

PROJECT METRAN
and the Architect in Collaborative Study

by

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Dear Dean Anderson:

In partial fulfillment of the requirements for the degree of
Master of Architecture, I hereby submit this thesis entitled
"PROJECT METRAN, and the Architect in Collaborative Study".

Respectfully,

Scott L. Danielson

A C K N O W L E D G E M E N T S

I would like to express my special gratitude to the following people for their assistance and encouragement during the development of this thesis: Dean William Seifert and Professor Dwight Baumann of the faculty in the Interdepartmental Systems Design Group, and Professor Jerzy Soltan of Harvard's Graduate School of Design.

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T A B L E O F C O N T E N T S

LETTER OF SUBMITTAL

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A B S T R A C T

This thesis is a study of collaboration; a summary of transportation objectives, and the possible vehicles and networks to fulfill them; and a suggestion of changes in urban form and patterns due to transit's impact.

Highlights of conclusions are:

- Collaboration should be encouraged in the curriculum. Without participation with other fields the architect is in danger of misinterpreting the world, or being unable to communicate with it effectively.
- Leadership must be practiced. It must be willing to make decisions without all the facts, and capable of getting people to talk to one another.

- Transportation planning must be co-ordinated with general metropolitan objectives covering social, economic, political and visual considerations.
- A metropolitan government is necessary.
- Technology must play an expanding role in transit systems particularly in traffic control.
- Transit systems should move both goods and people.
- Private and Mass transit vehicles share computer controlled roadways.
- Rail transit is phased-out to improve the flexibility of mass transit vehicles and fuller utilization of the facilities.
- Ultimate use of rental vehicles for nearly all private driving is highly probable, with mass transit vehicles approaching them in size.
- Transit networks can present a coherent and pleasant experience of urban environment to the rider. They must also be as pleasant and constructive to the pedestrian experience.

H I S T O R Y

This thesis was developed as a result of participation in an interdisciplinary study course given in the Spring of 1966 at M.I.T. The course has been in operation for five years and from a brave beginning combining only several branches of engineering towards a common goal, it has expanded into a truly interdepartmental collaborative effort combining students from Electrical, Aeronautical, Mechanical and Civil Engineering, Political Science, Economics, City Planning, and Architecture. It has been a unique opportunity to study a problem in its totality, to become familiar with the modes of thought characteristic of other disciplines, and to try to make the architect's concerns explicit to future clients, engineers,

and/or policy makers. The problem presented to the students, to design an evolutionary, integrated urban transportation system, was in every way as unique and worthy of joint effort.

The group spent nearly two months organizing itself and defining the scope of the problem. As the course progressed the need for better communication, for more rigorous methods of research and data collection, and for strong leadership willing and able to establish goals early and to direct man-power became unmistakably clear. Yet there is a case for leaving the students to wrestle with these aspects alone. Sometimes there was no choice but to do so, since certain problems have no accepted solution. By establishing its own structure and goals the group did discover their importance and the time they consume - but in this we were only perpetuating an inefficiency disturbing in professional and governmental practice.

Vannevar Bush has written a beautiful essay for M.I.T.'s alumni magazine Technology Review entitled "Man's Use of Men", in which he alludes to the need for competent leaders and organizations developed in such a way that each individual finds fulfillment. We can fill engineering specifications fairly easily, but we are inadequately prepared to meet human needs. Schools and foundations should put more funds and energy into research for understanding group dynamics. How do you reach people who hide behind elaborate but obscure theories, or blur their ideas with words having special definitions (which they are rarely able to define)? How do you

keep a group working for common goals rather than splintering into interest-factions that operate with Messianic fervor on their own scheme and waste tremendous energy decrying the plans of others? How do you give your own ideas greater impact so that you have the best possibility of achieving them? Or, how do you establish attitudes for taking criticism seriously, but not "to heart"? - which involves also knowing how to give criticism. It is awfully easy to think we can do these things "naturally", but when you've served in the military, or observed faculty disputes, or found yourself ineffective in a committee, untitled nature seems ill-equipped to produce the required skills.

After two months of preliminary work a single scheme for a transit network was chosen and more detailed studies were undertaken. As the sole architect in the study I found much of my time spent in integrating the work of the sub-groups and in presenting visual displays showing the various systems working together. Involvement in co-ordination, as well as in generating concepts for several of the transit systems left little time for visual studies of city form, or roadways and stations per se. In studying the context for transit systems and in developing group rapport, however, I learned a great deal about the roots for a valid architecture. Such architecture must grow in response to a wide range of human needs and philosophies, and it should be developed "in situ" amongst those people who will some day build and live in it. If the architect is to say something relevant about the world he cannot operate in a vacuum.

T H E P R O B L E M S T A T E M E N T

The statement of the problem given the group in February was to design an integrated, evolutionary urban transportation system. The magnitude of the problem to be solved is evident in the following observations. There is a lack of co-ordination between metropolitan agencies and between transit interests: a public transit agency fails to mesh its rail network with that of the highway department, or road-people decry rail's obsolescence, while rail-people despair road's government subsidies. Detroit changes body styles every year forcing superficial obsolescence in 2 or 3 years, whereas the real condition of the car is good for another 3 to 6 years. There is a lack of technological innovation in today's

vehicle and network: no roll-bars or collision absorbing fenders, unsynchronized traffic signals, etc. Mass transit systems have to fight with other vehicles for space on the city street, their schedules don't jibb, or the network is too open and gives poor accessibility. A look at any "freeway" at rush-hour suffices for comment on congestion and the proliferation of the private automobile. Networks are imposed on cities without any consideration of visual or social conflicts - whether the structure will block the view or sun from one's windows, or whether there are apartments available and suitable for the low income families being evicted. Nor is enough thought given to the economic impact of the roadways on the urban economy. Finally, there is the social role of the transit system and the effect of mobility. Watts is certainly not exclusively a transit problem, but because the Negro community had little or no transportation it had little access to good jobs, education or housing, and finally exploded last summer. Transportation is increasingly in the spotlight. Its influence will have to be understood, and its objectives clearly stated and pursued, if the problem is to be met. **PROJECT METRAN** (METropolitan TRANsportation) is an attempt to do just that.

