TRANSPORTATION AND URBAN FORM

by

RICHARD WARREN SMITH
B. Arch. - University of Southern California, 1965

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARCHITECTURE

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
July, 1966

Signature of Author

Certified by

Accepted by

Department of Architecture
Thesis Supervisor
Chairman, Department of Architecture
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>PART</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>QUALITATIVE ASPECTS OF THE PRESENT AMERICAN CITY AND ITS POSSIBLE TRANSFORMATIONS</td>
<td>1</td>
</tr>
<tr>
<td>II</td>
<td>GRAPHICAL DISPLAY AND ANALYSIS OF THE PRESENT AMERICAN CITY AND SOME POSSIBLE TRANSFORMATIONS - INCLUDING ASPECTS OF TRANSPORTATION</td>
<td>20</td>
</tr>
<tr>
<td>III</td>
<td>GRAPHICAL DISPLAY AND ANALYSIS OF A POLYNUCLEATED CITY STRUCTURE AND ITS RELATED PATTERN OF TRANSPORTATION</td>
<td>21</td>
</tr>
<tr>
<td>IV</td>
<td>GENERAL GRAPHICAL DISPLAY AND ANALYSIS OF NETWORK STRUCTURES, GEOMETRIES, PATTERNS, AND SYSTEMS</td>
<td>22</td>
</tr>
<tr>
<td>V</td>
<td>SYNTHESIS OF URBAN STRUCTURES AND TRANSPORTATION NETWORKS - A NEW CITY</td>
<td>23</td>
</tr>
<tr>
<td>VI</td>
<td>TRANSFORMATION OF AN EXISTING CITY: BOSTON</td>
<td>24</td>
</tr>
<tr>
<td>VII</td>
<td>APPENDIX AND BIBLIOGRAPHY</td>
<td>30</td>
</tr>
</tbody>
</table>
TRANSPORTATION AND URBAN FORM

ABSTRACT

This thesis begins with a qualitative analysis of the present state of our cities and their transformations. The emphasis is placed on the relation of the city form to quality of life, growth, and transportation. These three aspects are inseparable. A major change in any one of them will generate major changes in the others.

The thesis research leads me to believe that the present typical American city cannot bear some of the problems that it is likely to encounter in the immediate future without deleterious effect; that the problem is a matter of urban structure. This leads to the investigation and synthesis of urban forms and networks which embody the concept of growth and the manifest quality of urban life. The result is delineated in general and in detail in a hypothetical New City.

The transformation of an existing city, Boston, is undertaken to exemplify an approach to solving some of the problems which the American city faces, and which Boston typifies.
The final mission of the city is to further man's conscious participation in the cosmic and the historic process. Through its own complex and enduring structure, the city vastly augments man's ability to interpret these processes and take an active, formative part in them, so that every phase of the drama it stages shall have, to the highest degree possible, the illumination of consciousness, the stamp of purpose, the color of love. That magnification of all the dimensions of life, through emotional communion, rational communication, technological mastery and above all, dramatic representation, has been the supreme office of the city in history. And it remains the chief reason for the city's continued existence.

PART I

QUALITATIVE ASPECTS OF THE PRESENT AMERICAN CITY
AND ITS POSSIBLE TRANSFORMATIONS
In an abstract study which aims at concluding with some principles of operation and the configurations they generate, it is necessary to begin by abstracting principles from the subject. Consequently it is necessary to ask what purposes the city serves to its inhabitants. It seems that the first condition of cities is to satisfy collective functions. Historically the principal functions have been religion; marketing (exchange), social affairs (festivals, celebrations, etc.), defense and industry. Of these, religion and defense are no longer principal constituents of the urban structure.

For purposes of clarity and for functional reasons in this study I am defining urban form as the physical disposition of the major urban functions. These functions are places of residence, places of work, commercial and manufacturing, and places of consumer activity, retail sales and entertainment. It may be noted that the variable in urban form is the physical disposition of the functions and not the functions themselves as they are present in any urban structure.

Physical disposition denotes placement in space and whether the urban functions are separate entities or are atomized in a homogeneous configuration there exists a linking structure which connects the functions; this structure is the transportation network which will be pursued further on.

The interrelated and simultaneous occurrence of the industrialization and urbanization of our society presents us with cities which have grown around conditions that are no longer relevant. For example, Boston Harbor is surrounded by shipping wharves and warehouses which
have scarcely been used for decades, since railroads and trucking have replaced sea shipment as the principal method of national distribution.

Static centralization, a no longer relevant urban configuration, has caused residential areas to surround centralized workplaces producing inorganic growth and the daily centripetal-centrifugal movement cycle. This movement pattern may have been no problem 150 years ago, but today is the cause of waste in time and energy and if not changed may be the limiting factor on a city's future growth capability.

A graphical display of the growth of the American city will generally show new increments in the form of concentric circles. This form of growth is also exhibited by the cores of cities. The cores grow in a destructive way; the immediate areas in the shadow of core expansion receive the least expenditures on maintenance and improvements possible and consequently degenerate into substandard structures.

Since land values tend to be contiguous to adjacent areas the tendency to produce substandard areas extends far beyond the anticipated core expansion area. Add to this the general urban exodus of the middle class families and the subsequent bottoming in market value of their former residences and the general area of degeneration extends further as the former middle class residences will also receive minimum expenditures on maintenance and improvement.

The growth pattern of the central city inevitably results in an accessibility problem; the middle class exurbanites still use the core for employment, shopping and entertainment. Increases are occurring
in both the numbers of these people and in the distance between their residences and the core.

Although in some cases new manufacturing facilities are being established in the urban fringe areas they are not very significant in terms of changing accessibility conditions; they are generally of the esoteric kind requiring highly skilled employees who generally reside in adjacent areas. These new industries can be little else as the unskilled employee generally finds residence in the central degenerate residential area where living expenses are commensurate with his wage. Transportation facilities and costs provide this sort of person with little accessibility to new fringe area industries.

The general resulting pattern is that unskilled lower class people find employment in the manufacturing areas of the core and find residence in the areas most immediately adjacent to the core. The semi-skilled and skilled employees of the middle class find employment in the commercial areas of the core and residence in areas as far away from the core as possible, within the limits of reasonable accessibility.

That the places of employment are predominantly in the center of our cities and the places of residence are surrounding the center is both the consequence of history and of city forms which do not have the capability of growth inherent to their configurations. The result is a daily accessibility problem in which the morning trips converge on the center of the city and the late afternoon trips are dispersed centrifugally.

The accessibility problem which this central convergence causes can certainly be solved by the technological means now available to
us but it is valid to ask whether this is the appropriate direction to take in the solution of the problem.

That we can alleviate the accessibility problems of the present is obvious - we only have to will it and spend the money. However, as the urban freeway programs have shown us, increasing accessibility to handle present and anticipated demands has the unfortunate result of being inadequate because the program increases the growth rate of the center and creates demands far in excess of the demands which were anticipated and designed for. Many new freeway links and extensions have been found inadequate to handle traffic demands soon after or even on their opening day.

What may be called for is not the application of new technological means - which seem to put the problem off to some future date rather than solve it - but foresight: a new concept of the city which is structured around not only ideas of the urban "good life" but ideas of growth.

