ON BUILDING INROADS:
an inhabitable bridge on the Charles

by

David Solnick
B.A., University of California
Santa Cruz, California
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Ph.D., State University of New York
Stony Brook, New York
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Signature of the author

David Solnick, Department of Architecture
January 17, 1992

Certified by

Maurice Smith, Thesis Supervisor
Professor of Architecture

Accepted by

Renee Chow
Chairperson, Departmental Committee on Graduate Students

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Abstract
The proliferation of the automobile in the 20th century has
created a new form of road in its wake: the urban
highway. Walled-off, elevated, depressed, or buried, these
highways are often detached and divisive of their
surroundings. The thesis presents an exploration of ways
to weave the highway into the urban fold by designing it
to accommodate and generate its built environment. The
medium for this exploration was the design of an
inhabited bridge, at the site where Massachusetts Avenue
crosses the Charles River between Boston and Cambridge.
The work leads to a proposal in which portions of
elevated highways are designed to become public support
systems that could be used and extended for adjacent
habitation.

Thesis Supervisor: Maurice Smith
Title: Professor of Architecture
To my father and brother, who struggled similarly.
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1 Introduction

Roads of various forms have been with us for a long time, evolving gradually to accommodate the changing demands of the foot, the hoof, and the wheel. Although a longer view of history may prove otherwise, from the present standpoint it seems that the large scale introduction of the automobile during the 20th century has brought a cataclysmic change in that long evolution. To accommodate the vast numbers of large, fast-moving, noisy, polluting, and ever-potentially life-threatening machines, we have abundantly provided the automobile with a wholly new kind of passageway. Whereas roads were traditionally woven almost seamlessly into the urban fabric, taking on the form of streets as they entered a city, the modern high-speed road\(^1\) remains aloof—walled-off, elevated, depressed, or buried in its own domain. The form of the modern highway, I will argue, reflects not only the dictates of the car's size and speed, but also our lingering fear of this pervasive product of modern technology.

We live in a technological age. New machines come our way often, and we pride

\(^1\)The road, which is associated with the Anglo-Saxon word "ride", suggests passage of people and goods from one destination to another. The street, on the other hand, is defined as an area, usually surfaced in some way, that is set aside for public access and use, and need not lead to a noteworthy destination [J. Rykwert "The Street: The Use of Its History"]. The term "road" or "highway" will be used here primarily to refer to their urban incarnations, which are quite recent.
ourselves on our ability to learn how to use them. The telephone, the computer, the television, the fax: all seem to slip, with greater or lesser ease, into our daily lives. But the technical facility alone is thin. We learn how to use new machines, that is, what they do, which buttons to push, where to put the paper, when to speak (after the beep). This should not be taken as evidence of their assimilation into the culture, however, which is a much longer process.

High-speed transport, first in the form of trains, later individualized with the automobile, has been in common use for hardly a century. The train was the biggest, fastest-moving thing that mankind had ever encountered, fostering a fear tempered only by the fact that it was confined to a narrow track. Though smaller, the automobile is more frightening still, because of its ability to range freely over human turf. The size of the car and its roadways, and the speed at which it travels, force upon us a conception of scale that is different from anything the environment has yet demanded of us.

The first step in any assimilation of new technology is to 'tame' it, to adapt it as closely as possible to our natural lifestyles and to our sense of scale. We have made little progress in this. Allowable car speeds are determined by a tradeoff between efficiency of transport and the probability of accidental death, often with little regard to the nature of the surroundings. Roadways, in turn, are sized for that speed, and for our inability (unlike the train) to confine the car to its own width. The technology is still the master.

But change is afoot. The car has gradually gotten smaller, safer, quieter, less polluting\(^2\), and generally more familiar. The exciting but uneasy romance with its speed and freedom is passing, leaving us more awake to the damage caused by our uncompromising accommodation to its demands. The time seems right to approach the difficult problems of a lasting relationship, one in which the two parties—cars and their roads, people and their

\(^2\)Recent legislation passed in states on both seaboards will require the manufacture of pollution-free automobiles by the next decade.
cities—are mutual partners. The contention of this thesis is that the form of this still new phenomenon, the urban highway, can be compatible with, and perhaps even supportive of, the urban forms with which it cohabits. The hope is that the future will find the contemporary urban road as integral to its environment as traditional roads and streets were in theirs.
**A personal note**

Having written a thesis once before, in biology, I have no illusions about the scholarly influence or permanence of the final document, but see it more as a disciplined journal of a personal exploration. It begins with a few pieces of personal history that led to my interest in the problems of the modern road.