O B J E C T I V E S

Given the scope and complexity of the problem, the group took considerable time to specify the problem areas and to establish objectives and criteria for the solution. The study covered four fields: the social economic, political, and visual.

Before going on to a discussion of these four areas, the raison d'etre (the why?) of the city requires investigation in order to understand what qualities are necessary for its success.

Developing over centuries, cities have variously served for defense, as a labor source for production of food, goods, and buildings, for concentration of religious practices, for commerce, education,

government, and culture - culture as not only the preservation of Behaviors, Intellect, and Art of past generations, but as a living, spontaneous environment for contemporary man to fulfill himself.

It is this last element which I feel is the most significant today - cities must provide an environment contributing to man's fulfillment. Kevin Lynch in the Winter issue of Daedalus in 1961 suggested nine attributes of cities which are good measures for such an environment, namely: choice - the freedom to select friends, education, residence, work, etc., from a wide variety; interaction - the possibility for many or few social contacts both planned and spontaneous; cost - the provision of an environment (form, goods and services, etc.) at a price acceptable for the desired goals; comfort - the control of climate, noise, pollution, and adequacy of indoor and outdoor space, etc; participation - the opportunity to manage and modify one's own world to some extent; growth and adaptability - the capability to shift and expand with a minimum of effort; continuity - the moderation of growth and change so as not to destroy community balance or sense of history - evolution instead of revolution; and lastly image - the clarity and beauty with which the components of the city are built and related. To this I would add education - the power of the environment to convey and inculcate values and behavior norms. The role of transportation in contributing to these attributes of the healthy city can now be discussed in terms of the four fields mentioned earlier - social, economic, political, and visual.

SOCIAL OBJECTIVES

The group found the social impact of transportation to be extremely powerful, yet subtle and difficult to measure. One of the first objectives in this social realm should be to develop the transit ways (road and rail) into a lattice or grid form. This would provide maximum accessibility to all parts of a metropolitan region, facilitating greater choice of residence and work. In combination with low user cost, the grid network gives adequate mobility to low income groups. Unable to afford the high initial and operating costs of a private automobile, and frequently without any mass transit available, low income families are often forced into restricted zones of the city, or forced to accept minimum-standard jobs. With low cost transit running over a complex network, these families would have access to jobs and recreation outside their neighborhood. This mobility creates the possibility for choice, for interaction with other social groups, and for education and moderate participation in developing an image of the whole city in which they live. A prime example of dangers arising from the failure to provide mobility to all income classes has been the riots in the town of Watts in Los Angeles, California, last year. Because the Negro population of Watts cannot afford private automobiles, and because Los Angeles has no mass transit system, they are confined to their suburb, unable to learn about and reach jobs that go unfilled in the wider metropolitan region. Without

accessibility to work and wages, the economic base of Watts has been extremely weak. Educational facilities have suffered, and frustration and the sense of being forgotten have built to explosive proportions. Low cost, highly accessible mass transportation would be a major social tool for rehabilitation.

In developing a more extensive network to achieve accessibility, care must be exercised to minimize land-taking. Especially in high density areas the taking of property for new rights-of-way often results in the loss of housing and destruction of the neighborhood's social structure. Where such occurrences are necessary for the proper functioning of a comprehensive transportation system, special attention should be given to maximizing continuity. One means to this end would be provision of funds for new housing in the area or rent subsidy so that relocation would be reduced to a move "down the street".

Continuity would also be enhanced by encouraging community participation in transit decisions of the planning body. By entering into the early stages of planning, the residents would have more of a chance of gaining a hearing. And the planners would gain a higher degree of understanding and co-operation from the public. In legal support of resident action, boards of review for property taken by eminent domain should be established to offer recourse to families about to be relocated. This would have to be accompanied by legal aid necessary to put their case over.

The growing role of recreation is another important social concern influencing transportation systems. In New York City, polls revealed that 70% of the sample considered a pleasure drive their number one form of outdoor recreation. If this is true of all urban centers, then being able to just "go for a drive" is a significant performance specification. A transit network must provide ease of access to open space, "to the country", as well as affording vistas of the city through which it passes. This is even more imperative in view of an expanding population and a decreasing work-week which will make leisure time a major social problem unless people know how (and have the facilities) to use it. Even now, there is a need for easier access to recreation facilities for city dwellers. As Sumner Myers, Project Director of the National Planning Association, has put it, half the enjoyment of city living is in knowing you can get away from it on the weekends - that you can choose to spend your leisure time by the water or in the mountains, away from the pressures that urban life inflicts upon its inhabitants. It is unlikely that urban pressures will decline with a 30-hour work-week; so longer weekends will have to continue their crucial social function of rejuvenation. The transportation system must be ready to serve this requirement as well as those stated previously.