The pre-industrial revolution city was the stronghold of the middle and upper classes. In less than 200 years the city has been transformed into an entrapment for the lower classes. This - not being a static condition - can only be expected to be exaggerated as time passes with no effort being made to alter the pattern.

The present city extended into the future will produce no new delights but will exaggerate the present problems. The formation of regional or metropolitan governments will be inhibited by the mutual antagonism between the racial minorities inhabiting the core of the city and the middle classes who inhabit the suburbs surrounding the city. The suburbanites may be able to extract from the core those
necessities and amenities on which they depend. The extraction of some industries is under way and to some extent the shopping facilities and the commercial and entertainment facilities. If this is successfully achieved, then they may be able to turn away from the core city and ignore its existence. The core city would then continue its present course of degeneration, but at an accelerated rate. It need not be all that bad though, if some regenerative forces come into play.

Cities are now experiencing the stress of a new set of forces which are trying to reach an equilibrium. They may be described as centrifugal and centripetal.

The centrifugal forces have been identified as:
1. Movement in response to the need for private space - escape from overcrowding.
2. Escape from degenerate social and political structures.
3. Satisfaction of middle class living patterns - space and yard.
4. Need of large areas for new industries.

These forces have been augmented by automobility and communications.

Contributive forces are: transient industries, businesses and services, families able to purchase suburban homes, restrictive zoning, racial discrimination, rising city taxes.

It may be noted that the most dramatic change in urban form in recent history occurred immediately after World War II, a period in which the middle class expanded and attained an extended mobility and produced most of the centrifugal forces.
The centripetal forces have been identified as:

1. Growing administrative (manufacturing and finance) functions which are interdependent on each other and services.
2. Affinity to urban values; convenience to work, immediacy to specialized contacts and facilities, stimulation of diversity.
3. Urban renewal and new mass transportation systems.

There is an increasing awareness of the need and ability to do something about our cities. There are efforts being made to coordinate or consolidate local governments into a regional or metropolitan structure. Once this is done and the problems are considered with vision then we may see a new kind of urban life.

If the centripetal forces play the major formative role in the transition of our present cities then we may see extreme concentrations or super cities come into being. This would put an emphasis on high density housing with an extensive three-dimensional transportation system. This would effectively eliminate automobility. People would tend toward extreme specialization and there would be an immense problem of environmental relief. Such a city structure might approach the characteristics of an organism where individuals would be subordinated to expediencies in the operation of the city. To come into existence the super city would have to be consciously willed as it is something which would not be produced by aimless growth. It would probably have to be willed by a totalitarian government which would also be required to run it.

Letting the centrifugal forces play to the fullest extent would produce a city characterized as general dispersion. The socially
homogeneous neighborhoods would not be as large as they are now; some middle class families would exchange residential areas with lower class families. This would be accompanied by a decrease in ethnic discrimination and an increase in mobility for the lower classes. There would be a reduction in the number of short and long work trips with an increase in the average length work trips. There would be a continuation in the dispersion of shopping areas and an extension of the dispersion of manufacturing facilities and a new dispersal of commercial facilities. All of this is possible but heavily dependent on communications, regional government, and a regional highway network. Mass transportation would be almost impossible due to the resulting densities; the closest possibility would be an automated highway system.

General urban dispersion would produce a structure which would generally allow only planned or preconceived experiences as the resulting individual automobility would permit contact with other people only at origins and planned destinations.

The scale of experienced environment would be so great as to prevent comprehension resulting in the inability to form an identity and a sense of community. In the sense that the urban family structure, especially suburban, has been noted for its looseness it might totally collapse under the fragmentation of general dispersion.

An urban structure based on dispersion might produce the sort of anarchy characterized by the old west - where one does what he can get away with. Certainly there would tend to be the anonymity that results from excessive impersonal relationships. In this case anonymity would not arise from the need or desire for it, but from a lack of environmental and social situations which enhance the generation of personal
relationships.

An abstracted and exaggerated contrast between the super city and general dispersion is that the super city would have everything everywhere, the person is static, he would not have to move as all of his needs would be more efficiently moved to him. Effectively the person would "return to the womb" of an omnipresent benevolent social structure. The validity of the person and reason for his existence becomes vague.

On the other hand, general dispersion as a city form would have everything in some definite place; the person becomes totally dynamic like the inhabitants of paradise - one merely gathers his needs as he moves throughout his environment. Existence becomes movement from one need satisfaction to another.

In both abstractions the person loses identity; in the super city the scale of environment and operational expediencies prevents its formation, also because of the complex interface necessary between person and environment; in other words, norm compliance would necessarily become the totality of the person. General dispersion would separate person from person by the tendency toward anarchy and the lack of repetitive confrontation between persons due to random and excessive movement necessary for personal satisfaction.

The relevance of both abstractions is the implication they have to the relationship between the individual and collective embodied in an environmental structure. Norm generation is an operational necessity in the formation of human relationships whether between individuals or a person and a group. When norm compliance becomes an imperative
due to environmental structure it becomes destructive to the individual and to the collective in that it forms artificial relationships — relationships which have no intrinsic value. To some extent this is bound to happen as we are incapable of structuring our environment as a pure manifestation of the individual-collective relationship. The point is to minimize environmentally induced norm compliance which in turn maximizes the range of choice and spontaneity that persons may exercise.

Minimizing norm compliance or maximizing range of choice requires an environmental structure which could be created only by a great deal of effort. Such an effort can happen when people realize the consequences of such an undertaking and the consequences of continuing the present form of aimless city growth which necessarily includes an increase in norm compliance in its growth pattern.

Growth is the significant controlling factor not only because of the environmental deterioration it produces or the accessibility problems it creates but because it has the physical attribute of scale and scale reflects a human cognizance. A city of limited size may have any sort of environmental structure and not make undue demands for norm compliance — it may be sufficient in size to allow enough anonymity so that personal relationships do not become oppressive, small enough to enhance the formation of personal relationships, large enough to provide diversity and vitality but not so large as to produce the negative aspects of accessibility.

That a city can grow to any size is apparently true but that a city can exceed a limit in scale is also apparent. That the limit on
scale is recognizable to the senses but is not quantifiable gives rise to questions not only on the placement of the limit but also to the actual existence of such a limit. It can be said that the existence of the limit is open chiefly to sense but there is support for the existence of this kind of limit in some of the diverse studies on man, although positionality of the limit is still vague. Two such references are that of experimental art forms and current information theory. The experiments done with pure abstractions in both music ("organized sound") and cinematography indicate a definite limit in the ability of an audience to assimilate sensations presented in an unstructured or unfamiliar pattern. The studies in information theory indicate a limit on the rate at which information can be assimilated if learning is to occur. There is also the awareness that knowledge is finite. Since environmental experience can also be seen as assimilation of information which the mind has an inherent need to pattern, or understand, then it is apparent that if information is presented at a rate which exceeds the assimilative capability of the mind then, as other experiences show us, the mind will abandon any effort to make a pattern. This amounts to disengagement of the mind from the subject. When the mind abandons the effort to make a cognizant structure from the urban environment the result is apathy; apathy in that case is total compliance.

