Lessons From The Underground
*The Pedagogic Possibility of Urban Infrastructure*

by Zachariah Kramer

B.A. Art History (1994)
Swarthmore College

Submitted to the Department of Architecture in Partial Fulfillment of the Requirements for the Degree of Master of Architecture at the Massachusetts Institute of Technology, February 2002

Signature of Author

Department of Architecture
January 18, 2002

Certified by

Anne Whiston Spirn
Professor of Landscape Architecture and Planning
Thesis Supervisor

Accepted by

Andrew Scott
Associate Professor of Architecture
Chairman, Department Committee on Graduate Students

© 2002 Zachariah Kramer. All Rights Reserved.

The author hereby grants to MIT permission to reproduce and to distribute publicly paper and electronic copies of this thesis document in whole or in part.
DISCLAIMER NOTICE

The accompanying media item for this thesis is available in the MIT Libraries or Institute Archives.

Thank you.
THESIS READERS

Takehiko Nagakura
Associate Professor of Design and Computation

J. Kimo S. Griggs, FAIA
Lecturer in Architecture
Graduate School of Design, Harvard University

Hubert Murray, FAIA
Visiting Associate Professor

ILLUSTRATION CREDITS

All photographs, diagrams, and renderings are by the author unless otherwise noted. See “Notes On Production” for more information about the digital production for this thesis.

Many figures were created by overlaying diagrams on maps and plans from various sources. Where appropriate, sources of the underlying imagery are noted in the caption.

The “Central/Artery Tunnel model” is a comprehensive model of the project at completion, located at the Massachusetts Turnpike Authority CA/T Headquarters, 185 Kneeland Street, Boston, MA. It was photographed by the author with permission.

This thesis is printed on Strathmore 25% cotton, acid-free, 28 lb. paper. Four image pages are printed on Epson Archival Matte Paper using an Epson 2000P photo printer with archival ink.
Lessons From The Underground
The Pedagogic Possibility of Urban Infrastructure

by Zachariah Kramer

Submitted to the Department of Architecture on January 18, 2002 in
Partial Fulfillment of the Requirements for the Degree of Master of Architecture

Thesis Advisor
Anne Whiston Spirn
Professor of Landscape Architecture and Planning

ABSTRACT

There is no end of superlatives regarding Boston's Central Artery/Tunnel project [CA/T], also known as "The Big Dig". Each day, as the budget grows and the construction progresses, another benchmark is passed. It has been ubiquitous in the city for over a decade, and yet, the goal of this project—that has literally torn through the earth of downtown, South Boston, East Boston, and finally stretched across the Charles River to Charlestown—is to conceal the enormous infrastructure change as much as possible.

The artificiality of a city is easily forgotten—in part because it is tremendously complex to consider how a city is formed. Repeated visits to the same places yield distinct impressions. An enriched awareness of a place makes it unique among the complexity, a destination.

This thesis proposes four new destinations, distributed along the CA/T path through Boston, that will enrich the awareness of the city and its supporting infrastructure. By strategically choosing installation points, each with different architectural requirements, unique aspects of the CA/T can be revealed. A visit to the four sites will yield an understanding—through direct physical experience—of the CA/T and its path through Boston, and of urban infrastructure there and elsewhere.

All of the locations present opportunities to explain the myriad urban implications—from hydrology to neighborhood formation—inherent in such an enormous endeavor. The hope is to increase a visitor's awareness of their surroundings, and to foster the questions that lead to a deeper awareness of this and other places.
Earning the Masters of Architecture has been one of the most arduous tasks I have ever undertaken. This book will represent my thesis, the theoretical capstone of my graduate work, but it cannot pretend to represent the personal effort necessary complete the academic program.

Every sliver of time, every spare thought, tremendous physical effort and discipline, as well as every dollar in my (and many from others') accounts, has been required in the past three and one half years. They have drawn from a well of personal resources that I bored ever deeper while constantly draining it dry.

Of course, without support from my family and those around me, I would not have been able to attend, much less to finish. The intense friendships I have developed here are among those I value most. Professor and friend Anne Whiston Spiri's advice, encouragement, and exceptional dedication was essential to my final year in the program, and will continue to inspire me in future endeavors. My father Albert, mother Shirley, and brother Caleb provided the kind of quiet support that, if called upon, would have turned into a raging flood. Thank you all.

It is thrilling to be done.
# CONTENTS

**ILLUSTRATION CREDITS / THESIS READERS** ........................................... 2  
**ABSTRACT** .................................................................................................. 3  
**ACKNOWLEDGMENTS** ............................................................................... 4  
**STARTING POINTS** ................................................................................ 6  
**EXHIBITION** ............................................................................................ 15  
**INTRODUCTION** ....................................................................................... 16  
**DESTINATIONS** .......................................................................................... 19  

1. **MOVING** ............................................................................................... 20  
   Site Analysis .............................................................................................. 21  
   Early Proposal ........................................................................................... 26  
   Final Proposal ........................................................................................... 28  

2. **BREATHING** .......................................................................................... 34  
   Site Analysis .............................................................................................. 35  
   Function .................................................................................................... 36  

3. **DIGGING** .............................................................................................. 40  
   Site Analysis .............................................................................................. 41  
   Early Proposals ......................................................................................... 45  
   Final Proposal ........................................................................................... 49  

4. **EXCHANGING** ..................................................................................... 58  
   Site Analysis .............................................................................................. 59  
   Design Proposal .......................................................................................... 62  

**PROCESS** ................................................................................................. 68  
**REVIEW** .................................................................................................. 70  
**NOTES ON PRODUCTION** ...................................................................... 72  
**BIBLIOGRAPHY** ....................................................................................... 75
STARTING POINTS
**EXHIBITION**

The preceding photographs, and approximately 16 others, were scanned, enlarged, and printed for an exhibition in MIT's Rotch Library of Architecture and Planning, on display from February 1–28, 2002.

The photographs in the exhibition were selected from over 300 images. They represent many of the details and themes that have been compelling interests for me, as well as the diverse scales and bizarre environments that are common across the entire Central Artery/Tunnel project. There is a seemingly unending supply of superlatives about the project—the constantly changing visual landscape of construction (and destruction) must be counted as significant among them.
INTRODUCTION

A COMPELLING INTEREST

My fascination with the Central Artery/Tunnel ([CA/T], also known as the “Big Dig”) began while photographing the project in the fall of 2000. Encouraged by Professor Spirn to use photography as a way of reading (analyzing) and telling (helping others to see from an analytical viewpoint), I used photographs and written journals as tools of investigation.

I struggled to depict the gargantuan, almost geologic, scale of the project. The physical size is overwhelming. Enormous construction sites have been created and removed, oversized equipment of all types has been used in diverse processes of construction. Even the size of the individual elements is extreme, such as #16 (2” diameter) steel-reinforcing bar, or thick stainless steel cables that suspend the new Zakim Bridge. An entire tunnel has been submerged under the Boston Harbor, more than five miles of bentonite slurry walls (many three or four feet thick and up to 120’ deep) have been cast, thousands of tons of temporary steel have been used to support the elevated artery while the Central Artery/Tunnel is inserted beneath. In almost every way, from the perennially-burgeoning budget ($15 billion at the time of writing) to the growing Spectacle Island (one of the sites receiving excavated dirt), the project is mammoth in scope and complexity.