ECONOMIC OBJECTIVES

The economic influence of transportation is equally as significant as its social influence, and is easier to discern. The transport system must facilitate interaction between the nation and the region. Road, rail, air and sea networks must be sufficiently organized regionally, and up-to-date technologically so as to mesh smoothly with national trends and systems of movement. Had Chicago not developed O'Hare Airport and expressways into the Loop the city would have been hindered in its growth and in turn, national growth would have been affected. The relationship can be stated another way: Chicago's location and attendant concentration of economic power are so favorable and vital, that its transportation system is forced to keep pace to avoid tremendous financial losses.

Keeping costs competitive for the flow of goods and people is important not only for maintaining the economic health of the region, but also for stimulating its growth. Accessibility within a region (like an extensive network of free, public roads) can encourage development of business and industry, thereby attracting an increase in population, services, etc. The opening of Route 128 around Boston provided access to land which, in combination with access to the "Brain-Trusts" of local universities, has been developed for research and light industry at an astounding rate. Thus, the desirability of a modern, competitive and accessible transit system is proven.

The cost in natural resources must also be taken into account. The obsolescence designed into the transit industry, while generating a high level of new sales and possibly maintaining or increasing employment, does so at a tremendous cost in the rate of consumption of the nation's metals, oil, and rubber resources - and in the multiplication of junkyards (Figure 4.1).

Figure 4.1

WASTE



The pollution of air and water resources is equally costly, and more immediately observable in the brown skies over cities and in the brown rivers, lakes, and bays - no swimming allowed - beside them. Transportation is a particularly heavy contributor to pollution. The individual gasoline engines in the millions of autos, buses and

trucks glutting our highways give off staggering quantities of carbon and nitrogen products which are not assimilated by the atmosphere. These products combine with other elements to create corrosive and poisonous by-products, forming smog, which blights the industrial urban areas throughout the world (Figure 4.2).

Figure 4.2



Polluting water resources is somewhat less directly traceable to transit, but the uncontrolled disposal of waste products from oil refineries into waterways is one instance of that relationship. Electric power, though less efficient than the gasoline engine, is cheaper when considered in the light of the indirect costs of

pollution. Fuel cells or central power plants generating electricity would provide energy under controlled conditions in which waste-products could be processed before release into the air or water. Similarly, disposal equipment to treat the effluent and allow safe discharge could be developed for refineries.

The effects of transportation on both pollution and consumption of natural resources are extensive, and currently unconventional thinking is required to assess their real costs. Americans have been extremely negligent in starting programs to control and avert misuse of their natural resources. Though efforts to establish programs recently have been initiated in Congress, they are timid starts and must be followed up and expanded. We can no longer afford to hesitate.

The final, and most important economic objective for transportation is to achieve an operating system with non-negative net costs and benefits. That is, after balancing the direct and indirect costs of equipment, payroll, and natural resources against the direct and indirect benefits of social mobility, new industry attracted, etc. the annual budget ends in the black.

Wherever possible, transportation systems should be paid for by their own services, not by government subsidy. The concentration of riders during commute hours currently places an impossible load on both private and public transit networks. Such peaking leaves costly facilities and equipment idle during the off-peak hours.

To achieve viability an optimum distribution of users or uses must be sought and developed.

However, economic operation without subsidy must not be made a rigid policy, if to do so would mean ignoring social, political and visual considerations. For example, certain routes of the mass transit system may have to operate marginally or at a loss in order to provide the mobility critical for better integration of low income groups into the wider society. It may also be necessary to spend time, not presently budgeted, to achieve desired public understanding and support. Further, in order to achieve visual clarity and richness, the cost of networks and designs may have to be increased. In these cases, balancing the ledger on the basis of monetary costs only is not a sufficient goal for transit planners. Imaginative work in many fields is needed to discover ways of minimizing monetary costs while taking broad and humane account of the real effects of the transportation system created.

POLITICAL OBJECTIVES

The social impact roughly sketched previously, the large outlays of money, and the great number of constituents served make transportation a political issue. In tracing the effects of transit

systems the group came to several conclusions of political importance.

Most significant is the need for a unified governmental authority for transportation planning in metropolitan areas. Boston's predicament is typical. The Department of Public Works, the Massachusetts Port Authority, the Massachusetts Bay Transit Authority, and the Metropolitan District Commission (there are more) all operate components of the transit system in the Boston region. With such fragmentation of authority, there results duplication of service in some areas, lack of service in others, and continued use of vehicles or networks no longer suited to the transit role (maintained by the pressure of vested interests) - in short, unco-ordinated planning of single components.

In fact, a co-ordinated metropolitan government, not just a transit planning authority, is required. Transportation needs cannot be met unless the system is designed to serve regional land-use patterns; these patterns cannot be developed without a comprehensive metropolitan planning board; and in turn, the board's efforts will be fruitless unless there is an executive body empowered to establish and enforce regional goals. Suburbs can no longer be allowed to drain urban centers of commercial and cultural benefits without helping to pay the costs.

This certainly applies to urban transportation, and in Boston there is cause for hope based on recent successful efforts to expand the

old Metropolitan Transit Authority into the MBTA. But such changes in geographic scope must also be accompanied by broad functional changes involving the MPA, the MDC, etc. Only as metropolitan transit agencies gain power and province can they effectively strike the optimum modal-mix of private and public, road and rail, land, sea and air.

The existence of a metropolitan transit authority would serve other political objectives as well. By bringing together all transit interests, the authority would help maximize the use of existing rights-of-way, since their use would no longer be selfishly guarded, or ignored for lack of vision. The authority could plan the best routes, see if any existing channels matched, and if so, to see that that channel was developed to its optimum use, Using existing rights-of-way wherever feasible minimizes relocating homes and jobs.