I grew up in the suburbs of Los Angeles, undeniably the premier laboratory for observing the effects of automobiles on (sub)urban life. The first and perhaps most important influence was very local: the short suburban street that my playmates and I 'owned', only occasionally conceding its use to automobiles, to the accompaniment of our chant "Car, Car, C-A-R". In contrast to many reported observations of typical suburban life, I have vivid memories of life in the street and almost none of our perfectly comfortable backyard. This condition was completely inverted, however, when at the age of nine I moved to a house that was much more removed from the street (both horizontally and vertically), which in any case was hopelessly lost to the inexorable demands of traffic. Here, my memories of the backyard are much clearer than those of the street, and commensurately emptier of the social life that the street fostered. In retrospect, at least, this thesis may be an attempt to recreate some aspects of my earlier street life, though at the much larger scale of transportation that I was exposed to only as I grew older.

I spent much time on highways and freeways, not only on the usual daily travels but also on car and 'motor home' vacations and frequent hitchhiking excursions—a particularly intimate highway experience because of the commonly long waits for a ride. In addition, several long trips on freight trains may have nurtured some intimacy with that form of large-scale transportation.

Indeed, my first awareness of the possibilities of integrating transportation and habitation came on a train: the recently completed 'el' in Detroit, which passes through a convention hall where, during my trip, I was unexpectedly treated to a brief view of an antique car show. But apparently I have
had a more long-standing predilection for these concerns, in that many of my past studio projects have involved an exploration of road- (or rail-) building relationships: a train station designed as a retail street [1], an office building engulfing a street [2], and a meeting hall built as an extension of a small town Main Street [3]. The thesis project is a continuing, and now more conscious, exploration of issues that have been simmering for some time.

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2 The Road–Building Relationship
Forms of Estrangement

The isolation of roads from their environment is easiest to see—and easiest to justify—at the largest scales. Devoted exclusively to the engineering dictates of traffic speed and volume, the modern urban highway is incompatible with any form of habitation aside from the hermetically sealed life inside of a passing automobile [4]. Indeed, the justifications of wind tunnel tests notwithstanding, it is difficult not to see the capsular design of the automobile itself [5] as a strategy to separate its human contents from an inhospitable roadway, which is separated in
The car becomes a bubble inside of a tube.\textsuperscript{3} [6,7]

The singular form of urban highways has dual effects: one to isolate the highway from its environment, the other to isolate different parts of the environment from each other. Despite the Central Artery's elevated profile, for example, Boston residents perceive it as having amputated the North End from the remainder of the city.\textsuperscript{4} Continuity appears to be zero-sum: extreme continuity in one direction creates extreme discontinuity laterally.

The experience of traveling on these highways is as dissociative as the form itself. Residents of Boston and Los Angeles describe the freeways as not being "in" the rest of the city. They are uncertain of the freeways' whereabouts relative to the urban fabric, and they have a sense of disorientation when using them.\textsuperscript{5} Much like travel on an airplane, highway travel leaves one with a vague uncertainty of what lies between the place of departure and the destination.

Two principal aspects of the urban highway contribute to its antagonism. One is its size. Narrow-minded notions of engineering efficiency have created highways whose extreme, unbroken widths are inappropriate to urban settings. Such roads not only create their own inhospitable environments, but when elevated they destroy the ground beneath them by robbing it of light. Even six lanes joined side-by-side, a modestly-sized highway by modern standards, has this effect.

The other aspect is the road's structural isolation. Whether elevated or not, the highway represents a singular system which, with rare exception, develops no exchange with the urban systems around it. Even when a highway passes within an arm's reach of the adjacent buildings, its formal independence speaks clearly of its defiance of its

\textsuperscript{3}Train travel, on the other hand, paints a different image. Although the train takes the form of an insular tube, the narrow width of the track and the lack of any dividers, guard rails, or walls causes the 'road' to disappear altogether from the rider's experience. The train offers only one layer of separation to the automobile's two, which may help to explain the nearly universal appeal of trains over buses.

\textsuperscript{4}K. Lynch, \textit{The Image of the City}, pp. 56-66.

