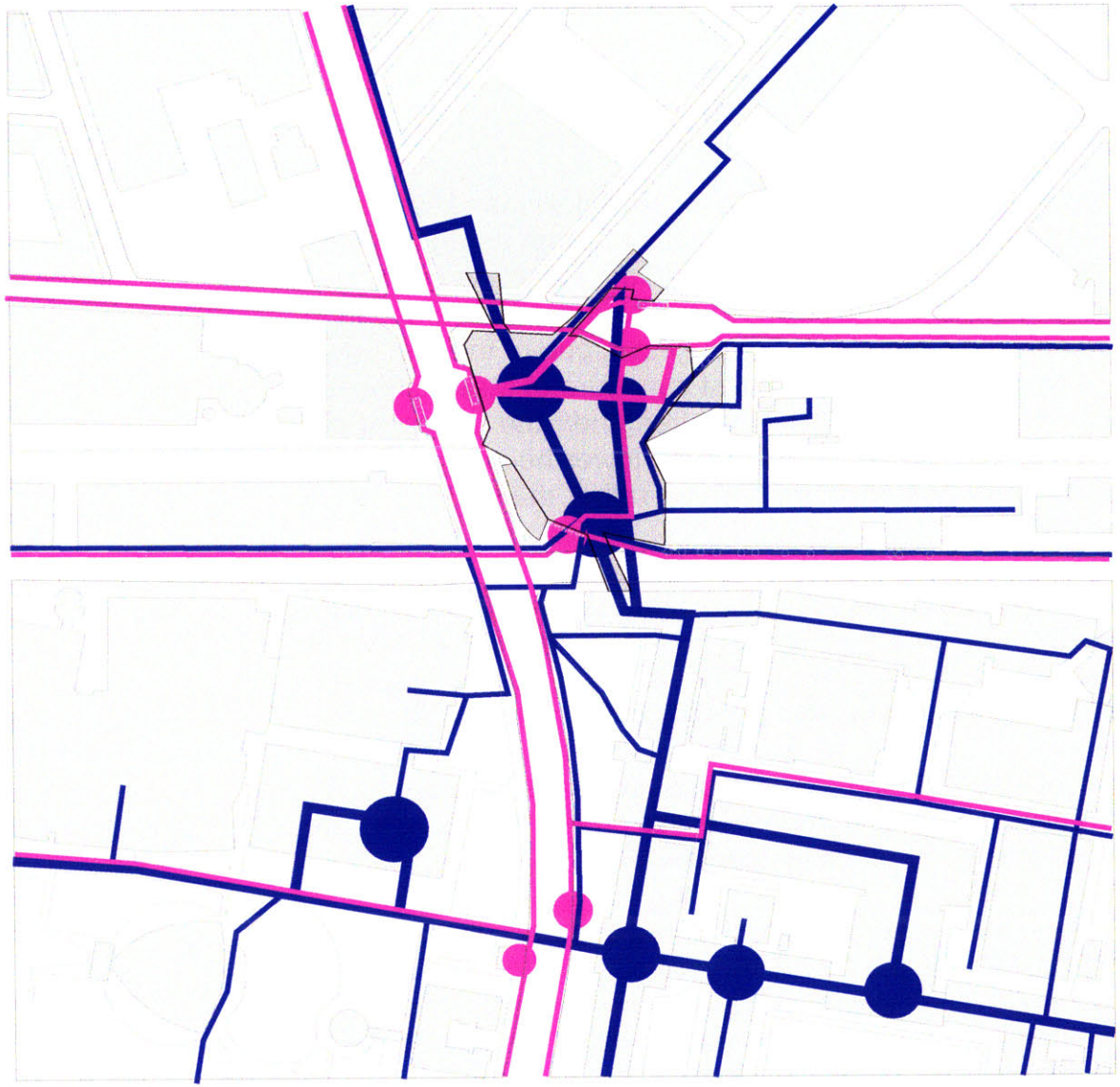
FAR: 4.27

The Floor Area Ratio of the project is 4.7, higher than the average 3.3 in the Cambridge area.[19] However, the project contributes greatly to the public realm by providing amenities to the city as well as the institutional community. The stacking of disparate programs allows for a 24-7 operation of the site, which would otherwise be impossible for a single program transit project.

[19] The City of Cambridge homepage: http://www.cambridgema.gov/



MIT AND URBAN CONNECTIVITY



Finally, bringing the project back to the greater urban and institutional scale, this diagram shows how the building becomes both a node as well as a connective tissue for the MIT campus, connecting the east and west campus, as well as becoming a catalyst for future campus expansion northward.

