STUDIES FOR AN INTEGRATED INTERCHANGE
OF VARIOUS CHANNELS OF MOVEMENT

by

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B. Arch., University of Minnesota, 1964

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY
June, 1966

Signature of Author

Certified by

Accepted by

Thesis Supervisor

Chairman, Departmental Committee on
Graduate Studies
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I. Thesis Statement
Studies for an Integrated Interchange of Various Channels of Movement

The studies were developed within the urban transportation problem for this year's Master's Thesis. They are concerned specifically to investigate the role of the expressway in urban settings and hope to find solutions to some of the problems in making it an integrated part of the urban fabric.

The studies specifically utilize Boston and the Inner Belt as an example, though there is ample evidence that this is no unique problem in Boston only. Chicago, Philadelphia, San Francisco, and many other cities have felt the disruptive force of the expressway. As yet there is little indication of a systematic way to deal with the problem or how to study it.

A number of problems may be pointed out that make the present day urban expressway such an obstacle to its environment. Though the expressway, rural or urban, must be designed for movement, it is just as important, if not more so, to consider its effect on the next larger and smaller context of its environment. It is generally found that here the expressway with its large scale of construction finds few similar elements of scale in urban situations. It also seems that if similar elements are available in terms of distinct parts of cities, specific neighborhoods, large geographic features, the expressway usually manages to negate all these opportunities and finds its own disruptive way. One could easily conclude that the expressway is an
unmanageable scale in the urban fabric and should be allowed only in open country, where it may exist with open space around it. There is little evidence that we have this choice and the only thing remains, namely to find processes and means by which expressways can be integrated into the urban fabric.

Presently decisions in the development process of urban expressways are primarily based on traffic studies, financing, legal and political problems. Though these considerations are necessary they do not consider the urban situation as a whole, but rather solve specific departmentalized problems in the best way possible under the situation. To arrive at a solution which considers the expressway as an integral part of the urban fabric it will become necessary to evolve a much more complex and coordinated effort of a greater number of professions whose concern is the working of our cities.

The urban designer's contribution to this effort can be to recognize forces and events that exist in urban activity of today which hold meaning for the future and to shape and organize them in three-dimensional spaces.

This thesis proposes: That points of access of various channels of movement may be integrated with one another, to provide an optimum amount of interchange among the various channels of movement.

2. That this accessibility may be utilized to encourage transfer of mode of movement by providing large parking facilities related to it and therefore act as a control point in limiting traffic in urban core areas.
3. That this accessibility may also act as an activity generator for the interchange by encouraging development of high density housing, commercial and office facilities, in connection with the interchange.

4. That new methods of implementation must be found to realize such a complex undertaking.

The objectives are:

1) That the scale of the expressway interchange is to be solved in the context of all other scales.

2) That vehicular parking be connected to the expressway.

3) That visual orientation between all movement channels should be maintained.

4) That the interchange be adaptable to construction financing and operation in a variety of ways to allow a number of ways for its implementation.

The data utilized here were taken from the 1965-75 General Plan for Boston and the Regional Core prepared by the Boston Redevelopment Authority. Data for the Inner Belt and specifically the Cambridge, Central Square site were obtained from the Cambridge City Planning Board.

The Cambridge, Central Square site was chosen as a general type so that parts of this study could be utilized, since this section of the expressway is still in the preliminary stages. The site also contains all major movement channels to make such an integrated proposal possible. Thirdly it has a large commercial development
for which this mode may generate new activity in combination with high density housing and office and commercial facilities.