\textsuperscript{5}\textit{ibid.}
environment, and contributes to the sense of estrangement that we feel toward it. The Embarcadero Freeway in San Francisco [8] and the Central Artery Expressway in Boston are two examples. Both will soon pass into history, or, more precisely, into the ground. While once applauded for their structural prowess, they are now offered as examples of the absurdity of building elevated highways in cities. The problem, however, is not the medium but the way it is used. If these highways had been considered as a part of the city rather than merely a way through it, a very different form would result. So long as the metaphor for these roads is an artery, the mistakes of the past are destined to be repeated.6

Non-urban landscapes have also suffered from the highway designer's misuse of the artery concept. The parkway shown here, however, demonstrates that this need not be the case [9]. The division of the road into two manageable parts, and the absence of unnecessary curbs and dividers, have made it a comfortable feature of the landscape. There are several similar parkways on the east coast of the United States, which were built especially for leisure driving. When 'getting there' becomes as important as 'being there', the road is less likely to take on the form of an artery.

6It is foreboding that the land above Boston's soon-to-be-depressed expressway is officially dubbed the Central Artery Corridor—literally a tube flanked by walls!
Rural roads in many parts of the world are nothing more than packed, cleared paths through the landscape. This one in Mali is obviously in tune with its surroundings [10]. A similar road built there by a Western governmental agency [11], on the other hand, is designed such that it appears separated from the landscape, passing but not acknowledging an adjacent village. It has acquired an arterial form through the simple addition of stone curbs. The stones are well within the technical means of the Malians themselves, but are not used because they have no functional justification, for drainage or otherwise. They represent a qualitatively different perception of access.

Habraken has argued that, in Western cultures, accessways are seen as discrete, abstract forms that provide an independent framework for the territories they serve. The most obvious example is the grid, which has the form of a Cartesian coordinate system regardless of the nature of its surroundings. Like any pure geometric form, it is an abstraction that requires no reference to any other form. In the Middle Eastern town, by contrast, accessways are derived from the form of the neighboring territories. In the creation of a new village or a new area of a town, private domains are established first, gradually expanding to build the paths that eventually lie between them. The final form of the access is perceived not as an abstract figure but rather

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7 N.J. Habraken *The Appearance of the Form*, pp. 32-34.
The Road-Building Relationship

as the embodiment of a host of complex physical and social relationships. Access built in this way cannot exist independently of its surroundings, for it is entirely determined by them. The paths in the Dogon villages of Mali appear to be similar [12], suggesting that this type of organization is not limited to the Middle East.

In the Western tradition, the territorial primacy of the road is so strong that it may be established long after—and sometimes at the expense of—the areas it serves. A prominent example are the road-construction works of Baron Haussmann in Paris, carried out with the blessings of Napoleon III. Under the guise of slum clearance, large swathes of housing were razed to make way for wide boulevards, the freeways of the 19th century [13]. In Haussmann's words, "The first job was to drive streets through the city from one side to the other, by tearing open the central districts..."8 Though urban renewal was the purported justification, the primary motive was to allow rapid military deployment against civil insurrection. In short, the roads were an expression of political control. Similar, though less dictatorial, conditions made possible the urban renewal schemes of Robert Moses and others in New York, Boston, and elsewhere, with the boulevards elevated as expressways.9

8Haussmann Mémoires vol. II, p. 33.
9The construction of roads as a manifest act of political power dates back to the Romans and before. In the 7th century B.C., an Assyrian king built a paved, 90-foot-wide processional way, lined with pillars. Anyone building so much as an overhanging balcony was liable
While these examples represent relatively extreme acts of political will, they point out a critical fact nonetheless: nearly all roads are owned by public bodies. Transit authorities, departments of transportation and public works, from the local level to the national, are the keepers of the roads, including some varying amount of right of way to either side of them and, extending vertically, all air and underground rights as well. The separation of roads is thereby institutionalized through the embodiment of their control in a separate agency with full ownership rights.  

While it is difficult to imagine highway ownership by any but a public agency, it must be recognized that such ownership is the principal cause of the highway's isolation. The issue this raises is fundamental: how do we reconcile public ownership with the possibility for private use? It is probably fair to say that the largest hurdles to overcome have more to do with legal, administrative, and bureaucratic constraints than with design. On the other hand, one can hope that the presentation of viable proposals will serve as a catalyst for change.

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10In some cases, external pressures help to diffuse institutional rights and the public/private boundaries they create. For example, public transit stations are often filled with retail businesses, such as the Bloomingdale's department store that extends underground into the New York subway. The pressures of high density occupation can have similar effects: the sidewalks of Manhattan often overlie the basements of adjacent retail and residential establishments, which pay a tax in proportion to the square footage of the incursion.
Forms of Reconciliation

There is a long history of proposals to integrate major roads with buildings and the larger urban fabric. I have divided them into two categories, according to the form that they take: (1) those in which the built environment takes on the form of the road, and (2) those in which the road and buildings are interwoven but remain formally independent.