Although my photographic work was concentrated in the downtown area of the Central Artery/Tunnel, this area constitutes only about half of the entire project. The endeavor—the insertion of a major roadway into an already busy downtown corridor—is overwhelmingly complicated: structurally, politically, and logistically. Further, the critical maintenance of urban functions—traffic flowing, pipes draining, people moving—leads to uncommon and enormously expensive construction solutions. Tunnels were jacked underneath still-functioning train lines, roadway tunnels inserted underneath the South Station subway stop.

Several themes that emerged from the photographs provided the raw material for four animated, musical photographic essays, entitled “Rebar”, “Cranes”, “Night”, and “Graffiti.” The last contained reflections on the themes evinced by the other three—the small materials and complicated processes that create enormous infrastructure like tunnels and bridges; the extraordinary though temporary construction environments; and the presence of natural processes in odd landscapes completely conceived and constructed by humans. The essays were presented in a website intended to have a subjective point of view, rather than to create a step-by-step
documentation of the construction. Through this lens, a visitor to the site might begin to understand the enormous impact that the Central Artery/Tunnel (as well as the elevated artery that preceded it) has had on Boston.

**WHAT NEXT**

When wondering how to translate these interests into an architectural thesis, I kept a pedagogic goal in mind. My interest in the Central Artery/Tunnel is only partially due to its physical existence—it is also due to a longstanding fascination with the methods, materials, and details used in the project. How could these generate a thesis, be taken from the realm of my obsessions to the communicative realms of teaching and discovery? A museum seems too limited, attempts to see many places through one single place, and does not provide the direct experience that has been so compelling to me.

Instead, it seemed that the CA/T, with distinct and varied physical characteristics along its entire route, would be best understood through distributed experiences. I chose to create architectural solutions that would provide, like my photographic explorations (some of which required creative means of access), a direct understanding of objects and their contexts. For example, one of the design proposals uses bentonite slurry walls be used to enclose an interpretive facility (the rich texture of the earthen walls in which they are cast is usually hidden). Another proposes a descent to the depths of the project near South Station, to reveal the geologic makeup of the site, with bedrock 120' below the loose fill under most of downtown Boston. Further, the architectural vocabulary of my interventions would use elements that are relevant to the Central Artery/Tunnel structure, echoing the new construction, perhaps even recalling the old elevated artery.

From my experience photographing the project, I began to choose sites to represent key aspects of the CA/T, from the structural to the urban. The next question was how to use architecture as a tool to give visitors to the sites a direct and meaningful experience, like those that repeatedly drew me to the project over the course of one year.
DESTINATIONS

To give a comprehensive overview of the CA/T project, I made places to pause, to view directly the extraordinary scales and complexities of the project.

Four sites were chosen for interpretive installations. Each site offers a unique combination of features, creating—for a visitor to all four—a coherent understanding of the project.

Each installation tells an individual tale of urban infrastructure.

1. MOVING
2. BREATHING
3. DIGGING
4. EXCHANGING

These destinations seek to fundamentally change the perception of urban infrastructure, from unwelcome impediments in the city to recognized urban landmarks. It is a credit to the CA/T designers and engineers that such a shift is possible.

"Where freeways have failed, it has been because their designers have ignored their form-giving potentials and their inherent qualities as works of art in the city. They have been thought of only as traffic carriers but, in fact, they are a new form of urban sculpture for motion." (Lawrence Halprin, Highways, p. 5)

I hope the experience of the destinations will travel with a visitor after the CA/T has been left behind, creating interest in the infrastructure of this and other places.
1. MOVING

THE LEONARD P. ZAKIM BUNKER HILL BRIDGE

Underneath the bridge, there is palpable calm. The deck of the bridge hangs above, not oppressing, but reflecting, lighting, framing the space, leading the eye across the river. Through the bridge the sky looks higher—this space compressed seeps out skyward. The horizontal, controlled river crosses, and is in turn crossed above, by soaring highway connectors, a train bridge, the locks.

This place will be—after the trucks and cranes and scaffolding have moved on—quiet. Never silent, but calm, despite constant motion encircling it. The white noise is punctuated—a truck down-shifting, a lock door opening, a boat horn sounding, a train crossing—but always there is the sound of motion.

A slit parts the bridge, invites ascent to another viewpoint. Height promises clarity, release, overview. The other side—above—becomes possible, the light winds down the tower to the ground, to pedestrians passing by, to people disembarking the ferry, to boaters on a Saturday. A long climb shifts the viewpoint, perspective changes, the ascent is part of the destination—a human motion added to a scene where constantly crossing motors are king.

The height reveals. Planes encircle Logan, cars and truck roll on (precariously close, eye level), a boat wake parts the river. Travelers pass, cross the Tobin Bridge to the North Shore, zoom on to the rest of New England. Heading south the roadway descends and enters the ground next to Fleet Center—the grade here is steep and traffic charges in and out. Above this widemouth fissure the ground level looks reclaimed, curiously open. The path of the buried artery remains visible in the above ground shape of Boston. This mouth is the beginning or end of a path through the city—a crucial gateway to a project with deep roots underground.
SITE ANALYSIS

The Zakim Bridge (complete in 2002) connects the northern end of the Central Artery/Tunnel to Charlestown and to points north.

The viaducts and bridge seen in the photo on the previous page will be removed after the new bridge and roadways are completed. The existing I-93 bridge has been a source of frustration since the seventies when traffic volume started to exceed the capacity of the Central Artery, completed in the nineteen sixties.

Though the new bridge is well-designed structurally and as an addition to the Boston skyline, the spaces around the bridge have received less attention. The plans call for parks but they have not been designed in detail. One park has been completed on the Charlestown side of the river, but despite a monument and historical installation, it feels isolated and still suffers from the looming I-93 bridge overhead. On both sides of the river, the view from underneath the bridge is scenic, with the Charles River leading west, and the Boston harbor and Charlestown Navy Yard visible to the east.

The Charlestown landing of the Zakim Bridge is above several highway connections and a busy section of Lynde Street which leads (via the Charlestown bridge) to the North End. On the Boston side, the bridge deck arrives about 30 feet above ground level, and continues to descend to finally enter the artery tunnels before reaching Causeway Street.

The space below the bridge offers a unique view of the deck span leading across the water to Charlestown. Also visible are the Fleet Center, the rail
View of the Boston side tower legs, taken from a river lock.

The aerial view was taken before new bridge construction had begun. Note the large area taken up by the North Station train lines. The highway connections in the upper half will be completely revised as part of the CA/T work. Image from ortho.mit.edu.

lines leaving North Station, the Police station, and the Charles River locks to the east.

The train lines that emerge from North Station/Fleet Center sever the recreational path that runs ten miles along the Charles River to Watertown. Without a connection to this path, the space beneath the bridge will be a dead end.

Walkers, bikers, and runners cross the Charles River locks daily, passing by this area under the bridge. If a pedestrian crossing of the train lines were added, the recreational path would be accessible to Charlestown residents. This, and the compelling view of the river underneath the graceful bridge span, are reasons to improve the space at the end of Beverly Street.

A portion of the Zakim bridge can be seen next to the newly completed Storrow Drive Connector. Image from GlobeXplorer.com.
Another reason (as can be imagined from ground level next the river) is that the view from a high vantage point is quite telling. The Central Artery/Tunnel route, through the heart of Boston, was first discussed in the 1930s and eventually constructed in the 1950s. In Robert Moses style, neighborhoods made way for an elevated roadway that cut off the North End from downtown and created a physical barrier several miles long. This story is visible in the current street plan of downtown.