Western civilization did not learn to question its origin, situation, and destiny until the historical events of social and industrial revolutions had occurred. The eighteenth and nineteenth centuries saw a transition in thinking from the idea that the world, man, and civilization were designed and made by an omnipotent being,
for some purpose, to the idea that the world, man, and civilization are dynamic instances in a process of change which is an end in itself. The substitution of process for purpose has tremendous bearing on a view of the situation and destiny of civilization. If one accepts the idea of divine purpose then one accepts the situation and destiny of civilization as a matter of fact; that all things have a fate relative to some purpose and that the delineation of the purpose is not accessible to man. The beginnings of practically all western cities were accompanied by this frame of thinking.

That entities are not self contained but have reference to a continuing process of which any entity is only an instance in a stage of development, not toward a final and perfect form, but a continual attempt to find an equilibriant position with forces which are constantly changing is the current world view. Had this view been extant during the formative stages of our cities, we might be in a vastly different position. As it goes with basic ideas we are a century behind in most of our actions in that they do not correspond to our ideas. The transition is under way and is generally being propelled by the exigencies of the situation.

The most far reaching consequence of seeing the world as process instead of purpose is that no longer can objects or organizations be looked at in a static sense; to be understood they will have to be looked at in light of the process which produced them, their present state, and with acknowledgement of the fact that they exist in a field of forces which will produce changes in the objects or organizations as they pass through time.
The renaissance produced the conceptual framework of the closed system; an abstracted way of looking at the world which necessitates an arbitrary cutting of links between the abstraction and the rest of the world. This necessitated a futile effort in maintaining the ruptured links. Futile because the predominant links of nature and change are inexorable.

Change integrated into the conceptual framework generates a world view of open-endedness; beginnings and ends are ambiguous, final and perfect states become irrelevant.

Change as it affects the urban environment is not as much in response to the forces of nature as it is to changes in human value and condition. The greatest force exerted on the urban structure is growth in response to the persistent growth and urbanization of the population.

If the fact that our urban environment exists in a continuum of change is accepted, and if the desire to minimize norm compliance is activated, then a policy which embodies both the fact and the desire can be formed.

Physical scale held within the limits of the assimilative capability of the human mind is an apparent contradiction to unlimited growth but a polynucleated configuration accommodates both; the growth of a spread pattern with nodes would probably be limited only by geography. Persons would tend to have repetitive relationships with primarily one center which would produce a physical scale characteristic according to the relationship of the center to its adjacent parts. In a polynucleated configuration the effect of scale limitation would
be on the distance between nodes, the densities in and around the nodes, and the relationship between the two limits.

The basic values of private space and automobility are attributes of low densities; the diversity of urban life is an attribute of high density. That the desire for private space and automobility are self-evidently basic values in American culture can hardly be contested; one only has to see what these values have done to city forms in the last twenty years, or see their marks on the artifacts and media of popular culture. That the diversity and vitality of urban life and its accompanying density are indispensable to the city is reflected in the notion that western civilization is dependent in development and existence on urban centers. That we technologically do not need urban centers any more due to comprehensive means of communications is a notion that springs from a misunderstanding of both technological means and the consequent lack of urban centers. One can reject this notion of urban structure according to ideas of human value and the transcendence of those values into human culture. Both high and low density areas can be resolved into a healthy configuration of contrast and accommodation by a polynucleated structure.

The notion that the city is an organism is related to the notion that the city is too large to be understood or controlled, that it exhibits a characteristic of life which, like a biological cell, seems to be autonomous. Or it may be that, like a biological cell, the city has a total relationship to the world, that its links are effectively infinite and thus eludes human comprehension. The city is not an organism - a structure with parts so integrated that their
relation to one another is governed by their relation to the whole. The simile is useful in understanding the effect of some parts on the whole, but it can lead to a misunderstanding of the relationship of the parts. Organisms are not composed of autonomous parts. The city is a kinetic organization by virtue of its autonomous parts, in which there is a hierarchy of social norm compliance generated by the volition of individuals or groups.

Social hierarchies, from the individual, to groups, communities, etc., finally to society may be seen as scale increments by which an individual relates to groups of people by abstracting the attributes of the group. The formation of a relationship between an individual and a group or between two groups can be either volitional or as a matter of compliance to necessity. In the case of volitional formation the causes are mutually inherent desire. In the case of necessary compliance the causes are environmental exigencies. Both situations are related to accessibility and to range of choices in the environment. If the general accessibility is high then group formations may occur without the limitations of time and space; members of a group could be anywhere in the city. Where accessibility is low, group formations may only occur in close proximities like tight neighborhoods and since groups tend to be either inclusive or exclusive of individuals in their proximities one would tend to join or get out of the area, resulting in norm compliance due to environmental structure. Low accessibility increases norm compliance. High accessibility is neutral in the issue. If one has the same general accessibility to his work place no matter where he lives then this will not be a
criterion; he will live in an area in which there is a social grouping to which he has an affinity, or if he is not concerned about the social grouping of a particular area, he may still choose to live there and have accessibility to any of the social groupings in any other part of the city.

The concept of culture as a pattern of behavior is a concept related to homeostasis and as such is archaic. That notion of culture is applicable to those societies of the past in which there was an apparent homeostasis because of the slow rate of change. The concept degenerates into a concern for tasteful judgments and a participation in the "finer things of life."

Accepting the world as process means a new definition of the word culture and its implications. Doing so is full of risks due to short-sightedness, but still it must be done.

History evidences that the ancient Greeks, medieval European Christians, classical Japanese, and primitive cultures like the American Indians had in common the phenomenon of spontaneity. History evidences that culture is spontaneous acts emanating from ideals. What our age changes from the ages past is a world of process for a world of purpose. What our age adds is the individual as an offspring from the idea of the world as process. In the past a person's destiny was generally a matter of the geometry of purpose. In that the person has no assigned destiny other than that of volition modified by chance and capability, the person becomes an individual.

The world as process has the social dynamics of the new duality of individual and collective; dynamics in the sense of all dualities -
the ascension of one will mean the regression of the other. The en-
vironmental implications of the new social dynamics are not vague in
the sense that certain environmental characteristics accommodate spont-
anaeity and other characteristics induce norm compliance which is re-
gressive in terms of culture.

Culture seen as the relation of spontaneous acts to ideals finds
its residence in individuals and its most meaningful expression in the
collective. Along with spontanaeity the Humanistic Psychologists con-
sider the healthy human being to have the characteristics of a clear
perception of reality, and a firm self identity. The attainment of
these characteristics is a growth process in which the ideas or ideals
of the individual are confronted by experience in a spontaneous manner.
When this happens in a group or in a collective dimension it means
that the group or society is in a transcendent position; a position of
unity with the world as process.

The environmental implications to the growth process of individuals
and of the collective dimension is the same: certain environmental con-
figurations accommodate or induce spontanaeity and certain configura-
tions induce non-spontanaeity or norm compliance which is regressive
in cultural terms. Examples of configurations which induce compliance
are the suburban tracts and old high density urban areas. The sub-
urban tract because of the extremes of public and private configurations
with no intermediaries; one is either in the street in the car or one
is in his house; the only possible socializing can occur only within
the private spaces of the house, and in the context of a preplanned
activity or on the intrusion of the visitor. There is little chance
for spontaneous social exchange and no degrees of situations between
public or private, only one or the other.