RENDERINGS - EXTERIOR VIEW FROM MASSACHUSETTS AVENUE

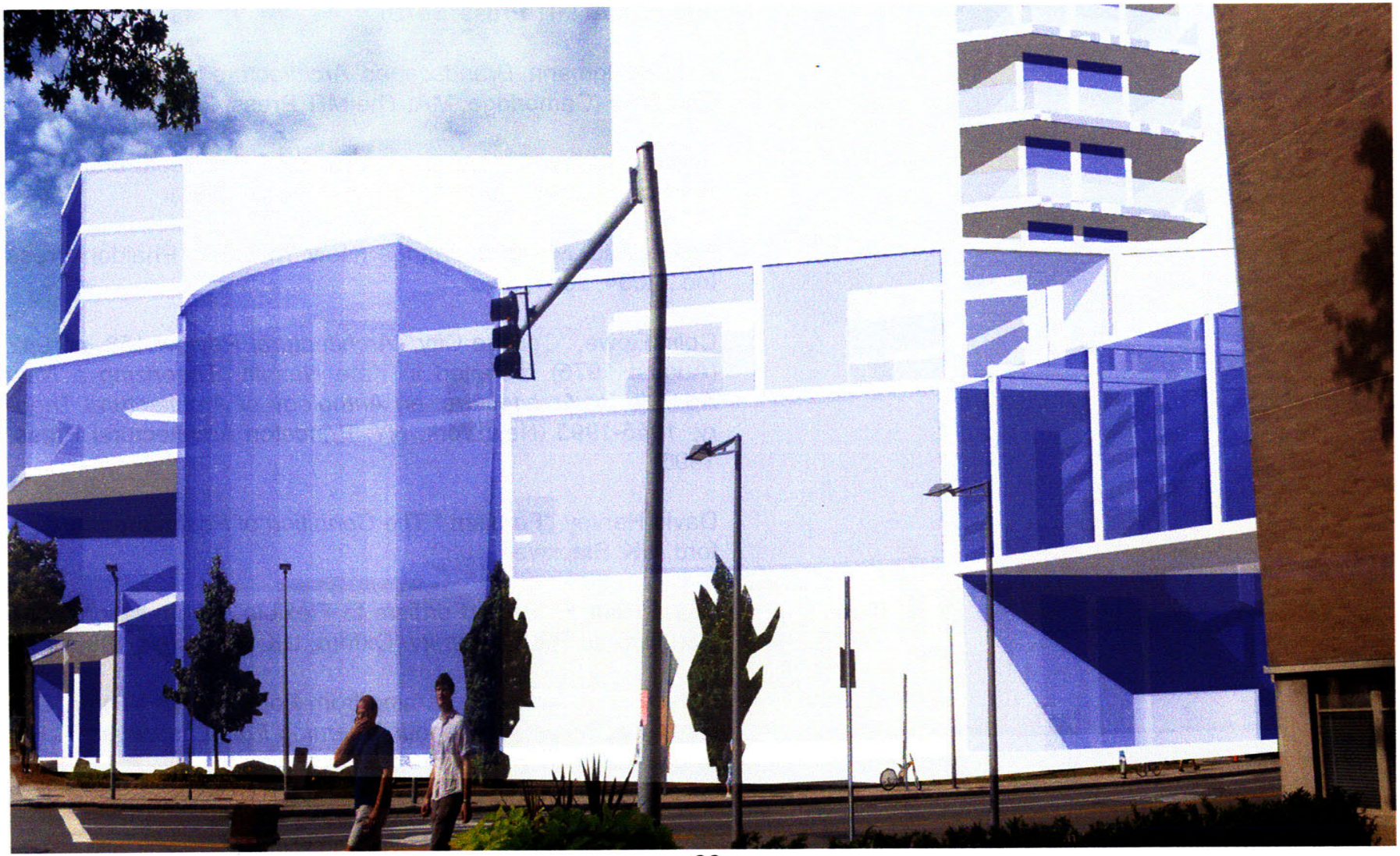
The renderings of the project's exterior view from Massachusetts Avenue suggests the project's strength as an icon and image for both MIT and the City of Cambridge. As one drives along Massachusetts Avenue, crossing the Harvard Bridge and entering Cambridge, the project is one of the first buildings to be seen. The north-east curvature of Massachusetts Avenue successfully works to strengthen the image of the building. Yet, the staggering of the tower heights allows for gradual recognition of the building rather than a surprise to the driver.

The project becomes the image of MIT and East Cambridge. Whether one enters by driving on Massachusetts Avenue or whether one approaches by the proposed Urban Ring BRT, the building becomes the gateway to the city and campus.

As Curitiba BRT and TransMilenio serve as the images for the cities of Curitiba and Bogota, this project will serve as the image of the City of Cambridge and MIT.

Through a completely different formal approach than Curitiba or TransMilenio, the thesis "Form Follows Flows - The Boston Urban Ring" explores the design implications of public transit in the 21st century by synthesizing the disciplines of Urban Planning, Urban Design and Architecture.


WAREHOUSE
METROPOLITAN
LONGFELLOW BR
TRUCK DETOUR



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