The first category has its origins in the Linear City movement, which began in Madrid in the early 1880s with the writings and designs of Arturo Soria y Mata [14]. His utopian Ciudad Lineal "would be a single street of 500 meter's width and of such a length that may be necessary—such will be the city of the future, whose extremities could be Cadiz and St. Petersburg, or Peking and Brussels."[11] This immense belt was to include all of the public buildings and services necessary for the residents flanking it. The intended form of transportation was a horse-drawn tram.

Soria’s ideas were taken up and elaborated by the American Edgar Chambless, who in 1910 offered his proposal for a single line of concrete houses, continuously attached and transcontinental if need be, lying above three levels of monorail and below a pedestrian promenade [15]. Cultivated land flanked both...
sides. In the 1940s, with a less agrarian intent, Le Corbusier proposed his well-known Cité Lineaire Industrielle for the city of Algiers. Here a motorway lies atop several elongated floors of user-designed housing units, winding sinuously from the countryside through a megastructural cityscape [16,17].

Up until rather recently, a remarkable number of related schemes have been proposed by a variety of architectural luminaries, including Tange's proposal for Boston Harbor (1959) [18], Eisenman's and Graves's for the Northeast Corridor (1965) [19], Rudolph's for Lower Manhattan (1970) [20], and Geoffrey Jellicoe's 2-dimensional gridded
variation, called Motopia [21]. One linear scheme has actually been built: a freeway atop three stories of shops and restaurants which curves through the heart of Tokyo [22].

An underlying motivation for some of these proposals, Eisenman's and Rudolph's among them, is the construction of a built environment intentionally separated from a surrounding landscape that is considered to be inhospitable or unseemly. The independence of the linear form can thus act in reverse, attempting to create a habitable environment amidst a (perceived) inhabitable one. Either way, the power of the linear form as a separator is clear.

All of these proposals have in common that the buildings take their form from the road, suggesting, perhaps, that domestic life is meant to be similar to travel on a highway. It is difficult to imagine more vivid examples of technology—in this case the technology of speed—as masters of its creators; or a more vivid manifestation of the territorial primacy of the Western road.

The second category of past proposals is less radical: roads and buildings each maintain their respective forms. The strategy for integrating the two is to design roads that penetrate buildings or, conversely, buildings
that surround roads. The precedents for this approach date back to the Renaissance, from da Vinci's provocative sketches of tunnels under buildings [23] to the inhabited bridges then common in cities. Although the linear constraints of these bridges sometimes confined the buildings to the same form, as with the Ponte Vecchio [24], in the majority of examples the buildings make remarkably little formal accommodation to their unusual 'hosts', appearing much as they would in a more traditional, landed setting [25].

The advent of rail transit in the 19th century brought a second wave of proposals to incorporate transportation into buildings. The Crystal Way in London, for example [26], was to be a pedestrian arcade built over underground transit, which carried its own arcade below. A plethora of ever more elaborate proposals continued to follow in the wake of industrial expansion, some largely fanciful [27,28], but others more serious. Le
The Road-Building Relationship

Corbusier’s Contemporary City for Three Million Inhabitants (1922), which incorporated mega-highways into mega-buildings [29], served as an aspiration for many of the urban renewal schemes that followed World War II.

But it is only at much smaller scales (thankfully) that we find these concepts realized. Grand Central Terminal in New York

is an extraordinary example of the integration of auto, rail, and pedestrian accessways with public and commercial building functions. Yet its Beaux Arts facade successfully hides the fact, expressing the public hall but none of the transportation functions that make it possible. The form of the building remains steadfastly independent of the access that serves it, so the section comes as a complete surprise [30].

More often than not, the intertwining of roads and buildings comes about incrementally rather than as part of a larger design. The FDR Drive in Manhattan, originally alone in its route along the edge of the East River, is gradually being engulfed with overlying parks, esplanades, university
buildings, and apartment houses, greatly enriching the experience of the road. But the enrichment is unintended, and we can expect it to abate as the road becomes more completely encased. Despite the proximity and opportunities for exchange, the roads and buildings are ultimately considered to be mutually disconnected. In this and many other examples of its type, the formal independence of the road and buildings works against the possibilities for their integration.

I have discussed two basic forms of road-building integration. In the first, the road dominates to such an extent that the buildings take on its linear form. In the other, roads and buildings maintain their separate formal identities, remaining largely independent in use. The design experiment that follows is intended to explore a third approach which lies between these two. It tests the possibility of designing roads and buildings that are distinguishable in form but mutually dependent by virtue of a common structural system. The road suggests building, the building suggests road, their integration enhanced by the possibilities for reciprocal transformation.
EXPLORING A NEW RELATIONSHIP

We must reorder our thinking and realize that highways should include in their design and construction the parks, offices, and shops required for urban development.