The existing high density urban areas on the other hand induce a
norm compliance as a result of their accommodating a density level for
which they were not designed. The result is overcrowding in which a
standard of environmental operation can be achieved only by compliance
to a norm which the inhabitants by consensus or necessity adhere to.
Most of these areas, being large single family residences, converted
into multiple dwellings, suffer from the same suburban problem of public
and private spaces with little in between. The little in between amounts
to spaces like foyers where the mailboxes are, corridors, areas where
the trash cans are, or parking spaces. However, there is considerable
difference between these urban areas and the suburbs in that the urban
areas have the support of neighborhood facilities and services like
drugstores and laundromats which constitute real semi-public spaces.

Although accessibility is generally high in the more dense urban
areas and there is some gradation between public and private space
there exists the problem that the gradation occurs more on the public
side of the issue. Both private space and semi-private space are
either non-existent or deficient in character. Specifically, a
dwelling unit is often no more private than a room in a large house,
and generally the dweller has no semi-private space between his
private unit and the public street. Although this is an architectural
problem, it has a definite relation to the adjacent movement pattern.

To sum up and form criteria for the next section of this thesis:

Present city growth is inorganic because it is not structurally
acknowledged but organic growth can be attained by urban configuration.
Scale limitation within the context of unlimited growth can be achieved by a polynucleated configuration.

The city is not an organism because it contains autonomous parts; it is a kinetic organization by virtue of the interrelating of the autonomous parts.

Non-volitional norm compliance in social group formation is an attribute of low accessibility; whereas high accessibility allows volition to be the chief cause of group formation.

Movement patterns define public and private spaces; the relative intensity of movement or accessibility is commensurate to the degree of publickness or privateness of the adjacent spaces.

The structuring of movement patterns and adjacent spaces can generate an environmental structure which can be responsive to man as an individual and in the collective dimension and to cultural attainment.
PART II

GRAPHICAL DISPLAY AND ANALYSIS OF THE PRESENT AMERICAN CITY AND SOME POSSIBLE TRANSFORMATIONS - INCLUDING ASPECTS OF TRANSPORTATION
% DISTRIBUTION OF LAND USES AND
ACCOMPANYING DENSITIES COMBINED TO
FORM CURVES ON POPULATION, JOBS
AND EMPLOYEE DISTRIBUTION
RELATIVE TO THE CENTER OF CITY

A. POPULATION AT A DENSITY OF 175 FAMILIES/ACRE THROUGHOUT CITY
B. " " " " 40 " " " " CITY CENTER
C. EMPLOYEES GENERATED BY POPULATION CURVE B
D. POPULATION GENERATED BY PRESENT DENSITIES
E. EMPLOYEES GENERATED BY PRESENT POPULATION
F. POPULATION NECESSARY TO GENERATE EMPLOYEES IN
IMMEDIATE AREA OF PRESENT EMPLOYMENT
G. PRESENT WPS & COMMERCIAL EMPLOYMENT DISTRIBUTION
H. COMMERCIAL EMPLOYMENT ONLY
I. SURPLUS RESIDENT EMPLOYEES FOR JOBS IN IMMEDIATE AREA
J. DEFICIT
D CENTER CITY AT PRESENT - DISTANCE BETWEEN CENTROIDS OF JOBS & EMPLOYEES.

A: POPULATION CURVE
B: RESIDENT EMPLOYEES
C: JOBS

D = AVE WORK TRIP LENGTH, NOT COUNTING LATERAL MOVEMENT
CJ = CENTROID OF JOBS
CE = CENTROID OF EMPLOYEES

EFFICIENCY = D/CIRCUIT LENGTH = 625% ON RADIAL PUBLIC TRANSPORTATION

A' FUTURE POPULATION CURVE

B CENTER CITY IN THE FUTURE - DISTANCE BETWEEN CENTROIDS OF JOBS & EMPLOYEES.

D' - D = TRIP LENGTH INCREASE WITH NEW GROWTH.
CONCENTRATED "SUPER CITY"

A = Population curve to produce jobs; employees = to jobs in area
B = Resident employees
C = Jobs, existing distribution

Cj, centroid of jobs, and Cq, centroid of employment,
coincide making average trip length = 0 excepting
lateral, random, & vertical movement in both the
concentrated & dispersed configurations of the city.

GENERAL DISPERSION
THE TOP CURVE IS OF PRESENT CENTRAL CITY MOVEMENTS AND SHOWS WHY THEIR PUBLIC TRANSPORTATION SYSTEMS CAN BE ONLY 25% EFFECTIVE. IN THE MORNING THE SYSTEM CARRIES ~1/2 FULL CAPACITY, 1/2 THE CIRCUIT LENGTH (THE TRIP IN), AND THEN RETURNS, WITH NO FREQUENCIES, TO THE END OF THE CIRCUIT TO MAKE ANOTHER TRIP IN. THE AFTERNOON SEQUENCE IS THE REVERSE OF THE MORNING. THE BOTTOM CURVE SHOWS EQUAL NUMBERS OF PEOPLE MOVING IN OPPOSITE DIRECTIONS WHICH WOULD PRODUCE AN EFFICIENCY OF 50%. THIS IS MADE POSSIBLE BY CHANGING DESTINATIONS & SUGGESTS A NEW URBN FORM
PART III

GRAPHICAL DISPLAY AND ANALYSIS OF A
POLYNUCLEATED CITY STRUCTURE AND ITS
RELATED PATTERNS OF TRANSPORTATION
A DISTRIBUTION OF LAND USE: ON A LINE THROUGH CENTERS OF HOPE.

A: TRANSPORTATION
B: RESIDENTIAL
C: MANUFACTURING
D: COMMERCIAL
E: VACANT & AGRICULTURAL.
Distribution of land uses and accompanying densities combined to form curves on population, jobs, and employer distribution relative to the nodes.

A: Residential population relative to MPA or commerce center.
B: Growth of pop. (to ~ 175,000)
C: Employment generated by pop.
D: Growth in emp. due to growth in pop.
E: Jobs
F: Growth in jobs
G: Surplus: sufficient employees for jobs in neighborhood
H: Deficit
1D WORK TRIP LENGTH

LOCAL CIRCUIT

\[ P = \frac{d(e_{\text{COMMERC.}}) + d(m_{\text{MPS.}})}{\text{TOTAL TRIPS}} \]

\[ \text{EFFICIENCY} = \frac{d(e + d(m))}{d(m)} \times 100\% \]

REGIONAL CIRCUIT (TWO DIMENSIONAL)

\[ P = \frac{[d(e_{\text{TRIP}1}) + \cdots + d(e_{\text{TRIP}n})] + [d(m_{\text{TRIP}1}) + \cdots + d(m_{\text{TRIP}n})]}{(\text{TRIP}1 \cdots \text{TRIP}n) + (\text{TRIP}1 \cdots \text{TRIP}n)} \]
RECIPROCAL LOOP

By having residential concentrations between nodes of employment there can be a full utilization of the movement systems.
STUDIES IN POLYNUCLEATED CONFIGURATIONS WITH THE GEOPOLITICAL LOOP AND GROWTH CAPABILITY
PART IV