The removal of the elevated artery (the roadway clogged with traffic in the photograph) will free a tremendous amount of space in downtown Boston. The Zakim bridge vantage point, at the northern extent of the Central Artery project, allows a viewer to easily grasp the significance of the Central Artery route.

(The plans for the newly available surface space are not yet finalized. Many competing schemes have been proposed: the only certainty at the time of writing is that 75 percent of the space will be reserved as green space.)

Aerial views also reveal the bridge’s importance in the regional transportation network. The Boston landing is encircled by almost every form of transportation, from the modern to the ancient.

The elevated artery and Charlestown crossing, leading from the bottom left, will be removed when the CAT tunnels and roadways are complete. Eight lanes running two miles have occupied a huge area of valuable real estate since the 1950s. Photo by Peter Vanderwarker.
There are cars descending into the tunnels (southbound) and across the Zakim and Tobin Bridges (northbound); small boats crossing from the Boston Harbor to the Charles river and vice-versa; trains arriving and departing North Station; MBTA ferry transports docking at the ferry terminal on Beverly Street; pedestrians crossing to Charlestown on the Charles River locks; and airplanes landing at Logan. These motions are diagrammed in the image above. Despite the man-made nature of this place, where even the river is controlled, natural forces still must be recognized—the wind is always shifting and the tides rise and fall.

There is little planned for the area underneath the bridge on the Boston side. A quick glance at the CA/T model at the project's headquarters (images, next page) shows that little planning effort has been directed to one of the most interesting spaces around the new bridge. With the boaters on the river, the passengers disembarking at the ferry terminal, people crossing to and from Charlestown, and commuters leaving North Station daily, there is an intensity of human activity here that should be recognized architecturally. I approached the proposal for this site concentrating on this small but intense space.

The pedestrian experience of this highly constructed area would be severe with only the little park visible in the model. A building inserted into the slot in the bridge roadway would offer a unique viewpoint on the area's complex transportation flows, an especially clear view of the Central Artery/Tunnel descent into the ground below Boston. It would provide a destination for visitors to the little park. At a later stage, a crossing of the North Station train lines would re-unite the Charles river recreation path with the pedestrian crossing to Charlestown.
I searched for some time for a way to insert an architectural proposal into this site. A tall tower would compete unduly with the Zakim bridge form, yet a higher vantage point was necessary to appreciate the features of the site. The Zakim crossing is a critical moment, where transportation flows that define the area are clearly visible, and I-93 leaves Boston for Charlestown and points north.

Finally, I located a slot between the main roadway and the Tobin Bridge offramps (model detail, right). The slot presents an excellent opportunity to rise above ground level.

I began to develop an architectural proposal for this crack in the road, based on my responses to this very active site. It is an excellent place to change the perception of a highly urban situation—to transform the surrounding infrastructure into an object of interest and to animate the walkers' daily path.
I took many photographs of the site and visited many times, trying to conceive a design solution. The more I visited, the more it seemed that the constant motion was the most important factor. And yet, the calm of the space below the bridge was appealing as a place of repose, as if in the eye of a storm. I wanted to enhance the experience of pausing in this location, but to gain a comprehensive view by pausing here, one must be above the infrastructure. I started by developing an observation tower.

While photographing I had been drawn to the overlapping linear compositions common in Central Artery/Tunnel construction sites. Cranes silhouetted against the sky, forests of rebar already installed and waiting on flatbed trucks, scaffolding staircases for ascending the Zakim Bridge towers. I used this vocabulary as a starting point for this initial design proposal.

The stairs climb a shear wall that supports the weight of the observation deck on top. The central wall turns at either end to provide lateral stability. Though the stairs are open to weather, like scaffolding, the platform is protected from sun, wind, and rain. The height is modest, about 50 feet, as it need only rise about 15 above the bridge (on the Boston side, the bridge deck is about 30 feet above ground level.) The shear wall is concrete, and the staircases lightweight metal, like the scaffolding stairs that were the tower's inspiration.

After sketching the initial proposal, I made a CAD model so that I would be able to rotate

A scaffolding staircase.

Author's sketch of the initial tower proposal.
the tower and generate multiple points of view. The image on the following page is a hidden-line rendering of the tower.

To understand the proposed tower in the bridge context, I made another CAD model and placed the tower in the slot of the Zakim Bridge. Both the bridge and the tower models were rendered as Quicktime Virtual Reality (QTVR) animations, that allow the viewer to rotate the point of view around the model (this rendering is available on the included CD).

The committee had several suggestions for this first proposal. Professor Murray found the vocabulary heavy and earthbound, where the tower should suggest lightness and ascent. Further, to achieve the goal of animating the little park below, the design needed to reach out more to the surrounding area. The relationship of the tower to the ground vicinity is important, since it was intended to add interest to the walking paths between Boston and Charlestown. These connections were suggested by my site analysis but not well-realized in the proposal. Professor Nagakura suggested that a linear slot might want a more linear building—this proposal is more of a point tower, and a linear form might be more effective as an insert to the slot in the Zakim Bridge.

The reconsideration of the tower form seemed relatively easy compared to dealing with an issue central to the rest of the semester's work. How would my installations dovetail with the features that surround them? It is from these connections, that adapt to the features of the site, that an architectural proposal derives its locational necessity. As the thesis developed, the interaction of the designed installation and the site would become a major focus for three of the four destinations. My goal became, as the semester seemed ever shorter, to define the parameters of the architectural connections as much as the connections themselves.
After meeting with the committee, I developed a scheme that would include landscaping as well as an architectural intervention. A plan view is shown to the right.

Rows of trees make a path to lead walkers towards the Charles river crossing or to the observation tower. At ground level, the path leading to the tower continues to the place of repose under the bridge, and is well-lit to clearly mark the tower entrance at night.

The tower has been re-conceived as linear, like the slot that it occupies. This change orients the tower towards downtown, as if pointing to the Central Artery tunnel entrances at Causeway Street. The allée between the trees would be visible to pedestrians from Causeway Street, also to passengers arriving on the MBTA ferry (the dock is visible on the right in the plan above). The tower calls attention to the space below the bridge and promises a unique experience for those that climb above.

A plan view of the proposed design. The arrows indicate viewpoints shown in pages below.
The tower, though deliberately simple, is designed to announce this promise. The tectonic vocabulary consists of small steel members in square and round sections, with tensile cross-bracing. A shear wall runs longitudinally, and the transverse structures support the observation deck and resist racking in the short axis. Thin metal cladding, perhaps perforated stainless steel or aluminum, is applied to the longitudinal shear wall. This cladding peels away from the shear wall as it rises higher. The intention is to make the architectural vocabulary more aerial and less terrestrial.

For this proposal I again made CAD models and rendered QTVR (see caption) movies. The geometry of the bridge was a major consideration in the design of my linear tower—the design is intended to look like an addition to the Zakim Bridge rather than part of the bridge design.

On the following pages there are renderings taken from different vantage points around the structure.

Stills from a Quicktime Virtual Reality (QTVR) animation, which allows the viewer to rotate the point of view around the model (this rendering is available on the CD included with this thesis.)
Two views of the approach to the tower from Causeway Street. The path to the pedestrian crossing across the locks diverges to include the installation and a small space under the bridge. Eventually a connection is made across the North Station train tracks.
Left: View down the I-93 roadway as it enters the tunnels below Causeway Street. The tower stands above the roadway, parting the northbound traffic.