Lawrence Halprin
Freeways
The Design Experiment

In 1985, the Metropolitan District Commission announced that the Harvard Bridge, on which Massachusetts Avenue crosses the Charles River, would undergo complete reconstruction. Furthermore, I will imagine, they proposed an unusual collaboration for the project. The MDC would join with MIT to build a new bridge as a site for a mix of university housing, cafés, and public facilities. In a spirit of experimentation, they selected as architect an MIT thesis student eager to explore new ways to integrate roads and buildings.

The project has several advantages in this regard. (1) Because a bridge is the most structural form of road, it offers greater opportunities to explore the use of a structural system as a medium for integrating the road with buildings. (2) An elevated road offers possibilities for exploring road–building relationships in section. (3) Although the road is of manageable width (4 lanes), it takes the form of a highway as it crosses the river, a form whose integration I am especially interested in pursuing. (4) The required spans are short and therefore free of the engineering constraints associated with a long-span bridge. (5) Because the road lies over water, it maintains a degree of independence from its context, facilitating a focus on road–building integration. (6) The bridge is an accessway for pedestrians as much as for wheeled traffic.
The Process

The design process included the following stages.

- I designed a primary structural system with the potential to be used for both road and buildings. Secondary and tertiary systems were then incorporated, with the inhabitation of the primary structure in mind.
- I explored a set of access systems, at several scales, which were consistent with the structural system. These included access for automobiles, pedestrians, public spaces and dwellings, and considered issues of public and private domains.
- I explored a set of building forms that were compatible with both the structural systems and access systems.

These sets were used as a palette from which a projection was developed. I concentrated in particular on the development of a student residential hall associated with the bridge. Although the stages occurred roughly in the order above, there was much backtracking as well. For example, because a structural system was begun before I had an understanding of the possible access systems or building forms, its design required frequent modification.
The Results

Structural systems
A single primary structural system was used for the road and the associated buildings, with the idea of ensuring a degree of formal integration between them. The system comprises a series of concrete Vierendeel trusses, which are not strictly trusses but rather spanning frames. Thus, they have the potential to act both as a spanning system and as a more typical building frame. For the longest river spans, the Vierendeel was transformed to a 'bow string' truss simply by curving the top chord, which introduces the more efficient spanning properties characteristic of an arch.

To create the basic structural 'subunit', two trusses were joined in parallel (doubled), with varying distances between them depending on their use. The length of the road was built up through the addition of several of these Vierendeel 'subunits', each of which is both territorial and autonomously stable. Unlike the continuous extrusion characteristic of elevated roads, the bridge is composed of a string of these discrete parts. Each has the potential to generate habitation either by displacement from the road or by further doubling, in plan or section.

The use of doubling to generate territory with a range of dimensions was central to the design of the structural system and, in fact, the entire project. The trusses comprise a doubled chord stabilized by (optionally) doubled vertical members. Columns are doubled to generate a usable territory reaching to the ground (which will be used for access). The truss is doubled horizontally to generate the stable subunit that can accommodate both roads and habitable territories. The subunit is in turn doubled in plan and section to generate still larger dimensions, some for public use. The bow string trusses are paired lengthwise to generate the longer river span, and paired laterally to generate the shorter river span. Finally, the entire bridge is doubled by reflection in the water.

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12 This and several other premises of the design will be presented without comment here, but will be critically assessed in the next section.
The secondary system consists of concrete double-Ts which act as beams and horizontal surfaces, primarily at the level of the truss chords. The tertiary system is composed of concrete channels which act as floors and, turned upside down and tilted, as roofs. The channels are propped and hung on columns that pass between double-Ts, which separate to accept them. The column is thus associated with light, as are the larger territorial columns that support the trusses.

Additional systems
Where columns meet water, there is an intermediary system of piers on concrete piles. (A similar system is used for the existing bridge, except that the piles are hidden and are made of wood.) Landfill is used to create an island and to add to the existing shore.
Site Issues
The larger site outside the confines of the bridge was not developed in detail, but several design decisions were made that should be noted.