GRAPHICAL DISPLAY AND ANALYSIS OF
NETWORK STRUCTURES, GEOMETRIES, PATTERNS,
AND SYSTEMS
# Delination of Modes

<table>
<thead>
<tr>
<th>MODES</th>
<th>MILES OPERATIONAL DISTANCE</th>
<th>CHARACTERISTIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>3,000</td>
<td>POINT</td>
</tr>
<tr>
<td>M2</td>
<td>200</td>
<td>POINT</td>
</tr>
<tr>
<td>M3</td>
<td>30</td>
<td>LINE</td>
</tr>
<tr>
<td>M4</td>
<td>20</td>
<td>LINE</td>
</tr>
<tr>
<td>M5</td>
<td>20</td>
<td>POINT</td>
</tr>
<tr>
<td>M6</td>
<td>10</td>
<td>SURFACE</td>
</tr>
<tr>
<td>M7</td>
<td>10</td>
<td>LINE</td>
</tr>
<tr>
<td>M8</td>
<td>1</td>
<td>LINE</td>
</tr>
<tr>
<td>M9</td>
<td>1/4</td>
<td>SURFACE</td>
</tr>
</tbody>
</table>

Hierarchies of modes are related to efficient or appropriate means of overcoming distance.

The way the modes are linked determines whether the organization (matrix) is hierarchical or free.

Characteristics:
- **Point**: Constructed interchange - only place of link
- **Line**: Constructed interchange of network
  - Links required for change in direction
  - Links resemble at any point on line but limited by frequency
- **Surface**: No links between directions
Hierarchical Network

Pattern of taking a 5,000 mile trip from home.

Home -> L3 -> M0 -> L5 -> M1 -> L2 -> M4 -> L5 -> M2 -> L3

L3 = Link between modes 4 & mode 8

10 ways to get there with a minimum of 4 transfers

Hierarchical area organization resulting from hierarchical network.
HIERARCHICAL NETWORK EXAMPLE
FREE NETWORK

MATRIX

PATTERN OF TAKING A 2,000 MILE TRIP FROM HOME

MINIMUM OF 2 TRANSFERS
27 WAYS TO GET THERE
INTERRELATED MOVEMENT CHARACTERISTICS

AREA ORGANIZATION RESULTING FROM A FREE NETWORK

FREE MATRIX NETWORK EXAMPLE (OR ANY EXISTING CITY)
This matrix serves to show the relative position of the smallest entity, residence, through the largest, nation, by the modes in between. For example, if every residence in the city could be within walking distance of a national airport, M1, (a physical impossibility), then the availability would be 100% and every residence would have, effectively, every city in the country within walking distance. Realistically, though, if 50% of the residences have public transportation, M4 or M7, within walking distance then 50% of the residences have general access to an area within a 50 mile radius (M8) or a 10 mile radius (M7). Equal use of those modes available according to capacity is what tends to happen in most any city, especially during rush hours, but not in most "designed" cities - those with hierarchical networks. The superimposing of proposed modes on this matrix would serve as a test and clarification in the design of a network for a city.
**IRREGULAR ORTHOGONAL PATTERN**

Found in nature (cracked surfaces due to shrinkage; medieval villages etc.)

Resolution of boundary conditions of areas produced by autonomous processes.

Not a network, because continuity is not a process in its formation; rather a boundary pattern of aggregate areas.

**EVALUATION OF GEOMETRICAL PATTERNS**

For a given area:

1. Minimize boundary length $L$.
2. Minimize mean proximity from boundary $P_m$.
3. Minimize mean proximity from vertex $P_{m'}$.

**A. TRIANGULAR GEOMETRY**

$\rightarrow$ If $\alpha = 1$

Then $A = \left( \frac{\alpha}{2} \right)^2 = \left( \frac{2}{13} \right)^2 = \frac{4}{\sqrt{13}} = 0.433$

$P_m = \frac{2}{\sqrt{13}} = 0.287$

$P_{m'} = \frac{2}{\sqrt{13}} = 0.287$

$\alpha = \frac{1}{3}$
B. Quadrangle Geometry

\[ A = \frac{1}{2} \times 2 \times 1 = 1 \]

\[ L = \sqrt{A^2 + B^2} = \sqrt{1^2 + 1^2} = \sqrt{2} \]

\[ P_m = \frac{L}{2} = \frac{\sqrt{2}}{2} \]

\[ P_m' = \frac{L}{12} \]

\[ L_t = 2.64 \]

It may be seen that the most efficient form of the quadrangle geometry is the square since both \( P_m \) and \( P_m' \) would increase in a rectangular form as would \( L_t \).

C. Hexagonal Geometry

\[ A = \frac{1}{2} L^2 \cot 30^\circ = \frac{\sqrt{3}}{4} \]

\[ \frac{L}{\sqrt{3}} = \frac{2.6}{\sqrt{3}} = \frac{4.06}{\sqrt{3}} \]

\[ P_m = \frac{L}{\sqrt{3}} = \frac{2.6}{\sqrt{3}} = 1.2 \]

\[ P_m' = \frac{P_m}{\sqrt{3}} = \frac{1.2}{\sqrt{3}} = 0.23 \]

\[ L_t = 2.45 \]

D. Comparison

<table>
<thead>
<tr>
<th>Equal Areas</th>
<th>( \triangle )</th>
<th>( \square )</th>
<th>( \bigcirc )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( L_t )</td>
<td>2.6</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>( P_m )</td>
<td>1.1</td>
<td>0.11</td>
<td>0.12</td>
</tr>
<tr>
<td>( P_m' )</td>
<td>0.28</td>
<td>0.28</td>
<td>0.28</td>
</tr>
</tbody>
</table>
SEGMETRICAL CONTINUITY

A. TRIANGULAR
Least efficient in terms of geometry (4, 6, 8)
Most complete in terms of network - may be redundant

B. HEXAGONAL
Most efficient in terms of the geometrical element
Same network characteristics as triangular but with less efficiency.

C. SQUARE
Quite near the efficiency of the hexagonal element (except 16, 8, 4)
But with greater continuity, it is the most efficient of the three in terms of a network.

# Since 16 relates only to intersectional transit stations, it may be unimportant as transit pickups might have to be more frequent, as along boundary (6, 8, 4).
INTERCEPTOR D
INTERCEPTOR B
INTERCEPTOR A
INTERCEPTOR C

PASSENGER MODULES

PASS 100 FT.

STRIPED POST-TENSIONED CONCRETE MEMBERS TO SPAN 100 FT.