Below: The tower nested in the slot of the Zakim bridge. The nearby cables and the bridge geometry could be examined from the tower, but not from a moving vehicle. All of the transportation systems mentioned in the site analysis are visible from the observation level.
Right: Stills from the Quicktime Virtual Reality Movie. The Charles River locks are visible in the background.

Below: View from Portal Park, above where I-93 emerges from the tunnels.
A summary diagram showing the transportation systems that surround the tower and the Zakim Bridge. Fleet Center/North Station is in the background, the Charles River locks are just off to the right in the foreground.

The uncommon activity in the area and the strong form of the Zakim Bridge drew me to this site. Not knowing how to use architecture to enhance the place, I repeatedly visited, searching for some solution. The discovery of the quiet space beneath the bridge was a surprise, but together with the constant motion, I felt I had found the opportunity. The linear tower was developed for this unique location.

A visitor to the tower can see features of the Central/Artery Tunnel and the city. They can observe the natural and manmade forces that require such varied infrastructure—water, wind, cars, boats, trains, people.

It is one terminus of the CA/T, the northern end, a good place for an overview: the ever-alluring promise of height.
2. BREATHING

HAYMARKET VENT BUILDING

Cars, trucks, buses, taxis, pass twenty-four hours per day, each day of the year. Drivers roll up windows but there is protection already, fumes constantly evacuated from ducts built into the tunnels. Fresh air enters, circulates, indefinitely. This is an infrastructure that has physical realization, constant monitoring, and maintenance.

Half an urban block—high-priced real estate, between the North End and Government Center—in the heart of Haymarket, is devoted to ventilation. The tunnels must breathe, through lungs that extend laterally below ground and vertically above ground. Entire buildings are dedicated to the fans that power the ducts underground, the hidden alveola. The exhaust stacks are 120 feet tall, as tall as the deepest section of tunnel.

A transparent elevator goes up to the top of the shafts, but more intriguingly, down—into the earth. There must be something to see, an explanation promised by the elevator car passing into the ground. The vent building is no longer opaque, the building has a vital role above ground, for the tunnels and roadways below ground.

The people passing each day understand the building as part of the structure that supports the neighborhood. Reclaimed ground, covered and open, will be re-employed, made into another type of destination. But equally present, an above-ground marker of the underground complexity, the vent building works dutifully.
SITE ANALYSIS

The North End was cut off from the rest of downtown Boston during the construction of the elevated Central Artery in the nineteen fifties and sixties. It has been cut off yet more severely during construction of the new Central Artery/Tunnel. The crossings in use have been closed or restricted, with walkers redirected to temporary passages. These passages pass through the CA/T construction, underneath the elevated artery, and have windows installed to allow passersby to observe the construction. Many residents and tourists pause to look down at the dramatic work site below, while trucks rumble overhead.

An enormous space will be reclaimed once the elevated artery is removed (below). The dominating elevated artery has become spatially important—with the Sumner tunnel offramp (center of photo), it helps to define the space of the open-air Haymarket, where groceries are sold on most days of the week.

Vent Building 4 is under construction on the west side of the Central Artery. Its prominent location has made it of architectural interest. It will contain a small marketplace,

Looking northwest towards Haymarket at the bottom of the Callahan tunnel offramp. All above ground features will be removed.

Plan of the Haymarket area. Adapted from Bigdig.com parcel use map.

Vent Building 4 under construction. The CA/T space is visible to the lower right. All of the steel work is temporary scaffolding.
parking, and offices. The location is the major virtue—passed by thousands of pedestrians daily, it is easily accessible from the MBTA stations at both Haymarket and Government Center. With Haymarket and the North End on either side of the surface artery, an installation here would be available to the large viewing public that crosses the space each day.

**FUNCTION**

This area is strongly influenced by the tunnel's need to breathe and the pedestrian need to cross. There will be enormous underground air channels to ventilate the CA/T tunnels. Vent Building 4 serves a large length of the tunnels, but the respiration is not transparent to those passing between the North End and Government Center.

People walking by will likely have no sense of the role this building plays in the below-ground infrastructure. Fewer will know about the problems of tunnel ventilation, and that extensive ventilation planning is part of any tunnel project. During normal operation, fresh air must displace polluted traffic exhaust. During a fire, the ventilation system must stop the supply of fresh air, to avoid feeding oxygen to the fire. These systems are controlled at the CA/T Operations Control Center in South Boston, but Vent Building 4, like the six other vent

Vent building 4 is squeezed into a small parcel to the west of the surface artery. The middle section of both images, enclosed by dotted lines, marks space reclaimed by the removal of the former elevated artery. Background images from Bigdig.com and parcel use map.
buildings, must operate as part of this system.

Vent Building 4 is at the center of the image to the left. The towers are the exhaust stacks that release tunnel air to the atmosphere. Though the model at completion shows simple green space, the below-ground roots of the building extend far from the Vent Building itself (lower left and section).

The airflow in these branches is powered by enormous fans like that being assembled in the photo below. Fan rooms (next page) and the enormous supply and exhaust ducts will be impressive environments. As a goal of the proposal for Haymarket, I want to expose this critical function to the people that walk by daily. Integrating a tour facility into the vent building could do this. It is also important to find a way to announce, on the exterior of the vent building, the presence of this interior system.

The vent building has plenty of room for the minimal additions
that would be required to create such an interpretive installation. The vibrating, clean, enormous, loud fan rooms will be impressive on their own, and do not require many architectural changes. A tour of the vent building, including demonstrations that reveal the presence of air moving—such as an observation window with objects constantly suspended by the air flow, or the chance to enter and stand in a supply duct—makes the function of the building clear.

Visitors to the facility could enter from either Congress Street or Blackstone Street. From an entrance in the market level, people could descend to see the enormous fans and ducts, and to visit the small exhibition space. Or, going up, people would be able to see the mechanical penthouse, 78 feet above street level, and the exhaust stacks, 125 feet above the street.

The section on the next page diagrams the concept of the proposal. Architecturally, the project could be achieved by the addition of a glass-enclosed elevator rising from the mechanical rooms to the penthouse level. This elevator announces the presence of the interior facility on the facade—if located on the perimeter of the vent building, then pedestrians would see the shaft penetrate the ground plane, descending into the apparently solid ground.

The ventilation of tunnels all across the CA/T project is a major concern of the system designers. The lungs must provide enough fresh air for drivers to remain healthy, and also be highly controllable in the event of a tunnel fire. With seven vent buildings built along the...
length of the CA/T, the ventilation alone will have a major urban presence.

A Wallace Floyd Design Group architectural team, led by Chief Architect Hubert Murray, spent much time developing design guidelines for many parts of the CA/T. They were interested in making the vent buildings more expressive of their purpose than similar buildings in other large tunnel systems. They recognized that the public perception of these structures is important, and thus they were the focus of attention not commonly directed to these functional buildings.

Still, it is very difficult to communicate the function of a vent building on the exterior, and despite the designs, which are unique and expressive, an understanding of the system cannot be gained on the exterior alone.