In development of these studies which are explained and illustrated in the subsequent sections, a number of observations were made. An initial consideration of the channels of movement, especially the Inner Belt, did not reveal a clear approach to arrive at some solution to the problem. The subsequent analysis of channels of movement per se made clear the potential that existed in developing the access point of a movement channel. The specific organization of the Cambridge, Central Square site helped to establish the components for the various movement channels but also presented added problems of an existing pattern of development (strip commercial) into which the interchange would have to fit. It presented also an existing street pattern that would require reorganization on a large scale and other limitations, physical and legal, that would not be helpful at this stage. This led to the decision of making the proposal general in character to be able to find how it might be realized and to look at some of the difficulties without too many other problems imposed on it.
II. Analysis of Regional and Boston Areas
VEHICLES AND PERSONS ENTERING THE CORE AREA/24-HOUR PERIOD/AVERAGE WEEK DAY

<table>
<thead>
<tr>
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<th>1963 Subtotal</th>
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<th>1975 Subtotal</th>
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<td>the Core</td>
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<tr>
<td>By Public Transportation</td>
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<td>4.38</td>
<td>6.13</td>
<td>4.38</td>
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* long-haul, non-commuter traffic
** 7:30/9:30 a.m.
Rapid Transit

Regional Area

This map shows the planned extension of rapid transit services up to Route 128 making it a possible choice for location of interchanges, as the urban fabric expands in the years to come.
Plan for Rapid Transit
Regional Area

Transit complete
Transit proposed
Rapid Transit Boston Area

The extensive network of transit lines are shown to exist already up to the Inner Belt and provide the link for a potential transportation system within the core area. In view of developing interchanges with other modes of travel, some of the rapid transit stations may require relocation or replanning to make such interchangeability possible. It might also mean the replanning of places of access to and from the urban road system.
Plan for Rapid Transit
Boston Area

Transit complete
Transit proposed
Transit to be removed
Expressways for the Regional Area

The general pattern of expressways shown on this map indicates the circumferential layout of both Route 128 and the Inner Belt in relation to the Boston central area. Both roads are intended to control the traffic movement around the core, rather than through it. These major movement channels might be further utilized if they provided along their routes points of interchange allowing connections to other modes of travel, which would be more adaptable to the core area. Presently this applies more to the Inner Belt than Route 128, but with the increasing development of the area and the extension of bus and transit systems, Route 128 also may be utilized for points of interchange.
Expressways - Completed or Proposed
Regional Area
Expressway and Major Streets
Boston Area

The Inner Belt Expressway is shown on this map in its relationship to the major road network of Boston. The map clearly shows the circumferential nature of the Inner Belt and its advantageous location to facilitate interchange with major urban streets.
Parking Facilities and Roads

The road map system and parking facilities map shows the distribution of present and projected parking facilities.

The requirements for parking, generally off street, for the Boston core by 1975 will be 180,000 cars over a 24 hour period. 68,000 parking spaces should be available at a turnover of 2.7 cars per 24 hours. Long term parking requires about 40,000 spaces at a turnover of 1.5 cars per 24 hours. Short-term parking requires ca. 28,000 spaces at 4.4 cars per 24 hours.

Total existing supply of parking spaces of all kinds is 56,500 spaces of which 31,800 spaces constitute curb parking, illegal on street parking, and obsolete off street facilities which will be eliminated. This leaves 24,700 spaces available; to reach the projected total of 68,000 spaces, 31,300 spaces will have to be constructed before 1975.

The turnover ratio of 2.7 cars per 24 hours reflects the anticipation of increased transit use, compared with a turnover ratio of 2.5 cars per 24 hours in 1965.

It is projected that off street parking facilities will be constructed ranging from 500-5500 cars per facility. They should be located near major expressways and arterials at the edge of the core and off collector streets near major centers of activity. Short term parking should be concentrated near commercial centers.
Roadway System with Parking Facilities
Boston Area

Existing parking
Proposed parking
Expressway
Major street
Minor collectors
Functional Areas

Boston Area

The map of functional areas is made up of information from studies by the Boston Redevelopment Authority and a separate study by the Cambridge Planning Board. It indicates the variety of functional area that may be found along the expressway routes.
Functional Areas
Boston Area

Residential
Commercial
Public-Institutional
Industrial
Open Space
Potential Sites for Interchanges

Boston Area

This map shows the transit system superimposed over the expressway and major road system. The potential sites for interchanges are chosen to utilize the availability of major components of movement, rapid transit, expressway and major urban street. Depending on land use patterns, physical characteristics, etc., at each particular site a specific type of interchange may be developed. Presently only the proposal for South Station attempts such integration.
Potential Sites for Interchanges
Boston Area

Expressway
Transit
Major street
Transit access
Potential sites
III. Analysis of Channels of Movement
In order to get a better understanding of movement channels it was thought to be useful to look at them per se and distinguish some of their properties.