At this location, the Charles River is unusually wide for an urban waterway. The Thames in London, the Seine in Paris, the Danube in Vienna, the Vltava in Prague, all are sufficiently narrow to allow the two sides to be distinct parts of a larger whole. The sense of segregation between Boston and Cambridge is surely a consequence, at least in part, of the Charles's much greater width. To help bridge Boston and Cambridge by more than slivers of pavement, an island was introduced between them. Its form follows the flow of the river, and allows an easy connection to the Charles River Esplanade on the Boston side. The Esplanade currently dissolves into a foot path before it reaches the Harvard Bridge, preventing any sense of its continuation across the river. The island would serve to extend the full dimension of the Esplanade and to help establish a sense of continuity with Cambridge.\textsuperscript{13} In keeping with this intent, landfill was added to the Cambridge shore in order to widen the currently minimal zone between Memorial Drive and the river. This would provide sufficient dimension for the

\textsuperscript{13}Proposals for an island in this part of the Charles have been presented several times in the past [31], beginning as early as 1875 [A. Krieger "Past Futures"].
Cambridge side of a more continuous Esplanade.

Finally, Memorial Drive would be dropped below grade before Killian Court (when traveling west) rather than after, as it is now configured. This would allow the Court—and by inference all of MIT—to pass over Memorial Drive and to be directly connected with the river. This decision is consistent with the inhabitation of the bridge as an extension of MIT.

The roadway

The presence of the off-centered island creates three sections to the bridge: two different spans and the crossing of the island between them. The long span, on the Cambridge side, is traversed with tandem bow string trusses at a height of 40 feet, which is sufficient to allow the passage of small sailboats. As the roadway nears the island, its scale is attenuated by bringing the two outside lanes down into the Vierendeel trusses, and leaving the inside lanes above the structure. By bringing the outside lanes into the territory defined by the structure, this move also reinforces the natural differentiation between inside lanes carrying faster-moving, through traffic, and outside lanes carrying slower, more 'local' traffic. These are the lanes that will directly engage the inhabited sections of the bridge and, by descent on adjacent ramps, the island as well. Moreover, the pedestrian walkways and lookouts on either side of the bridge are associated with only these single lanes of traffic. In effect, the local lanes have taken on
some of the quality of streets (as defined in the first chapter), where a variety of public uses is as important as their destination. The through traffic remains up and open, more like that of a typical elevated expressway or a highway outside of the city. 

As the road leaves the island, the through lanes descend to join the other two. Cambridge-bound and Boston-bound traffic is split onto two side-by-side bridges, each of which is not only shorter but also lower and narrower than the main span. This reinforces the difference between the long and short spans, and accentuates the connection of the island to Boston. 

The public access of the bridge, whether by car or by foot, is intended to offer a variety of experiences through changes in the relationships to the structure, the ground, the water and the buildings. Plan and sectional moves, and the structure itself, help to reinforce differences in use and to domesticate the scale of the road.

Building form
The bridge has two zones of inhabitation, each intensifying an edge between the river and the island. Only the building on the edge toward Cambridge was developed in detail. 

Under the influence of the direction of the road, the building takes the form of parallel piers that extend over the river. As the distance from the road increases and its influence wanes, the piers shorten and the building takes on the direction of the river.

In general, piers perpendicular to a shore have the opportunity to generate more exchange with the water than do piers parallel. But it is uncommon for a narrow body of water such as this to have perpendicular piers, because they would impede water traffic and flow. The 'building-piers' used here, though, are raised up, allowing an exchange with the river without impeding its use. On the other hand, the low piers that support the columns of the building are oriented parallel to the river, much like the piers typically found elsewhere on the river.
Systems of building access
Zones of public and private use
Secondary access perpendicular to the bridge is initiated by the lateral displacement of one of the trusses (see diagram [34]). This generates a dimension that acts as a transitional zone between the roadway and the building. The zone includes an additional lane for cars, a fast-food establishment, and entrances to two restaurants and the dormitory itself. The 'canopy' for the dormitory entrance is an overhead ramp which provides access to rooftop parking. Movement into the building is thus suggested by the sense of motion inherent in the form of the ramp. The entry itself is a relatively narrow, single-height space, but the access gradually expands both in plan and section until reaching a large common area that opens to the river between the building-piers. This area serves as the collective dining space for the dormitory. The restaurants' terraces also open to this space between the piers, making it a large outdoor 'dining room' shared by the public and students alike. In this way, some of the public quality of the street is brought into the building, without sacrificing the security of the dormitory.

Beyond the common area, the secondary access (the 'spine' of the building) constricts before opening again to two levels of dormitory rooms for single and double occupancy. Dormitory suites for three to five occupants are located in the 'piers'. Thus, the dorm rooms, which have no collective space within, are associated with the common areas that are part of the secondary access, while the suites are situated on the more private, tertiary access of the perpendicular piers.