In the interest of time, and because it is primarily an addition an existing building, architectural forms for this proposal were not developed. Still, the discoveries made by a visitor to the envisioned facility remain vital to an understanding of the CA/T as an urban system, with invisible and complex roots below the city.
3. DIGGING

DEWEY SQUARE, DOWNTOWN BOSTON

Ground is not solid, bedrock lies 120' or more below piles, pipes, electric lines, sewers, fill, onramps, offramps, pavement, traffic lights. Daily people cross from South Station to the Finance District and downtown, then back again to trains and buses that take them away—as fast as possible, no delays. They cross on top of the red line tunnels, the silver line tube, utilities, water-logged fill, and the artery tunnels far beneath.

The path is an obstacle but should be a destination. Where the path crosses a shaft, suddenly the walking is not tiresome, is a viewpoint, to the winter wind above, to something clearly deep below. An elevator just out of reach descends, to somewhere—there must be something to see below. A daily journey becomes animate, interesting, a landmark.

Descent takes time, moving past the layers that make up Dewey Square. An alternation between rough concrete slurry walls and finished infrastructure, crossing utilities and the view to the sky far above. A passage through a new geology composed of man-made features yet still anchored to bedrock, the goal of the journey. At bedrock, two tunnels, technically complex, perennially filled with cars, ventilated, monitored. This is as deep as the bridge is tall—the places are connected by one roadway, in fact, underneath the city, invisible.

Dewey Square in September 2000, looking east.
SITE ANALYSIS

The Dewey Square section of the Central Artery/Tunnel project caught my attention soon after I arrived in Boston. From the temporary pedestrian walkway between the South Station train and bus terminals, it was possible to see to the depths of the project, over 100 feet below. This depth, and the steel scaffolding necessary to hold up the street that commuters were walking on, was amazing to me. Equally amazing was that many people walked by, while my face was pressed against the chain link fence, and did not stop to look down.

Reading about the CA/T in Dewey Square confirmed that it is one of the most extreme sections of the project. Bedrock is about 120' below street level, making the excavation work there difficult. Most of the land is fill, and surrounding buildings are supported on pressure piles. It would be essential to maintain the ground's load-bearing integrity during any excavations. Further, there are many underground complications, even more than those already endemic to urban undergrounds.

The Red Line Station box, including platforms, entry/exit facilities, and segments of the subway tunnels, is underneath Summer Street. A new Massachusetts Bay Transportation Authority (MBTA) underground bus line, the Silver Line, will be constructed on top of the Red Line box but underneath the street. And 120' below, the bottom of the CA/T highway tunnels will be resting on bedrock. I was unsure what sort of installation might reveal this complexity, and a great part of the work on Dewey Square was to locate an installation among these underground features.

There was a major construction problem in this area—the CA/T tunnels had to be inserted underneath the Red Line Station without disturbing the Station's structural integrity or preventing Red Line regular service. One proposal was to use jacked beams—by excavating a jacking pit...
alongside of the station, beams could be jacked from the pit to support the station box. Excavation could then take place underneath. This method was not chosen.

The final method is shown in the diagrams below. Injected grout dries the soil, making it possible to cast concrete supports for the Red Line station and to excavate in between.

Even before the term began, I wanted to somehow reveal the underground makeup of Dewey Square. From the surface, it is very hard to perceive the presence of the structures underneath. The depth is quite surprising when, during construction, one can look down from street level. Once the construction is over, the surface will be stitched back together, and again the invisible features cannot be perceived. I had in mind an installation where the process of descending was as important to the experience as the educational exhibitions located at the bottom.

Two states of the excavation technique used. The Red Line Station is shown dotted in red. Images from Bigdig.com.

A section from a study investigating jacked-beams as a construction technique. *Civil Engineering Practice*, Spring 1992, p.79.
Dewey Square is an extremely active area. In the morning and evening, thousands of commuters pass from South Station to the Financial District. This activity is important to an installation—if I could somehow integrate the entrance to my facility with the pedestrian crossing then I would guarantee exposure for the intervention. [A question since early in the project was the nature of the installations when not operating—would they be forlorn and abandoned urban spaces?]

The approximate positions of the crossing tunnels are shown in the street plan diagram. This was an essential mapping exercise, as I wanted to construct a three dimensional model that would help me locate an installation facility. This turned out to be much more difficult than it seemed, and was not ready until after the middle of the term. I continued examining the site, for once a location was chosen, my design intervention would be simple, with minimal above-ground features.

The primary pedestrian crossing of Dewey Square is indicated in the diagram (left, next page). This path crosses two major intersections with the planned surface artery. The surface planning along the entire CA/T route is controversial, but Dewey Square, like its underground features, seems to be a superlative moment. Many stakeholders have strong interests in the ground-level features, including a strong tenant association composed of businesses in the surrounding buildings. Because of the discussions, nothing has been definitively planned, although a tower by MIT Professor Wellington Reiter has been selected.

The crossing has always been forbidding in winter, and with few surface features planned to the north
of this area it will be especially harsh (image, below right).

Since the beginning of my work on Dewey Square, I have pictured a facility located at the bottom of a deep installation. Enclosed in roughly-texture bentonite slurry walls, this space would include exhibitions and displays of historical, constructional, and educational materials. More importantly, this space would include some opportunity for direct observation of the CA/T highway tunnels. The aural and visual opportunities are numerous—for example a live projection or a camera obscura revealing the traffic inside the Artery. It is a chance for stationary people to observe moving traffic, and to indicate a driver’s progress in the tunnel by marking the presence of downtown in the roadway. In the proposals that follow, the museum-like facility should be envisioned as unconventional—it is an extreme location, 120’ below ground-level and buried in bedrock—that calls for atypical exhibition design.

I saw the opportunity in Dewey Square to be the creation of a sheltered crossing for pedestrians, integrating the entrance of a deep shaft and museum with the crossing. The proposals were developed around this idea.
EARLY PROPOSALS

PROPOSAL 1

Because an escalator that descends 120’ requires a long horizontal run, this early proposal broke the escalator into three separate runs, arranged around a central shaft.

The escalators gradually descend to an interpretive facility at the bottom of the shaft (the ground plane is the triangle-like shape that the shaft penetrates.) The descent is punctuated by galleries along the way, where exhibition-like materials explain the underground features. The shaft would be cast as a bentonite slurry wall (the technology and form that has enabled so much of the tight-space construction necessary for the CA/T), having the texture of rough earth walls and reflecting the material quality of the construction environments.

The shaft would also have a functional role in this scheme. The CA/T, like all tunnels, needs an enormous supply of fresh air. It is provided by several ventilation systems. In this case, as part of the design idea, the shaft functions as a ventilator for the tunnels below. That gives the installation some architectural necessity beyond the exhibition of the CA/T. This idea would also be used in the next early proposal.
PROPOSAL 2

It proved very difficult to find a place to fit the previous proposal. Because of the triangular plan, it required a large footprint. If the escalator arrangement were changed, to a line rather than a triangle, the installation could likely fit between the massive slurry walls that rise from bedrock.

This scheme places the descent, with galleries as waystations, in a linear slot between the CA/T features. Again, the ventilation system of the tunnels is integrated into the installation, making the function part of the exhibition. Each gallery intersects an air shaft, progressively lower on the shaft as a visitor descends—this registers, via the view up the shaft, the depth each gallery.

One significant problem is that tall towers are necessary to avoid street-level particulate emission. In this part of the city, with so many parties interested, a semester is likely not enough to design towers that
are acceptable, despite the fun foray into tower prototypes.

In the renderings, the massive slurry walls are represented as dark grey curving surfaces (below right). The CA/T tunnels are at the bottom, and the Red Line Station and Silver Line tunnels are not shown.