For purposes of this study they are to be considered from two distinct aspects.

The first aspect considers channels of movement as distributors. By this is meant that they distribute movement from place to place. They are linear by the nature of movement in comparison to the second aspect of movement channels, points of access.

The problems with distributors exist mainly along their borders where they establish contact with surrounding environment. Generally their particular flow presents a barrier to be crossed only at a different grade level than that of the movement channel itself. This allows uninterrupted and smoother functioning of flow. It becomes especially important as the speed of movement increases.

The second aspect that may be observed about channels of movement are their points of access. They present the greater problem in urban design but also are the only places along a movement channel where events take place that may be integrated with other events occurring in the environment. There movement is diverted or absorbed by other channels of movement or comes to a stop altogether.

If a number of these points of access could be organized in three dimensions and their events coordinated with other events then each channel of movement could become integral with other channels of
movement. This point of interchange, made up of a number of points of access, becomes an activity generator for the environment around it and can be utilized for a number of advantages, depending on the particular functional use of the environment around it.
IV. Analysis of Cambridge, Central Square Site
The partial map of the city of Cambridge shows the general layout of streets in relation to Massachusetts Avenue. Also shown is the proposed route for the Inner Belt as developed by the Department of Public Works. Massachusetts Avenue at this point is a development of strip commercial facilities on both sides of the street. This development extends generally from Central Square to the Main Street intersection. The commercial facilities are generally one block deep with multi-family housing behind it. There also is some light industry in the area, generally towards the south.

Presently the Central Square subway station is located near Central Square. The subway channel is located almost directly beneath the surface of Massachusetts Avenue and generally follows its right of way, branching off under Main Street to Kenmore Square.

The second map in this section shows at larger scale the proposed intersection, as developed by the Department of Public Works. It is entirely located within a residential neighborhood and at first hand seems to take up a rather small area. Upon closer investigation it becomes evident that a number of residential streets are used for its functioning, making its physical dimension considerably larger. It may also be noticed here that all vehicular movement must be absorbed by the local street system, which even at present seems to be very insufficient. Generally it is scaled to local residential use. The desirability of the neighborhood in terms of housing will greatly decrease, and it may be stated that no apparent attempt is made to achieve any kind of integration into the urban fabric. Other than movement of traffic
the Inner Belt brings with it no other advantages at the present.

During the study of the Cambridge, Central Square site it became evident that not all aspects of the site could be solved within the framework of this thesis. For example, the physical dimensioning of the existing city block pattern with its streets would present limitations that would greatly influence any solution. There would be legal and political problems that would present difficulties. The site itself has geographical problems that could be hard to solve and would not help to establish a clear solution to the problem of integration of the movement channels.

It was therefore decided to utilize the major aspects of the site as a component system and develop the interchange as a general type. The disadvantage would be that the proposal would be diagrammatic in character, but possibly the problems of scale and functional relationships of the various elements could be more clearly studied. This led to the proposal which is explained in the following section.
V. Description of Proposal
The following components were chosen for development of the general proposal to integrate various channels of movement.