The anxiety and costs of moving - both in social ties and in monetary demand - often arouses a fierce resistance on the part of the citizens involved. But since they usually do not have sufficient political strength their pleas go unheard. Such treatment is destructive to a sense of participation and control over one's destiny, and increases political apathy and resentment. It is, ironically, self-defeating to the avowed goals of "renewal" usually associated with land-taking for transit or urban improvement. The social objectives recommending community participation and establishment of boards of appeal regarding land-taking have manifest

political significance in countering the apathy and resentment mentioned above.

Land-taking, coincidentally, usually exacts the heaviest toll in the "grey" areas between the urban core and the outer suburbs. In the core, land values are too high for extensive expressway systems; and outside the grey area the population is dispersed so the expressways branch out to become widely separated. In the grey area the land is neither expensive enough, nor the population dispersed sufficiently, to counter the expressways. Consequently, the expressways converge in the grey area with all their massive interchanges - note Boston's Inner Belt as a case in point; it collects all the radials and makes only one penetration of the CBD (which followed an existing rail right-of-way).

Thus the grey areas face the greatest hazards from transportation land requirements. Yet, the inhabitants, generally low income, are the least able to afford relocating, and the most in need of mass transit facilities (which takes more land - a vicious circle). From this brief survey it should be clear that the grey areas and their inhabitants must be studied more to develop their relationship to the whole urban region.

Two directions are hinted by the problem: one, that a true orthogonal transportation grid is preferred, since it tends to relieve the concentration at the core; but it also loses focus and

differentiation. Second, that in a radial-ring grid, since the radials converge on the core, the grey areas are actually the ideal location for low income groups since they can take a radial at an inner belt to any location in the region. If political and visual difficulties regarding air-rights over expressways can be resolved, then low-income housing and plazas could be erected over the road (and rail) networks and the social and political hazards would be eliminated.

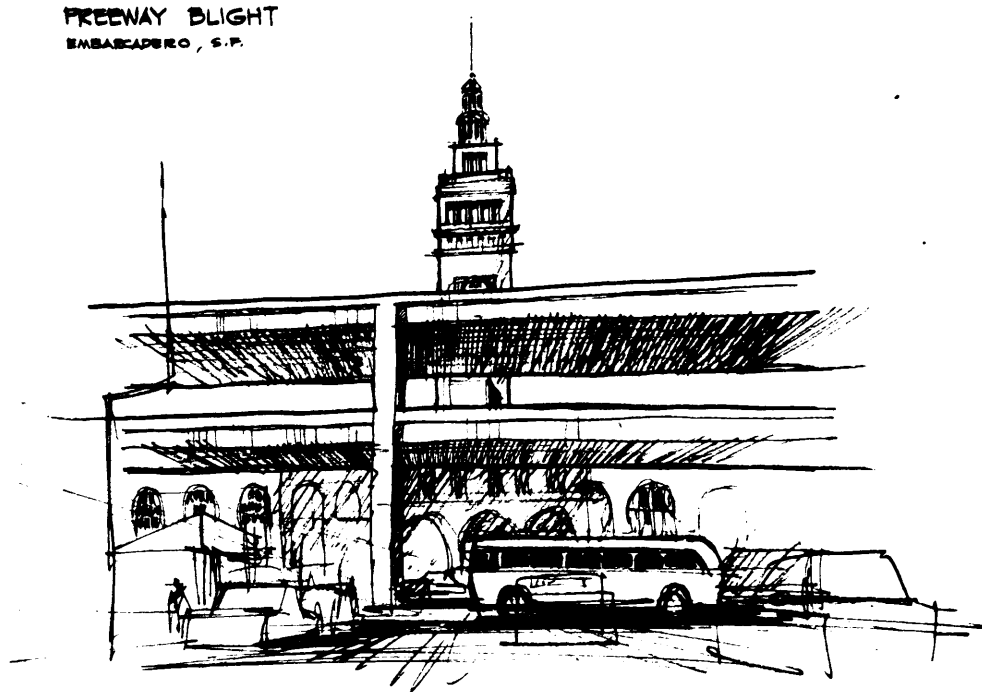
Demonstration projects of new systems offer one method for studying their effects and for gauging public opinion. They would provide real tests for scheduling and new technologies as well. Since private funding of such projects would be prohibitive, Federal funds now available through the demonstration projects program of the Department of Commerce should be sought. Federal support, possibly from demonstration cities funds, would also be expected to implement full-scale operational sub-systems. It is clear that cities will not survive, or at least not beautifully, if great sums (small compared to national defense or the space race) are not expended on transportation and the development of new city forms.

Demonstration projects also assist in providing for incremental growth of the system since they offer real models of the "next step". Such steps allow options for type of mode and network design tailored to public demand and the newest technology. To specify now in 1966, exactly how the system will be constituted in 1990 would be to

oversimplify the problem or to overstate the possibility of answering it for the future. Indeed, the point to be made by this study is its value as an approach to meeting changing transit needs: Objectives should be stated, a series of alternatives proposed in a general context, and then selected components tested and evaluated as funds are made available - and fully developed as needs warranted.