PASSENGER MODULE DRIVEN BY LINE POWER.
LARGE RUBBER TIRES
INTERCEPTOR SIMILAR EXCEPT: INDEPENDENT TOWER, HARDWARE, NO SEATS

SECTION THROUGH LINE & PASSENGER MODULE

PASSENGER MODULES PASSING AT 20 MPH:
INTERCEPTOR A - BEGIN ACCELERATION
INTERCEPTOR B - DECELERATION
INTERCEPTOR C - COLLECTING ON GROUND LOOP
INTERCEPTOR D - RETREATING FROM COLLECTING ON GROUND LOOP
A. I-
I

INTERCEPTOR A

INTERCEPTOR C

PASSSENGER MODULE

10 SECONDS

PASSSENGER MODULES - MAINTAINING CONTINUOUS 20 FPS
INTERCEPTOR A - ENGAGED PASSSENGER MODULES
INTERCEPTOR C - COLLECTING & DISCHARGING ON GROUND LOOP
10-30 SECONDS

INTERCEPTOR A - DISCHARGING INTO PASSENGER MODULE OR ACCEPTING PGMU

INTERCEPTOR A

INTERCEPTOR A - DISCHARGING PASSENGERS INTO PASSENGER MODULE

INTERCEPTOR A - ACCEPTING PASSENGERS FROM PASSENGER MODULE

INTERCEPTOR D - COLLECTING & DISCHARGING PASSENGERS ON GROUND LOOP

M

N

PASSENGER MODULES - 30 PGMU

INTERCEPTOR D
30-100 SECONDS

Passenger modules continue 30 m/seg.

INTERCEPTOR A - Decelerating - will begin collecting
on ground loop after discharging
passengers.

INTERCEPTOR D - From ground loop will intercept
next passenger module in 100 sec.

INTERCEPTOR B - Accelerating to intercept previous
modules, up from ground loop.

INTERCEPTOR P - From previous pass. mod. Now
collecting on ground loop.
GROWTH OF THE M7 NETWORK & MECHANISM

A. INCOMPLETE M7 NETWORK

1. ON INCOMPLETE M7 LOOPS, (LOW DENSITIES)
   INTERCEPTORS COMPLETE LOOP ON M7 NETWORK

2. EXPANSION OF M7 SERVICE
   A. EAST-WEST PART OF LOOP ELEVATED TO 65° NORTH-SOUTH ON GROUND
   B. NORTH-SOUTH

B. COMPLETE NETWORK - EXPANSION OF SERVICE

A. INCREASE FREQUENCY OF PASSENGER MODULE
   UP TO A MAXIMUM OF 1 EACH 25 SECONDS.
B. INCREASE NO. OF MODULES.
C. MAKE LOOPS TWO DIRECTIONAL
D. TERMINATE EVERY OTHER M7 INTERSECTIONAL STOP, THEREBY DOUBLING LENGTH FOR ACCELERATION ENGAGEMENT DECELERATION CYCLE:
   AUGMENT GROUND LOOP PATTERN TO COMPENSATE.
E. DOUBLE PASSENGER SPEED

C. QUANTITATIVE CONSEQUENCES OF SYSTEM GROWTH

B.A. ON SEVEN LOOPS, VELOCITY 30 FPS, FREQ 25 SEC., 8 MODULES (MAX CAP 208). TOTAL TRIPS TO COMMERCE NODE/QUAD = 216,000 PERSONS PER HOUR ON M7 ROAD ACCESS AQUA POP OF 170,000 INCL OTHER
B.B. INCREASE TO 4 MODULES = 432,000 PERSONS/HR TO COMM NODE/QUAD
   SUPPORTS 8 MILL POP/QUAD
B.C. MAKE LOOPS TWO DIRECTIONAL; DOUBLING CAPACITY. 864,000 PPL/HR COMM. NODE. SUPPORTS QUAD POP 7 MILL.
B.D. ENABLES B.E.
B.F. DOUBLE SPEED; DOUBLES CAP. 1,728,000 PPL/HR TO COMM.
   NODE, SUPPORTS QUAD POP 14 MILL.

14 MILLION QUAD POP = AVE. RESIDENTIAL DENSITY OF 1,400 PPL/ACRE
SINCE THIS IS ABOUT 20 TIMES THE CONCEIVABLE LIMIT.
IT CAN BE CONCLUDED THAT M7 WILL NOT LIMIT GROWTH
PUBLIC COXES - MAN: FUNCTIONS

A. VERTICAL TRANSPORTATION
   1. PEOPLE
   2. FREIGHT

B. STRUCTURAL SUPPORT
   1. VERTICAL
   2. HORIZONTAL

C. PUBLIC UTILITIES
   1. FLUIDS
      A. WASTE
      B. VENT
      2. USEABLE WATER
      3. GAS
   2. ELECTRICAL
      A. POWER
      B. COMMUNICATIONS
   3. MECHANICAL EQUIPMENT
      A. HEATING
      B. COOLING

D. INTERCHANGE Mv
   1. M
   2. M
   3. Md & Mw
   4. M1
   5. M8
   6. M2

E. REGULATE:
   1. RATE OF GROWTH IN AREA
   2. DENSITY OF LAND USE
1. Footing
2. Sub Surface Structure
   Utility Hook Up
3. Second Shaft
   Elevators
   Fire Stairs
4. First Lease
   1. Structural Extension
   2. Elevator Ext.
   3. Utilities Ext.
      A. Boiler Installation
      B. Refrigeration Pump Installation
      C. Water Tower Installation
      4. "Up" Escalators
5. Second Lease
   1. 4A
   2. 4C
   3. 4B.A
   4. 4B.B
   5. Replacement of Water Diver
      & Extension of Lines to 4.3.B
   6. Installation of "Down" Escalators
      in First Lease
7. Final Lease
   1. 5A
   2. 5.B
   3. 5.D
   4. 5.A
   5. 5.C
   6. Installation of All "Down" Esc.
   7. Construction of M4 Interiors
PART V

SYNTHESIS OF URBAN STRUCTURE AND TRANSPORTATION NETWORKS - A NEW CITY
SYNTHESIS OF POLY-NUCLEATED CONFIGURATION, RESIDENTIAL DENSITY CONFIGURATION, NETWORKS AND GROWTH CAPABILITY

A. PUBLIC TRANSPORTATION

B. PRIVATE TRANSPORTATION
C. COMBINATION OF PUBLIC & PRIVATE NETWORKS M, M₁, M₂
The density of the M₂ network corresponds to the density of the residential area it serves (see Ic).
GROWTH OF A NEW CITY

A. INITIATION

B. QUADRANT DELINIATION

C. NODE DELINIATION

A1. INITIATION OF M3
A2. INITIATION OF M6
A3. INITIATION OF COMMERCE
A4. INITIATION OF HPS
A5. INITIATION OF M7
EXISTING DEVELOPMENT

C1. EXTENSION OF M3
C2. EXTENSION OF M6
C3. EXTENSION OF COMMERCE
C4. " MPE NODE
C5. INITIATION OF NEW COMM
C6. " MRE NODE

DEVELOPMENT OF NODES DEPENDANT ON RESIDENTIAL DEVELOPMENT
DEVELOPMENT OF NODES DEPENDANT ON REGION INDEPENDENT ON RESIDENTIAL DEV. OF THE QUADRANT
D. NODE & QUADRANT DELINATION

E. COMPACTION OF QUADRANT

- \( P_1 \) EXTENSION OF M_3
- \( P_2 \) " " M_6
- \( P_3 \) " " COMMERCIAL
- \( P_4 \) " " MRS
- \( P_5 \) INITIATION OF NEW COMMERCIAL
- \( P_6 \) " " MRS
- \( P_7 \) EXTENSION OF M_4
- \( P_8 \) INITIATION OF M_4
- \( P_9 \) INITIATION OF M_3 IN NODES
- \( P_{10} \) " " M_6 EXCLUSION
  IN NODES
- \( P_{11} \) INITIATION OF M_5