1. **Urban expressway** (Inner Belt) carrying four lanes of traffic, plus one service or emergency lane in each direction.
   - Width of movement channel: 130 feet
   - Height of movement channel: 15-16 feet

2. **Rapid transit** (subway line)
   - One track in each direction
   - Width of movement channel: 20-25 feet
   - Height of movement channel: 15 feet

3. **Minor arterial street** (Massachusetts Avenue) carrying two lanes with one parking or emergency lane in each direction.
   - Width of movement channel: 60 feet
   - Height of movement channel: 15-16 feet

4. **Collector streets** (minor side streets) carrying one and one-half to two lanes in each direction.
   - Width of movement channel: 25-30 feet
   - Height of movement channel: 15-16 feet

5. **Pedestrian routes** (sidewalks)
   - Width of movement channel: varies
   - Height of movement channel: 8 feet

6. **Capsule car** (as proposed by the transportation study)
6. Capsule car (cont'd)

Width of movement channel  5 feet
Height of movement channel  8 feet

For purposes of study it was decided to plan level differences in terms of 10 respectively 20 foot vertical increments. This module would allow for clearance of the movement channel with room for construction.
Organization Diagram
The preceding three dimensional arrangement gives a number of advantages.

1. Utilizing direct access from the lowest level, via a parking turn off the expressway is connected to a large parking facility.

2. The parking facility containing approximately 4000 cars exists in four levels adjacent to the expressway. Rectilinear bay system allows the parking facility to be utilized as a base for construction that might extend from the surrounding commercial facility.

3. The subway station is exposed to natural light allowing easy visual orientation from it and to it. It is directly connected to the parking facility allowing convenient transfer of mode.

4. Pedestrian circulation is reorganized and a traffic free crossing is developed. This pedestrian movement channel is located directly below capsule car route, allowing convenient transfer.

5. The arrangement of components allows separation into various projects which can be implemented, financed, and administered by various agencies.

It is thought that the various integrated movement channels represent a three-dimensional spine, which may be utilized to generate further activity. Upon analysis of functional areas in the vicinity, a program of development could begin which would upgrade the present commercial complex. Due to possible development of high density residential
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1. Utilizing direct access from the lowest level, via a parking turn off the expressway is connected to a large parking facility.

2. The parking facility containing approximately 4000 cars exists in four levels adjacent to the expressway. Rectilinear bay system allows the parking facility to be utilized as a base for construction that might extend from the surrounding commercial facility.

3. The subway station is exposed to natural light allowing easy visual orientation from it and to it. It is directly connected to the parking facility allowing convenient transfer of mode.

4. Pedestrian circulation is reorganized and a traffic free crossing is developed. This pedestrian movement channel is located directly below capsule car route, allowing convenient transfer.

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It is thought that the various integrated movement channels represent a three-dimensional spine, which may be utilized to generate further activity. Upon analysis of functional areas in the vicinity, a program of development could begin which would upgrade the present commercial complex. Due to possible development of high density residential
complexes together with other functions a certain amount of expansion would take place. This could lead to development of a new commercial center for Cambridge. Connecting the expressway interchange to Massachusetts Avenue will bring an increased amount of traffic, requiring some streamlining in its design. Traffic free pedestrian crossings may be developed, similar to that presently being planned at M.I.T.

The large parking facility directly accessible from the expressway will encourage transfer to other modes of travel, transit, bus and capsule car. The interchangeability between modes will contribute to increased utilization of the transit system. It will reduce or stabilize the automobile traffic in the core area, and make available high value property that presently is allocated for parking facilities.
VI. Conclusion
The successful aspects of this thesis are:

1. That this is a step in the right direction of considering urban expressways not as traffic channels only, but to begin to use their potential generating power by integrating them into the urban fabric.

2. That a fairly well functioning relationship of the various elements has been found.

There are still a large number of difficulties.

One is presented by relating the large scale interchange to all other scales, and it may be that a more successful arrangement could be found. Also it seems that the concentration of many movement channels and their integration creates a very mechanistic, machine-like setup. A less concentrated arrangement would lend itself to be designed more freely.

There is presently no answer on how this interchange might affect the surrounding environment in its capacity as an activity generator. Another area of study should concentrate on methods of implementation, political, financing and administratively.

Since the development of a point of access along a movement channel represents only one aspect of a movement channel, more information is needed about the distributor.
VII. Selected Bibliography


1965-75 General Plan for the City of Boston and the Regional Core - Boston Redevelopment Authority.


A City is Not a Tree - Christopher Alexander.

VIII. Reproductions of Drawings and Model