In section, the tertiary access in the building-piers is organized in relation to a reference level at the same floor as the entry. A single gallery access serves two-story units on and above the reference level (common areas downstairs, bedrooms up), and one-story units below. This organization is a modified version
area in which children could play freely. It is an elevated cul-de-sac that reiterates, in a more private fashion, the activity of the street below.

Vertical access between the two reference levels (and to parking) is by elevators located within one of the truss's 'territorial' columns near the building entrance.

The access systems are intended to constitute an extended series of public-to-private transitions. By moving from primary to secondary to tertiary access in plan, and up and down from reference levels in section, one goes from the public realm of the street to the private bedrooms of the dwellings.

of that used by Le Corbusier for the Unité d'Habitation.

The same basic organization of the secondary and tertiary access is repeated in the inhabitation of the upper set of trusses, with one exception. Above the roadway is an open street that accesses 2-story married student apartments on either side of it. The raised street is intended as a secluded but communal
Exploring a New Relationship
An Assessment of the Experiment

The following discussion is meant to be a self-reflective appraisal of the design, presented with the hope of learning from the experiment and discovering new avenues for its continuation. Their beginnings are pursued in the final chapter.

The structural and organizational diagrams

Fundamental to the design experiment was the decision to use a single structural system for both the road and buildings. At least for smaller scales, this approach has some precedents. The most common is the arcaded street, in which columns descend from overhanging buildings and 'build' the territory of the street below [32]. Another example, unusual but clear, are the domes that enclose street and buildings in the Iranian town of Isfahan [33]. In the Dogon villages of Mali, the paths are built by the stone walls, granaries, and houses that build the adjacent compounds [12], a typical structural condition in places where access is defined by the surrounding territories.

Diagrammatically, a single, directional structural system could be arranged in two ways: parallel [34] or perpendicular [35] to the road. My earliest sketch model used primarily the perpendicular alternative [36]. The idea
here was to build the road incrementally from parts that each had the potential to be extended laterally for inhabitation, in this way eliminating the possibility of generating a typical extruded roadway. The principal problem of the approach is the contradiction inherent in not using the long dimension of the structural system to build the spans of the road. It takes a lot of logs to bridge a river if they are oriented in the direction of its flow.

But the alternative approach I have used has its own problems. Chief among them is the 'linear city' phenomenon discussed earlier, in which the inhabitation takes on the form of the road. The directional dominance of the structural system has led me into this trap, although less deeply than any of the linear planning schemes. A related problem created by the strong directionality is the inherent difficulty of moving off of it. The displacement of the trusses is intended to develop a zone of road-building exchange and to encourage lateral movement, but one must swim away from a strong structural "stream" in order to participate. The road still wins.

The concentration on a single primary structural system created other problems. The buildings became long-span in the same way as the road, which had the advantage of leaving the river and island open for public use, but the disadvantage of developing little exchange with the ground.
The obvious alternative to using one primary system is to use two. I avoided this alternative for fear of creating what appears in [37], which is a diagram of the usual highway built as a singular system isolated from those around it. In retrospect, however, a two-system approach, with opportunities for mutual exchange, would have been a better alternative [38]. A second primary system lateral to the first would formally suggest stopping and moving off the road into buildings of relatively more private use, helping to locally diminish the linearity of the road. The use of a second system is pursued in the final chapter.

Inhabitation of megastructure
A project involving the inhabitation of large scale structure invariably revisits issues that were raised during megastructure's heyday in the 1960s. Megastructure was then being built for its own sake, because it was technically possible, and because it coincided with then-popular notions of large scale urban renewal projects. It offered an opportunity to build above the blight of the collapsing inner city.14

In this project, on the other hand, the megastructure is first of all building a necessary component of the urban fabric—a bridge—which is then being exploited for its potential for inhabitation. (A similar conceptual approach was taken by Paolo Soleri in his drawing of the inhabitation of a dam [39].) The motivation is opportunistic, not grandiose.

14 Reyner Banham  *Megastructure: Urban Futures of the Recent Past.*
The program
The choice of a residential hall was dictated in part by a desire to use some of the thesis time to design a form of collective housing, which I hope to do in my professional future. But despite the proximity to housing on both ends of the bridge, it was not the most appropriate to the site. A more public program would have generated more opportunities for developing a richer exchange with the road.

The influence of the design process
The early concentration on the structural system, to the exclusion of issues relating to its use, contributed to the projection of a building dominated by its primary structure. While it is difficult to pursue variant structural systems, public and private uses, access systems, and building forms all at the earliest stage of a project, in the end such an approach may have led to a more balanced design.
4 THE NEXT STEP

The urban motorway design must be such that a new solution to adjacent building is implicit.