F. COMPLETION OF M_3 LOOPS
- \( F_1 \) EXTENSION OF PUBIC CORES
- \( F_2 \) INITIATION OF M_8 LINKS.
F. COMPACTION OF COMMERCE NODE

F₁ COMPLETION OF M₆ LINKS (M₆₋₆)
F₂ EXTENSION OF PUB CORES
F₃ CONSTRUCTION OF CAR PARKS ON NODE PERIPHERY WITH M₆₊ M₆ LINKS.
F₄ EXCLUSION OF M₆
F₅ COMPLETION OF L₄, L₅, L₆
F₆ INVASION OF RESIDENCES ON LAST EXTENSION OF PUB CORES (M₆₋₆)
6. CONSTRUCTION OF M6 LINKS
6. CONVERSION OF PARKING LOTS TO MFG. SPACE & WAREHOUSING
6. CONSTRUCTION OF CAR PARKS W/ M7 LINKS ON PERIPHERY
6. EXCLUSION OF M6
H. Possible growth pattern for a new city

Circled figures indicate maximum permissible growth of the particular area is achieved.
PORTION OF A THREE-DIMENSIONAL TRANSPORTATION NETWORK FOR A NEW CITY. LIGHT AREA IS PART OF A COMMERCIAL NODE; GREY AREA IS RESIDENTIAL.
M3: REGIONAL HIGHWAYS
M5: LOCAL AIR (HELICOPTER)
M7: LOCAL MASS TRANSIT
M8v: PUBLIC CORES

M4: REGIONAL MASS TRANSIT
M6: LOCAL HIGHWAYS
M8h: SUB-LOCAL MASS TRANSIT
G: PUBLIC GARAGES
BENDING CONFIGURATIONS - CONVENTIONAL AND TYPES SPANNING BETWEEN PUBLIC CORES - SEEN IN AFTERNOON (TOP)
AND HIGH SUN (BOTTOM)
A BUILDING CONFIGURATION BASED ON SPANNING BETWEEN PUBLIC CORES - AN INTEGRATION OF URBAN HORIZONTAL AND VERTICAL TRANSPORTATION SYSTEMS AND SPACES BOTH URBAN AND PRIVATE.
A POSSIBLE CITYSCAPE
PART VI

TRANSFORMATION OF AN EXISTING CITY: BOSTON
In the formative days of the Boston region township boundaries may have been set up in order to subdivide the inhabited region into a mosaic of areas, each small enough to have its center within an hour's walk of all its inhabitants. This was a natural procedure as long as there was only infrequent intercourse between adjacent townships - as long as they were relatively independent. But today, this is not the case; some townships are completely interdependent on each other yet maintain an independent political structure.

The consequence of this is a multitude of quasi political agencies which bridge across the independent townships where expedient. Commonly called authorities, they are a sort of intermediate between the townships and the state government but are staffed by officials who generally are not elected. The various authorities have the natural ability to become sort of fascistic autonomies like the New York Port Authority. As the interdependence of the townships increases, as it must in time, then the governmental effect of the authorities must increase also and new authorities will have to be created to manage new forms of township interdependence. The consequence of this is a decrease in the democratic process which each citizen can exercise in the control of his environment.

The Boston Metropolitan area can get along without the creation of a metropolitan government if it is willing to progressively relinquish portions of democratic government. Rather than argue in the realm of political philosophy it may be sufficient to state that a metropolitan government would be more efficient than a collection of independent
authorities in terms of coordinating operations toward unified objectives. The Boston area would be on the road to a metropolitan government if the various authorities in the area were coordinated with their policies being subjected to balloting in the affected areas.

That individuals derive an income from one area, yet do not financially support that area is parasitical. That parts of one metropolitan area are in competition for commercial development and the accompanying tax revenues is an ignorant way for an area to be developed.

In any event, if the Boston metropolitan area is to do any planning for future growth and attempt to alleviate some of its present problems then it will have to do so under the coordination of a metropolitan government, quasi or otherwise. It makes no sense at all to make plans for Boston City, year 1980, without planning for the entire metropolitan area.

Part VI of this thesis, the transformation of an existing city, presupposes a metropolitan or quasi metropolitan government in the area of that city. The objective of the transformation is to achieve a city structure which embodies those values developed in Part I of this thesis and stated on the last page of that part. The process by which this would be accomplished is evolutionary - a gradual transformation and superseding of existing structures into a growth pattern similar to that shown in Chart B of Part V. Partially simultaneously and partially sequentially the process would specifically be:

A. THE CONVERSION OF THE RAIL YARDS IN SOUTH BOSTON AND CAMBRIDGE-CHARLESTOWN TO NEW MANUFACTURING SITES.
Today these rail yards receive only partial usage. Their conversion to manufacturing sites would begin a nodal development which would produce three employment centers, including downtown Boston, with high density residential areas in between each node.

B. **REMOVAL OF EXISTING MANUFACTURING WAREHOUSING AND NAVY FROM BOSTON HARBOR.**

These activities are presently at a state of very low activity; they are facilities which are left over from the past when the harbor was very active. The harbor facilities have been made obsolete by new transportation modes. Boston harbor stands idle yet this part of Boston could provide the most amenable residential area in Boston if the densities were high enough to support accompanying maritime facilities.

C. **DEVELOPMENT OF HIGH DENSITY RESIDENTIAL AREA ON THE BOSTON HARBORFRONT.**

This would produce an employee source in between the proposed manufacturing nodes of South Boston and Cambridge-Charlestown, and the commercial node of Boston, also the existing and augmented manufacturing node of East Boston. Employment centers with a residential in between produces the reciprocal transportation loop, shown in graph E of Part III, which balances transportation networks and establishes a growth pattern.

D. **CONVERSION OF THE BOSTON SUBWAY TO THE M System (shown in graphs J through O of Part IV).**

The passenger modules would replace the existing trains. The
interceptors would travel around on the existing surface roads collecting and discharging passengers (similar to the ground loop part of M₁) and would enter down ramps to intercept the passenger module on the existing M.B.T.A. line. The existing subway line would have to be modified to accommodate the interception cycle. Except in very dense areas where the interception operation might not be possible, the passengers would not have to go below ground level, they would board the appropriate interceptor. The collecting-discharge route, the ground loop of the interceptor would replace much of the bus routing and being integrated with the bus routes and the former subway lines would greatly extend the service of the public transportation system in Boston.

E. DEVELOP RECIPROCAL LOOPS IN THE TRANSPORTATION PATTERN BY ESTABLISHING NODES IN THE METROPOLITAN AREA.

This would be done on the basis of the location of existing commercial and manufacturing areas, the generation of an alternating nodal structure, and accessibility patterns based on existing highways, subway lines, and railroad lines which could be converted to an extension of the M₁ system.

F. LINK NODES WITH THE M₁ SYSTEM.

This would be done by constructing new lines and converting some railroad r.o.w.s, and would be accompanied by the ground loop of the interceptors. The interceptor ground loop could easily respond to changes due to growth because of its use of existing and new surface roads.
G. CONFINE MAJOR GROWTH OF COMMERCIAL AND MANUFACTURING FACILITIES IN THE METROPOLITAN AREA TO NODES.