In reaching the final political objective the visual role of transportation was discussed as a base for political decisions. In particular, should decisions be made to favor the pedestrian interests (housing and merchant-type) or the driver-rider interests (road construction and auto industry-type). The conclusion was that components (assuming they work) should be selected as they enhance the pedestrian experience. This guideline is based on the observation that the person walking, since he travels more slowly and watches objects longer, is far more involved with his surroundings than the person driving who travels through the city at anywhere from 35-75 mph and is thereby unable to distinguish details or to linger over a view. For instance, in Figure 4.3, the pedestrian's view of the Ferry Building and the Bay in San Francisco should have carried more weight than the figures and desires of the State Highway engineers and contractors who wanted to build the Embarcadero Freeway. From this consideration it is an easy step to the visual aspects of the transit system.

Figure 4.3



VISUAL OBJECTIVES

Simply stated, the visual form of the transportation system should reflect the three preceding groups of objectives. Broadly speaking, the transit system and its political, social and economic bases should have a harmony and fitness that make of the whole an Esthetic. Having noted the importance of transit to the growth and life of the city, we should expect that transit will affect urban form as well. The need for accessibility and for a maximum of choice

in work and housing can be achieved in part through the development of multi-nuclear cities - urban complexes where a CBD might remain as the focus and identity of the metropolis (Union Square is uniquely the heart of San Francisco), but where sub-centers at some distance from the core would develop as very strong, distinct activity centers.

Development of a multi-nuclear metropolis, in conjunction with the creation and preservation of green belts, would allow controlled growth, and give architects and social scientists time to consider questions of optimal density. This emerges as a basic question. The work of the systems group clearly indicates the ability of technology to provide transportation to populations far more dense than those of New York or Tokyo. Therefore, those involved in urban planning must begin to seek answers to questions regarding the quality of life desired and the broader esthetic mentioned earlier. Important questions cluster around whether and how the desired patterns of urban life can be achieved visually, humanly, in densely populated regions.

Other animals are known to have definite sociability needs and limits, beyond which crowding triggers escape mechanisms or generates increasing stress (See Hall's article). There is also growing concern about the overcrowding, or saturation, of the landscape. Concerted research might reveal combinations of people, pollution, and paving that exceed an optimum balance for a given land area.

(Macinko's article). Or, we may find that if we can provide requisite amounts of privacy, light, air, and waste disposal there is no ceiling on density for humans. We are unable to provide these things now, so the "if" is crucial, assuming we desire to inhabit this planet indefinitely.

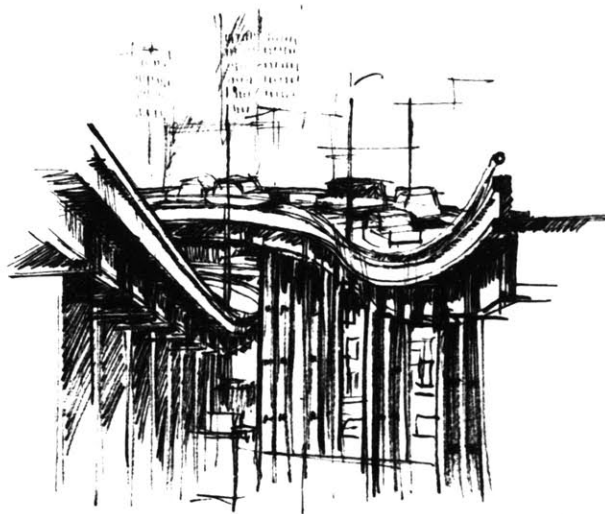
Assuming that the multi-core city will be developed to meet objectives mentioned in the earlier sections - the main concern moves to better integration of transportation networks with urban form. The networks should form boundaries between different land uses, thus articulating different functions. They should afford the traveler a survey of the region's activities in an exciting visual trip. They should be sensitively designed in relation to the immediate environment so that they take advantage of vistas and/or define spaces. The Embarcadero Freeway in San Francisco is a negative example (Figure 4.3); its construction within a few yards of the famous Ferry Building destroyed that building's function as the visual terminus of Market Street. Otherwise a fairly handsome concrete structure, the freeway by brutal upstaging has deprived the city of an important visual event and contributed nothing by way of compensation. The lower deck is below the Ferry Building's roof, so even the drivers gain no view. An alternate proposed just prior to the time of construction would have routed the freeway several hundred feet west of the Ferry Building in order to create a park and to retain the drama of the building. Regretably, the opportunity was lost by officials' failure to understand that real

costs (including visual values) are more important than direct costs (how much is the contract?).

Steps should be taken towards building roadways and other transit facilities into the urban structures themselves. This involves expanding and developing the use of air rights over existing expressways, but also the proper use of the "land rights" under elevated structures. Current practices permit freeways to dip and curve, cutting off impossible-to-use segments of land beneath them which are left barren or filled with parked cars (Figure 4.4). Such design alienates the freeway from the city

Figure 4.4

SPAGHETTI -ALA- TRANSPORTO



through which it passes. Air and land rights offer a positive use of transportation space - in Boston Proper, transportation facilities consume 52% of the land area.

Where there is not physical integration, the location of new roadways, or the siting of new buildings near existing roadways, should take into account the dynamic visual effects for the traveler. Objects which pass through his visual field faster than 12 minutes of arc per second will be blurred and contribute little meaning. Fast turns not only produce uncomfortable gravitational forces but create a nauseating visual experience. Appelyard, Lynch and Myer's book, The View from the Road, cites negative examples, and makes one of the first attempts to design a road consciously for a coherent visual sequence while travelling.