Professor Murray found it a typological error to mix the ventilation of my installation with that of the CA/T infrastructure: To do this, I would have to credibly describe how the systems interact, a difficult HVAC (Heating, Ventilation, and Cooling) project on its own, certainly not one towards which I wanted to direct a semester's effort.

This scheme was ultimately more complex than I had planned, presenting typological problems of a fundamental nature. What is the type of installation that I would spend the semester designing? Should I develop this scheme in much more detail or turn back and look at simpler options? I chose to the latter, as seen in the next concept.

Exhaust tower prototype.
PROPOSAL 3

More concept than proposal, I made a simple model to represent an idea I had for some time but had not yet presented. As diagrammed below in orange, a pedestrian passage could cross a shaft located in a nexus of the underground features. By this time in the term I had located the Red Line Station, the Silver Line, and the CA/T tunnels. The shaft shown in the diagram is placed so that it could be accessible to the pedestrian flow from downtown to South Station, and so that at bottom an interpretive facility could adjoin the northbound artery tunnel.

In the diagram, the ground plane has been removed and the depth of the underground features are shown. The grey surface shapes represent the proposed curb lines and are shown as transparent.

This simple concept of a passage and bridge is the foundation of the final proposal.

Above: View in the pedestrian passage.
Right: Plan diagram.
Above right: View down the shaft.
Minimal surface features mark the presence of the underground pedestrian crossing. These are, from upper left to lower right, the Finance District/Downtown entrance to the passage, a light well that helps with daytime lighting and announces the passage at night, and a rough concrete (bentonite slurry) shaft with an elevator for descent.

The next image shows the scheme with the ground plane removed.
With the ground plane removed, the new passage is visible. From top left to bottom right: The entrance is at the Finance District side, then the passage continues on to an intersection with the Red Line Station (there would be an entrance to the shaft and museum here), continues under the Silver Line, crosses a dramatic bridge through the shaft, and arrives to escalators leading to South Station.

The interpretive facility, containing exhibitions and educational materials, and perhaps an observation port into the CA/T tunnel, is at the bottom of the deep shaft. The shaft has been reshaped to reflect its position relative to other underground features.
The downtown entrance to the pedestrian passage. The architectural vocabulary is simple but the light well, the shaft, and the elevator house in the background make an above-ground visual connection between this entrance and South Station.
Above: View along the surface level light well. Glass panels would be mounted flush with the surrounding sidewalks. Lighting is located along this axis.

Right: A view back to the Finance District and downtown. My proposal is shown with the line edges. The deep shaft is visible in the foreground, with the passage crossing through.
View from above South Station, with the building and sidewalks rendered as transparent. The exit to South Station is conventional, similar to the existing facilities.

The elevator housing at the top of the shaft is visible here, as well as the passage bridge.
Below: View that walkers encounter while in the passage, heading towards South Station.

Left: View through the floor of the bridge. Glass panels are mounted on top of a light steel structure. The widest span of the bridge through the shaft is only fifteen feet so only modest structure is required.
Below: View up the shaft from the small museum at the bottom.

Right: View up from the bridge in the passage. The height of the surrounding buildings contrasts nicely with the depth of the shaft. The view is from bedrock below to skyscrapers above.
Stills from a Quicktime Virtual Reality animation, that allows the viewer to rotate the point of view around the model (this rendering is available on the CD included with this thesis.)

The underground features added in my proposal are shown in orange and as the textured concrete shaft. The ground plane is removed for clarity. The plane is located at the level where the escalators emerge from the entrance in frame 1.
The frame sequence runs from the top left to bottom right, across both pages.
4. Exchanging
Parcel 27A

The interstate system was proposed as a solution to transportation issues of the twentieth century. Still it is not complete—Boston has lagged behind—a gap in the network of arteries and veins of New England. The system converges on the interchange surrounding Parcel 27a—drivers on the Mass Pike are warned about this end, offered new routes north to New England, south to Rhode Island and Connecticut, straight ahead to the airport (another mode of transport). Those arriving from the south find an archetypal urban edge—tall buildings, obvious density, confusing streets, dense traffic.

Cranes are efficiently framed, simple steel rigid tubes invisible to the wind. During construction, the sky here was filled with cranes of all kinds, usually twenty visible at once. They called attention to a dynamic landscape that was excavated, covered with equipment, passing cars, passing trains.

Parcel 27a is a cutout left behind, a remainder of ground. In contrast to vehicles surrounding, in contrast to a driver’s expectation, Parcel 27a becomes a pedestrian destination. Amid roadways flying, ramps entering the ground, traffic constantly interchanging, a place to pause.

A tower calls attention, invites climbing. Aerial views bring clarity, the view is a destination, a chance for overview, welcoming to travelers, refreshing to residents. It is easy to park, then to walk, passing above and underneath the landscape of highway and interchange—the tower marks the destination for those on the ground.

The welcome center has the handouts of orientation but the tower view tells the story. A route through downtown first discussed in the thirties, made overwhelming in the fifties, obsolete in the sixties. Open sections across South Boston, ventilation buildings that mark the Ted Williams tunnel, airplanes touching down and taking off at Logan across the harbor. This is a crossroads, a key to the nervous system of regional transportation, a legacy of twentieth-century road planning.
SITE ANALYSIS

I was first drawn to this site because of the radical tunnel-jacking process. The Massachusetts Turnpike arrives from the west to an area just south of the South Station train terminal. As part of the CA/T construction, the Mass Pike will continue through tunnels underneath the Fort Point Channel and South Boston to end at Logan Airport.

This site is particularly difficult because daily train traffic, including Amtrak and commuter rail, had to continuously run while new tunnels were inserted beneath. Tunnel-jacking, outlined below, is the process that allowed for new tunnels to be placed underneath the working train lines.

The area under construction is enormous. For years the site has been marked by multiple cranes, heavy construction equipment, and piles of materials. The three excavation pits where the new tunnels are constructed are enormous: one tunnel segment was 380 feet long. At the southern end of the site, there are elevated roadways (the new I-93) crossing the train tracks and the Mass Pike. At the eastern side of the site, the construction overlaps with the Fort Point Channel, where tunnel sections are being floated into place and dropped on the channel bed, pre-dredged to receive them. A vent building is rising on top of one of these new segments. It is a striking environment, especially at night—I took many photographs here, of the frozen ground, of the cranes silhouetted against the sky.

The tunnel jacking sequence. First, the ground is frozen for six months, by circulating -20° F salt water in freeze pipes (1). Simultaneously, the tunnel segment is readied in the adjacent excavation pit (2). Excavators (3) grind away the frozen earth (4), and finally the tunnel section is jacked forward (5), three feet per day, provided there are no unexpected obstacles such as granite. Photos 2, 3, and 5 from Bigdig.com.
This area will be a domain of highways and underpasses once the construction is complete. The network of roads that feed the site are constantly being relocated as construction progresses and will continue to change as final road segments are completed and connected. Many of the new roadways will be located on the current construction site.

Parcel 27a (plan, next page) will be ringed by viaducts, offramps, open section roads, tunnels, surface streets, and the South Station rail lines. The Mass Turnpike (Interstate 90) and Interstate 93 cross here. Not a pedestrian friendly location, Parcel 27a will have two small buildings and a service road that connects to Kneeland Street and the Leather District to the north.