H. ESTABLISH PUBLIC CORES (M_v - Part IV Diagrams Q and R) IN THE HIGH DENSITY AREAS IN AND AROUND COMMERCE NODES.

I. BEGIN THE EXCLUSION OF AUTOMOBILES FROM THE DENSE NODES.
Replace by sub-local transportation systems (M_{sh}). This would be accompanied by the construction of car parks on the periphery of the nodes with links to M_7 or M_{sh} or both.

J. LINK COMMERCE NODES WITH M_3 NETWORK AND M_4 SYSTEM.

K. LINK MANUFACTURING NODES WITH THE M_3 NETWORK.
EXISTING BOSTON

MAJOR HIGHWAYS

MBTA

RR

INDUSTRIAL-MFG

COMMERCIAL

10 FAM./RES.ACRIE AVE.

3 FAM./RES.ACRIE AVE.
ABSTRACT:
MORNING MOVEMENT
- REMOVE INDUSTRY
- CONVERT RR YARD TO MFG
- CONVERT MBTA TO M7
ABSTRACT:

CONVERSION OF MBTA TO M7

PASSERGER MODULIE

INTERCEPTOR (HRNI). LOOP
2 ABSTRACT:
MORNING MOVEMENT
3: 

M7 Extension-Link Nodes:
- Add to M3 R.O.I.
- Add to RR R.O.I.
- New R.O.I.

M3 Extension:
- Add to RR R.O.I.
- New R.O.I.
ABSTRACT:

M7 NETWORK
RESIDENTIAL DENSITIES:
■ VERY HIGH
■ HIGH
■ LOW
4.

**LINK NODES**
- M3 EXTENSION
  - ADD TO RR R.O.IV.
  - NEW R.O.IV.
- M4 EXTENSION
  - ADD TO M7 R.O.IV.
  - ADD TO M7/M3 R.O.IV.
  - ADD TO RR R.O.IV.
ABSTRACT:

M3 NETWORK

M4 NETWORK
EXISTING BOSTON
VOLUMETRIC RESIDENTIAL ZONING
PART VII

APPENDIX AND BIBLIOGRAPHY
APPENDIX A: An example of Harbor front development; a project done in the fall of 1965 at M.I.T.

Although this project is not formally a part of this thesis, my thesis advisor and I felt that it should be included as it exemplifies some of the ideas developed in the thesis: the integration of diverse functions, transportation, form and space in an urban context.

There was no program to this project, only a general site area intended for residential development. The resultant configuration had 5,300 dwelling units at an average of 1000 sq. ft. each. This produces a population of about 19,000 people. Each unit has a double exposure; to the inner spaces - community - and to the outer spaces - privacy, solitude and distant views. The major question raised by the approach to the project was whether individuals and families would be subordinated by the structural exigencies of such large forms and spaces. I found that by carefully considering spatial transitions, arranging functions three dimensionally, and having the structure be essentially a rectangular grid triangulated in three planes that the forms and spaces would not subordinate their inhabitants, but could readily respond to them.

The diverse functions contained in this community are principally residences, professional and commercial offices, shops and stores, and special functions - along the linear ground element - like places for theater, meeting, worship, and recreation. The spine of the linear element is a pedestrian way and monorail line. The monorail links each elevator station, parking garages and subway stop. This gives the community immediate access to most of the city and links most of the city to the community.
The linkage of the city to the community was the major exploratory issue of the project: could the transition of spaces from the city to the community be such that the identity of the community was not as an object but as a space? As such the identity of the community would transcend the attributes of form. The identity of the community would become the feeling, the general character of the human activity that occupied the major space. The identity of the community would become human values as dynamic, responding in time, rather than static as when they are built into objects - buildings.
PLAN AT CONCOURSE LEVEL. LARGO CIRCLED LETTERS SHOW POSITION AND DIRECTION OF VIEWS FROM THE PRECEDING PAGE.
SECTION A-A

A: RESTAURANT
B: COMMERCIAL OFFICES
C: PROFESSIONAL OFFICES
D: SHOPS
E: MONORAIL STOP
F: RETAIL SALES
G: COMMERCIAL STORAGE
H: TENANT STORAGE
APPENDIX B: Abstractions on Man and Environment

Of relevance to the formation of a network or the generation of environmental qualities and scale may be the synthesis of the following ideas:

A. The Humanistic Psychologists suggest that the functioning of the mind has a direct relationship to the physical structure of the mind; that is, a state of well being or non-well being may depend not only on the actual environmental situation and the perceptual conditions of the individual, but also on the affinity of the environmental situation to the physical structure of the mind.

B. The Existentialists suggest that the consciousness of man alienates him from his world and produces a longing for unity.

C. The Humanistic Psychologists state that by virtue of man's consciousness he is able to transcend his existence by either loving-creating or hating-destroying and thus satisfy the longing for unity.

D. The notion of naturalistic poetry that if we someday look far enough into the human mind that we may find similes to rocks and trees. This idea is a sort of combination of A and B.

E. The concept of the world as a continuum of process in which the present state of an entity, or idea, can be understood only by looking at its present and past relation to the world.

The synthesis of these concepts produces a thought on the relation of man to the world: That when in nature we feel a unity because the unconscious mind is in the milieu from which it came. The conscious mind transcends nature by producing artificial structures, artificial environment which can extend or retard the unity of unconscious mind
to environment. Extend or retard depending on whether the artificial structures have an affinity to the structure of the unconscious mind.

That functional and rational environmental structures have an appeal to the conscious mind goes without saying. What is the appeal or affinities of the unconscious mind? Does the unconscious mind have a different rate of growth than the conscious mind? These questions give good reason to look for conditions of the environmental structure which will have an affinity to the totality of the human mind.
APPENDIX C: Abstractions on the Generation of an Architecture

Spatial order is a matter of efficiency that serves to expedite a pattern of human affairs and relate the pattern to the context of culture. Non-hierarchical spatial order allows a matrix of patterns to emerge whose generation is individual choice and whose context is degree of collective involvement.

The scale of space is connotative in terms of degree and character of collective involvement.

The sequence of spatial scale is dynamic in that it contrasts one spatial instance to another thereby extending the meaning of each instance in terms of degree and character of collective involvement.

Form is the introversion of a surface of an object. It has no relation to scale but to size.

Shape is the extroversion of a surface: as such it does not generate an object but generates space. Shape has scale by virtue of its human containment. Shape considered dynamically not only reflects human movement and the movement of light, but also the possibility that space may have to change its character in time in order to be responsive to changes in human processes. This allows the human choice of moving to new spaces or to stay in spaces which are modifiable.

Structure is enablement to shape. In that shape relates to human process then its enablement must be multi-positional. There is concurrance in the hierarchy of modification probability for both shape and structure: the rate of change for shape is inversely proportional to
the scale of space they relate to; considered generally, a member may have a rate of change or multi-positionality inversely proportional to its size or to the stresses it carries.
BIBLIOGRAPHY

Alexander, C.; The City is Not a Tree, Design, Jan. 66.
State of Illinois, Cook County & Chicago City; Chicago Area Transportation Study, 1956.