Uncontrolled economic use of road frontage has created trip sequences, too - but ones of tremendous chaos. As Peter Blake demonstrates in God's Own Junkyard, little or no thought has been given to controlled use of roads, or to the impact of accessibility on previously virgin land and on land values. Controls, and design standards, must be initiated to rehabilitate, direct, or prevent strip developments.

The visual clutter they cause is too often equalled by road signs thought to be instructive. Immediately the question of better graphics arises and with it the problem of information transfer.

Graphics must be simplified to use fewer words or to substitute symbols like those used in Europe. Anyone who has arrived at Park Square in Boston via the MBTA, and wishes to make a transfer, has experienced the problem: great sign boards are filled with destinations and permutations of cars you can take to reach them.

Preferable to simplified graphics would be the possibility of seeing where you were going. For transfers this might mean a route map that lights up when a car arrives going in that direction.

Ideally, no transfers would be necessary; once the decision to go to some destination was made and one entered a vehicle, one would travel non-stop to that destination. Station entries and platforms should orient in the direction of the destination rather than require turns or doubling-back. For departing a station the exits should be conspicuous, with openings that you could see out of from any point on the landing.

The fundamental objective in these few instances is to develop a positive visual role for transportation systems. They should help create a structured and coherent mental image of the environment in which the individual moves and "has his being".

The importance of considering the four fields - social, economic, political and visual - as operating together in determining the optimal system bears emphasis. There emerged, in fact, a few objectives that did not fit comfortably in any one of the four categories. They are presented now as general engineering specifications.

First, the effort of travel should be reduced. Delays in commuting, uncertainty of departure and arrival times, and multiple transfer of vehicles or modes over a given intra-urban trip expend a disproportionate amount of energy for the level of service.

Second, door-to-door travel time must be shortened. Higher speeds and shorter headways are required. Third, safety must be improved. Last year's toll of 50,000 traffic deaths speaks for itself. Fourth, interchangeability of vehicles on networks and their evolutionary compatibility are desirable characteristics in a system attempting maximum accessibility and utilization. Finally, the application of technology, and of computers in particular, should be exploited to the full in bringing the system up to the public's level of expectation. At a time when we can fly at speeds of 4-5000 mph and achieve the pinpoint landing of a satellite on the moon's surface, the man in the street must surely wonder why he still has to share that street with vehicles which, though powered by 400 horses, he can outwalk at 5:00 P.M.

S Y S T E M C O M P O N E N T S

The area studied was the Boston metropolitan region since it was readily at hand, was most familiar to the majority of students in the course; and there was a large amount of computer data on Boston at M.I.T. It should be noted, however, that the components as well as objectives were developed with an eye towards general urban problems and that the examples shown are to illustrate principles and not dictate form.

The Boston region is shown in Figure 5.1, roughly defined by Route 495 which is being built around the perimeter of the region. It contains 152 cities and towns, 2300 square miles, and approximately