It is a crossroads in many ways. The crossing of the Interstate highways, the rail lines, the South Station bus ramp (immediately to the north), and surface streets will surround the site with constant motion. It is a key location in the CA/T project—the meeting of roads that service Logan Airport, downtown Boston and the North End, South Boston, Cambridge-Somerville, and points west via the Mass Pike. It is also a key regional connection, one end of the 135 mile long Mass Pike, and a crucial connection in the New England regional transportation systems.

I began my search for an architectural proposal by looking into the parcels that would be part of the finished area. There are five, as shown in the diagram on the next page, Parcels 24, 25, 26a and 26b,
and 27a. All but 27a border the Leather District, a neighborhood of turn-of-the-century industrial buildings to the east of the bus station.

This is an urban neighborhood with daytime pedestrian traffic. It ends suddenly at the southern edge where the current construction site begins. Once construction is complete, a connection could be made between these parcels and the neighborhood, even extending farther south to the potentially forlorn Parcel 27a.

Parcel 27a is a perfect location for some sort of announcement that my installations were deployed throughout the city. There is a sense of arrival for commuters and travelers encountering the sudden, urban edge created by tall downtown buildings. The towers are a navigational device, a signal that an urban realm is ahead. Another tower, to advertise specifically the presence of my CA/T installations, here and farther north, was the starting point for the final proposal. This tower, and my proposal for the Zakim Bridge, mark the northern and southern extents of the CA/T in downtown Boston.

There is no welcome center nearby in Boston. Because of Parcel 27a’s nature as a crossroads, it is a desirable location to pause and orient, an ideal place to welcome travelers to a very confusing system of local streets. A rest stop and tower would allow travelers to see the area they are about to drive through, while taking maps and materials about Boston.
A tower and small welcome center were the first goals of the design work. Because of the surrounding roadways, I began by studying modifications to on- and offramps that would allow cars to access Parcel 27a.

After preliminary space studies, like that to the right, it became clear that there was not enough room to locate the welcome center, tower, and parking on the site. Further, with a vehicular connection to the roadways, the site is primarily accessed by vehicles rather than pedestrians. This road access, difficult to achieve anyway, further removed the site from the already detached, urban Leather District. And although the site seems undesirable as a pedestrian destination, walking underneath and above the highway loops and connections could be quite fascinating. This type of experience with urban infrastructure is exactly what this thesis seeks to create. Thus I looked for alternate ways to accommodate the arriving cars.

If the parking were detached, a more urban-scale proposal could be developed for Parcel 27a. By locating the parking on Parcel 24 or 25, a promenade could be created along the southern end of the Leather District. Together with residential apartment buildings (Parcels 26a and 26b are well-suited for high-rise residential housing, rather than low, row-house developments), this area would become a dense and multi-use neighborhood like the nearby streets. These features help complete the edge of the city so perceptible to arriving drivers.
Below is the site plan proposed for Parcel 27a. On the southern end of the site is an observation tower, on the northern end, a Welcome Center. Both of these are reached via walkway from the parking structure on Parcel 25. On Parcels 26a and 26b, adjoining the power plant on Kneeland Street and the current CA/T administration building, high-rise residential housing could be developed. In the background, the new vent building adjacent Fort Point channel is visible.

The tower would be clearly visible to drivers on the Mass Pike as well as I-93 North and South, and to passengers on buses and trains departing or arriving the South Station terminals.
Left: View from the southeast. The trees would be densely planted to create a clearing at the center of the site. These trees would create some barrier to airborne particulates released in car emissions. Robust species of the New England forest would be needed to sustain healthy growth in this manmade environment, but with little maintenance vegetation would fill in the perimeter.

Facing page: A view along the open space walkway, and a view of the walkway crossing to Parcel 27a from the Leather District. This passage, underneath one set of ramps and above two ramps cut into the ground, is a chance to experience the large sculptural forms of the highway structures.
Lighting fixtures designed in common for the four installations use architectural language to unite the separate sites. This approach helps visitors understand them as part of the same system.
If the trees were planted according to species, they could help show the structure of the site as they turn to autumn colors. With simple planning, this dramatic effect could create a signature presence for the Parcel 27a installation. It could serve as a landmark, signifying arrival, promising commuters that the drive is almost over, and offering travelers a chance to stop and get their bearings.
Viewpoints of the tower and of the climb to the observation deck on top. The tower is made of simple steel members, a reminder of the cranes that covered the site for many years. On top, the view of Boston reveals the shape of the city, and immediately makes clear the importance of the CA/T route, extending north through downtown, and east to Logan Airport.
When I proposed the Central Artery/Tunnel project as the site for my thesis, I knew scale would be a primary issue of the thesis work. I wanted to engage both the urban and the architectural scale.

The geographic size of the endeavor can be compared in magnitude to the relentless perseverance required of government, architects, planners, engineers, and contractors. The work has an almost geologic forcefulness, enduring through seasons and over years, seemingly unaffected by natural processes, by political changes, by the need for the city to continue functioning.

Though vast, the entire structure is composed of small elements like steel reinforcing bars. These small parts are combined to form enormous objects and assemblies.
Because of my interest in such extremes of scale, I approached the thesis work from this perspective, using architectural installations at the small scale and deploying a network of four sites at the urban scale.

I have attempted to tell an enormous story by creating very site-specific installations. They allow a visitor to understand the tremendous complexity of urban infrastructure without actually witnessing the construction. Though addressing the unique parameters of each site, the installations together tell the larger story of the Central Artery’s presence in Boston.

By visiting the four sites, the complexity and depth of the project can be understood directly. This knowledge enriches the perception of the urban environment while acknowledging the physical composition of the manmade landscape.
Though normally I take time to prepare my presentations, in the last week before the thesis review it was difficult to imagine finding any such time. Professor Spirn encouraged me to do so, to allow reviewers to visit the website (available online about 36 hours before the presentation) and to allow time to prepare my thoughts.

On the day of the final review, I realized that this pause for reflection was essential. The previous day, I had prepared questions to ask of the reviewers—this would direct their comments to subject areas of interest to me, avoiding the common situation of a review running away from the areas in which the student's work was concentrated. This process aided my reflection on what I had done during the term, providing some remove (and therefore clarity) from the work.

It was also essential to prepare the outline from which I presented, and to include a context for the reviewers. I established this context, as I have done in this book, by beginning with my photographic work. I also showed images of furniture that I have built, to give a sense of my interests. In this way the panel would be able to see some generative forces of the work that I had done.

I knew from early on that I did not want to do a traditional architectural thesis, designing one building on one site. I hoped to use distributed, targeted, relatively simple architecture to create a larger meaning across a wide area. The Central Artery/Tunnel was the perfect site for this goal, offering a long, expansive project with myriad opportunities for intervention.

I had been very concerned about the reception of my work, worried that it was not detailed enough to be architecturally credible, and not broad enough for a complete urban design. Much of the difficulty of the semester's work was the straddling of the line between architecture and design, and I believe that not until the final week did the proposals, taken as a whole position themselves in this middle ground. And much of the detail that was present, that I knew about because I built it into the CAD model, was not visible to the reviewers. I could not work at several different scales in front of the panel, though this was exactly what I had done in my geometric modeling.

The review panel consisted of Professor Spirn; my Readers (page 3); Professor Stanford Anderson, Head, MIT Department of Architecture; Marlon Blackwell, Visiting Associate Professor from the University of Arkansas where he teaches and maintains an architecture practice; and
Warren Schwartz, Principal, Schwartz Silver Architects, Boston.