Alison and Peter Smithson
The Team 10 Primer
This chapter puts forth a proposal for a simple approach to help make urban highways more a part of their environment. As was discussed in the opening chapter, the successful integration of roads into cities hinges to a large degree on the integration of private uses into a publicly-owned domain. This can be seen as a particular example of more general issues relating to the inhabitation, by individuals, of any kind of large scale support structure, whether it be apartment dwellers in a housing project or shopkeepers in a retail center. The social basis and design of support systems for housing have been discussed in some detail by Habraken, and many of the ideas can be applied to the inhabitation of roads. The essential position here is that a highway can act as a public support system for inhabitation.


The architectural problem that this engenders is the design of the larger structure in such a way that it supports the full range of uses by its potential inhabitants. Unlike a housing support system, which is dedicated to dwelling, a highway support must serve two constituents: the public road and the adjacent private uses. The design experiment outlined in the previous chapter suggests that it cannot do so with a single primary structural system, but requires at least two: one more adapted to the road, the other more adapted to building. How are these systems to be integrated in such a way that "a solution to adjacent building is implicit"?

The support system of the road, I argue, must contain within it the seeds of a second system that can be extended laterally or vertically for inhabitation. This is best illustrated with a simple example. The photograph opposite shows a set of trusses, which represent an elevated road system, supported by columns designed specifically to be extended laterally and vertically into a basic frame system that can support habitable building. A second example [support system A]
shows an elevated highway supported by concrete piers, with a typical large spacing between them. One section of the road is intensified by reducing the spacing of the columns, and infilling and extending them laterally to generate party walls for shops along a retail street, below and next to the roadway. The inhabitation coincides with structural intensification.

This example bears some resemblance to the Viaduct Place de la Bastille in Paris, where the arches have become the support system for inhabitation by shops [40]. An important difference is that, not being designed for such an eventuality, the viaduct offers no second system to extend beyond its own width. The shops remain limited to the territory of the viaduct's arches, much like the linear
planning schemes discussed earlier. The intent of the system suggested here is to encourage the building of lateral projections that go beyond the road, locally attenuating its linearity.

Support system B is a further elaboration of a support that uses a lateral frame system for inhabitation. Here again the columns are locally intensified, in this case (as in the Harvard Bridge project) over an island. The island is used merely to represent a site with the potential for inhabitation; the water a region without such potential. The increased density of the columns not only offers multiplied supports for lateral use, but also allows the web of the truss to be eliminated so that movement off the road is easy at the region of intensification. A conventional, rather than Vierendeel, truss is used here specifically because it puts greater limits on lateral movement (while being structurally more efficient). The road system is then seen more clearly as an alternation between a linear zone limited to a roadway and a laterally-extendable zone of potential inhabitation.

The inhabitation takes the form of a hotel and a convention center, which includes an exhibition hall and a large auditorium. The building system is an extension of the highway's supports: the column system for short-span requirements and the truss system for the large-span roof of the auditorium. Thus, while it uses systems derived from the road, the inhabitation is sufficiently independent to moderate the road's linearity. As one moves along the highway, the dominant systems alternate between road and building.

This projection also addresses two of the objections, raised in the last chapter, to the design of the dormitory: that its program was not sufficiently public for the nature of the site and that it developed little exchange with the ground. A convention center serves not only specialized business uses, but also public gatherings of many kinds.

Conclusion

These proposals for a road–building support system are preliminary; their development
requires a thesis of its own. As Habraken has outlined in some detail, one would need to begin with a zonal and sector analysis of the road and the territories along it before developing a compatible system to support them. This process would be considerably more complex than was Habraken's formulation for housing, since the range of possible uses along a highway is very large. The design of a support system would need to reflect this greater measure of potential diversity.

The implications for our cities, and for our attitudes toward urban highways, are manifold. The local response to a proposed freeway might be very different if its public builders offered the nucleus of a support system for (as well as access to) a new shopping center, for example. The attitude toward the Central Artery might now be very different if its builders had offered a support system to extend Haymarket into the North End.

The support system not only offers an architectural solution, but also a framework for collaboration between public and private interests. As a means to stimulate development, public agencies could offer a road with local potential for inhabitation. Conversely, private interests might be motivated to provide financial assistance for construction of road sections that offer such support. It may be pertinent that several developers have recently presented proposals to build privately-funded highways.

Only a small segment of a highway would need to develop such an exchange in order to alter the perception of its alienation from the urban fabric. An occasional offer of generosity is enough to bring one into the fold.

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16 Habraken et al. *op. cit.*
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