BOSTON METROPOLITAN REGION

152 CITIES & TOWNS
2300 SQ. MILES
3.6 MILLION INHABITANTS

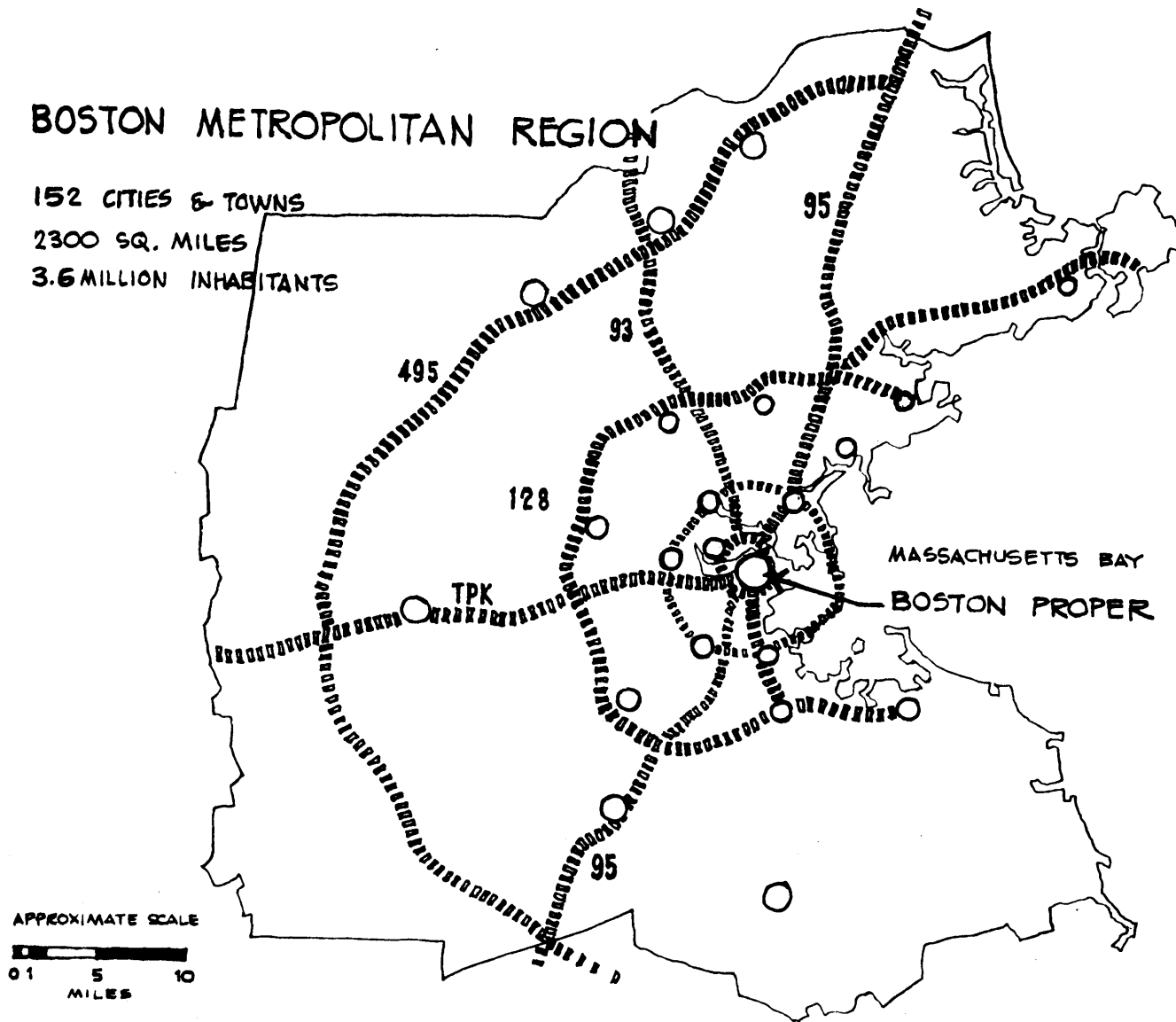


FIG. 5.1

THE BOSTON REGION

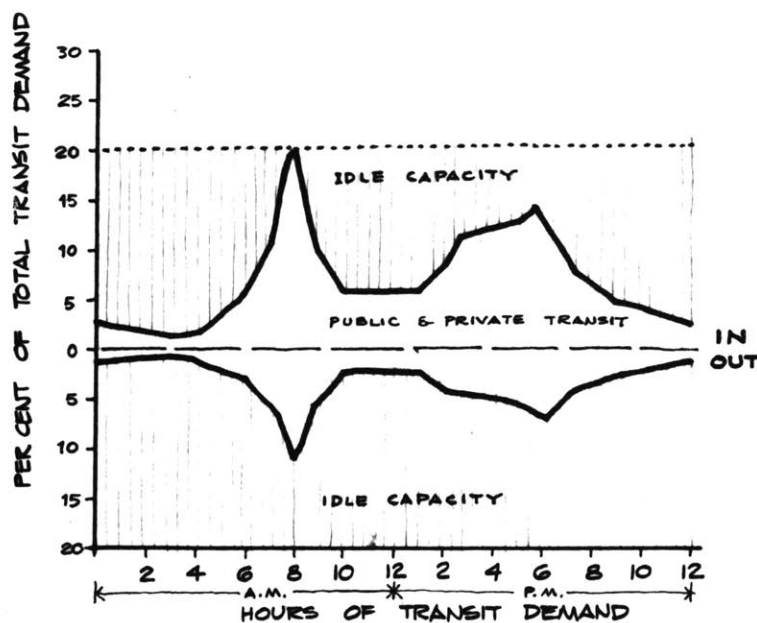
MULTI-NUCLEATED



FIG. 5.2

3.6 million inhabitants. In the next thirty years, the population will double or triple, making the need for developing transportation in an integrated network extremely important if congestion and visual blight is to be avoided. This growth should not concentrate solely in or near the Central Business District, but rather ~~to~~ develop in suburban centers around the nucleus (Figure 5.2). The increased importance of Gloucester, Salem, Lawrence, etc. would relieve the population pressure on the core, and by becoming cities with their own identity and services, they should increase the distribution of transit demands. This spread would result in two-way commuting on public transit routes during the peak hours (Figure 5.3), which is far more efficient since it fills seats going

Figure 5.3



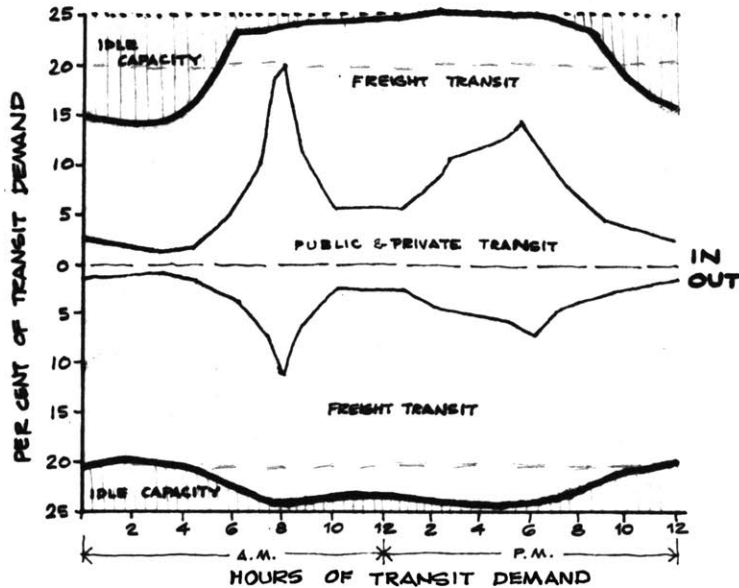
in each direction. These sub-centers should also strive for the greatest mix of activities consistent with maintaining a unique atmosphere. This would not only keep a flow of people moving in the centers to give them life, but also put people in the transit system during off-peak hours, boosting mass transit's efficiency by reducing the number of idle cars and personnel.