The panel received the work enthusiastically, to my surprise. I was relieved that they found the proposal squarely between architecture and urban design, an echo of the composition of my thesis committee. Professor Spirn is very comfortable thinking and working at the urban scale. Professor Murray engages at multiple scales and frames of reference, perhaps the reason that at a few moments in the term he seemed as confused by my project as I felt. Professors Griggs and Nagakura, although by no means restricted to this realm, often offered criticism focused on architectural decisions.

Many comments helped grant me perspective on the thesis work. Professor Nagakura thought that I had improved the proposals from the beginning of the term, when they were conceived as devices to view the sectional characteristics of the Central Artery/Tunnel. By the end, they had become autonomous installations, focused on the infrastructure, but not dependent on it. Warren Schwartz, who like Hubert Murray has extensive experience with the Big Dig, enjoyed the site selection—they are places that are indeed significant to the project, and two of four (the area under Zakim Bridge and Parcel 27a) will not be areas of concentrated surface planning. (Mr. Schwartz also expressed relief to see proposals removed from the bickering that has accompanied almost every reclaimed square foot of downtown space.) Kimo Griggs commented later that it was an interesting idea to change the perception of infrastructure—such a change in public interest could possibly lead to generic architectural approaches that celebrate necessary urban features like subway platforms and viaducts. Indeed, this seemed to be the principle that guided the Wallace Floyd team, led by Hubert Murray, as they created the design guidelines for the Central Artery/Tunnel project.

Finally, for future thesis students who likely have not read this far, I would like to emphasize that the review went well in large part because Professor Spirn helped me to prioritize the time to reflect, prepare my presentation, and rest. Finishing one day before the review allowed me to coherently discuss the work I had done, to match my words to the material that I showed the panel.

My review was early in the two days of thesis reviews, and I was sad to watch my peers, who of course had worked as hard as I had on very interesting theses, stumble through their presentations. Awake all night, bleary-eyed, and fatigued, their words did not match the high-quality material on the wall behind them. They did not direct the panel’s comments to areas they wanted to discuss, and did not establish the contexts of their projects. The reviewers’ comments were only peripherally related to the focus of the student’s six months of work.

It is not difficult to take control of the review, it is only difficult to decide to do so. An advisor’s encouragement is critical in the decision, as the student is blinded by an imagined pressure. I watched about half of this year’s reviews, and in every case I was disappointed for my peers that neither they nor their advisors had the wisdom to maximize the review. They were shortchanged at the theoretical culmination of their architecture education, and will remember an anticlimax rather than the satisfying closure that comes from reflection.
NOTES ON PRODUCTION

The renderings in this book and for the website were made with Form-Z 3.8 and Adobe Photoshop 6.0. Many illustrations were made with Adobe Illustrator 9.0. All ran on an Apple Macintosh Powerbook G3/400MHz. I have experience in 3D modeling in many programs, and prefer Form-Z for both modeling and rendering. I use Photoshop to composite photographs or other imagery with the renderings.

I also have extensive experience making real objects. At age 18 I began to learn carpentry while building a post-and-beam house in rural Maine. I continued to make furniture in wood, learned how to weld and forge, and have learned both manual and computer-controlled machining. I have built in many scales, from furniture to houses. Many of my happiest moments have been working with real materials to make full-scale objects.

The deep satisfaction that I have found in the past eleven years of this work was never mine as I worked on architectural models. Certainly this was partly due to the change of scale, also to the very purpose of architectural modeling—representing real objects. I had been accustomed to building in full-scale, and tiny materials seemed needlessly abstract to me. More importantly, the satisfaction never came because the construction project was always part of the design project—I, and my peers, were trying to solve the construction problem and the design problem at once. This is intensely difficult, and makes every decision laborious. To complicate matters, without an architectural undergraduate degree nor experience working for an architectural firm, I had to learn the means of architectural expression at the same time I had to use them to express my ideas.

Three dimensional CAD modeling offered me a way to deal with these issues. While building a complicated CAD model (and they grow to tremendous complexity, always pushing the limits of processors and memory), I feel a satisfaction similar to that of making real objects. The decisions that I make for a fabrication job—the size of elements, the sectional characteristics of the material, the crucial connection design—can be represented in the CAD model. A clevis looks like a clevis, a W-section like a steel I.
level of detail. Unlike drawing, in limited time I can generate representations at many scales, from many angles and levels of zoom.

This thesis had to be defined at radically different scales. At the largest, I was trying to work with the city, to understand and enhance the experience of a complex and historical eastern city and its regional transportation network. At the smallest, I was wondering what size column was needed to hold up the observation tower at the Zakim Bridge, or how a shaft could be positioned between the underground features at Dewey Square. What better means than a CAD model, where you can zoom in to see the cross bracing at the Zakim Bridge and zoom out to see the entire area with its surrounding features?

I anticipated much resistance when choosing this way of working. In my experience at MIT, I have seen CAD renderings frequently criticized as abstractions, illustrations only—the professors claim to demand something more experiential and always appreciate a lack of precision. But how many students can draw the

Rendering of a proposed insulin pump. I used the CAD files to cut parts with a waterjet and a laser cutter, and to make 3D prints.


beam, and the cross bracing is in perfect tension. The representation, though to some more abstract than an architectural drawing, to me feels more realistic, more palpable, and more credible as an object.

In part it is Form-Z that gives me as much control over geometric models as I have when welding or using the tablesaw. It is a wonderful modeler, allowing for both speed and flexibility. The geometric tools are sophisticated and the program offers many possibilities for deriving objects from objects, or from object typologies (e.g. extruding a picked face or outline). Further, the incorporated rendering packages can give quick-and-dirty or finely-polished images. It allows me to feel in control in the same way that I do when working in a shop equipped with a wide variety of quality tools and materials.

When working in Form-Z, not only do I get to make ‘structural’ decisions—how will two members meet, what shape are they—I get to see the model from any angle or
perspectives that represent an entry sequence in such limited time, and in many cases limited drawing experience? How many can take sections quickly or even accurately? Without painstaking and time-consuming work constructing a geometric model, CAD will not do this either, but once the model is built it is tremendously more flexible and informative than a single drawing.

I also tried to think frankly about the future of production. The example of a colleague of mine seems instructive—she arrived at MIT with no drawing experience and spent hours and hours learning to manually draft. She spent little time learning to use CAD programs. To some degree, it was her choice, and to some degree she was encouraged by the atmosphere of the program, but she learned an art that will be relegated to connoisseurs, to those who excel at the task. The rest of us, her included (she never did learn to excel at drafting), will be working with computers, learning new ways to represent architectural projects. We will learn new ways to present our work, such as web-based presentations. We will learn new ways to make real objects, using computer-controlled tools. Though certain qualities will be lost (the appeal of an ink on Mylar drawing, for example), others will be gained. This is what technology has always done—added some value and taken some away.

From the point of view of January 2002, I can only be glad to have spent so much time learning the tools that seem indispensable to future work. I consider one of the contributions of this thesis (and for this Professor Spirn’s assurances were essential) to be the determination necessary to generate the thesis inside my personal computer.
BIBLIOGRAPHY

BOOKS AND ARTICLES


**INTERNET RESOURCES**

http://www.bigdig.com—Contains many types of information about the project, including an excellent photographic archive.

http://ortho.mit.edu—For aerial imagery of the Boston area. Aerials are many years old but are scalable and downloadable.