The peaking problem could be reduced or eliminated by one further step - the use of transit facilities for moving goods as well as people. As metropolitan regions are developed and sub-centers flourish, the location of existing warehousing and wholesale facilities in the core will become less and less related to its users. Add to this the increasing land values, and the difficulty and inefficiency of hauling goods into the CBD for outward distribution later, and one has the basic parameters for a new goods storage and distribution system. Many warehousing and shipping facilities are already moving, so there is an ideal opportunity to co-ordinate their moves and that of the industry to serve a comprehensive metropolitan plan that links land-use and transportation.

If goods and distribution facilities were located in several centers along Route 128 you could achieve several major goals. First, land is both available and less expensive so that adequate buildings and space could be acquired. Second, the locations are on a major

guideway which is an ideal collector of transcontinental and inter-regional rail, road, and HSGT networks. With the development of Medford airport into an Air Freight center, mentioned later in this chapter, air networks are also tied-in. Third, you release land in denser urban centers for development into parks, housing, stores and offices. Fourth, the locations along 128 are nearly half-way between the core and the perimeter so that distribution is greatly reduced, in time and mileage. Fifth, and last, mass transit facilities would provide excellent channels and nodes. Containerized transit vehicles would handle cargo during off-peak hours, virtually eliminating idle capacity (Figure 5.4). Subway stations modified

Figure 5.4

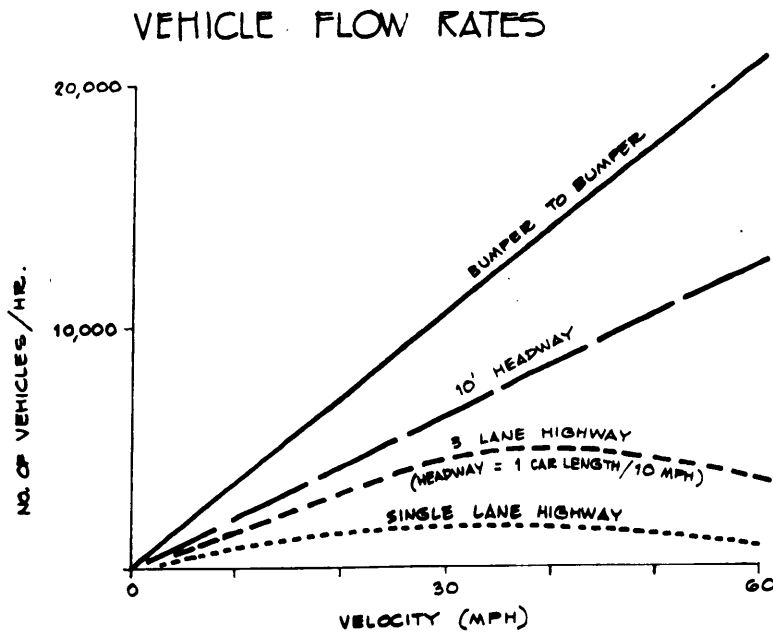


to include special sidings and underground storage rooms, plus new "stations" exclusively for cargo, would provide excellent out-of-sight servant functions for the CBD and large sub-centers. Terminals might be above grade, but "buried" in a utility core (See Appendix A).

With the definition of urban subcenters and a storage and distribution system, one can see the tremendous interaction possible between transportation and its environment. It also introduces the context in which the vehicles and networks will serve that are to be described in the following paragraphs.

A look at the capacities of various networks pointed to computer control very early. The graph in Figure 5.5 indicates the capacity

Figure 5.5

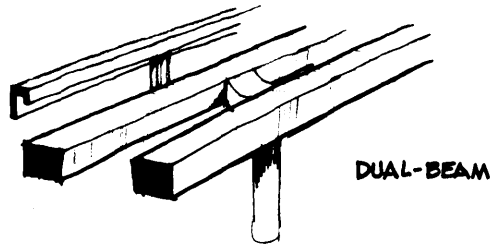
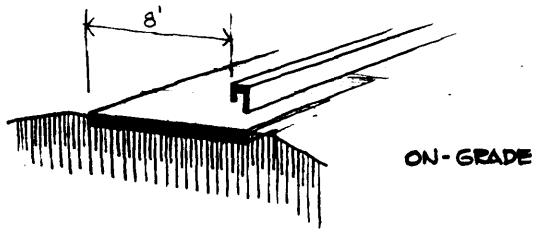


of computer guided roadways versus manual control and makes the story quite forceful. By running vehicles bumper to bumper, the capacity at sixty miles per hour on a single lane of automated roadway is 21,000 vehicles per hour. However, as bumper to bumper traffic is a little hard to control, the vehicles would operate at ten foot headways. With such a headway capacity drops, but still remains over 12,000 vehicles per hour per lane, at sixty miles per hour. The tremendous advantage of computer control is clear when compared with the capacity of an existing three lane manual freeway, where we see the capacity never exceeds approximately 5,000 vehicles per hour - traveling at forty miles per hour. The capacity actually drops off at higher speeds because of the increase in headway required for a certain degree of safety. Therefore, we can triple or quadruple the capacity of networks without increasing the number of lanes by using computer controlled roadways, which we shall call guideways.

The guideway might look like the two possibilities illustrated in Figure 5.6. One is on-grade, with an "L" shaped guide-rail on the side, carrying guidance and power; the other is an aerial system, which would be comprised of two concrete beams and the "L" shaped guide-rail. This latter scheme assumes a higher degree of fail-safe or fail-soft capability. The on-grade system provides that vehicles in an emergency disengage and roll off to the shoulder lane and stop for repairs. The dual beam system would not allow that; it would

Figure 5.6

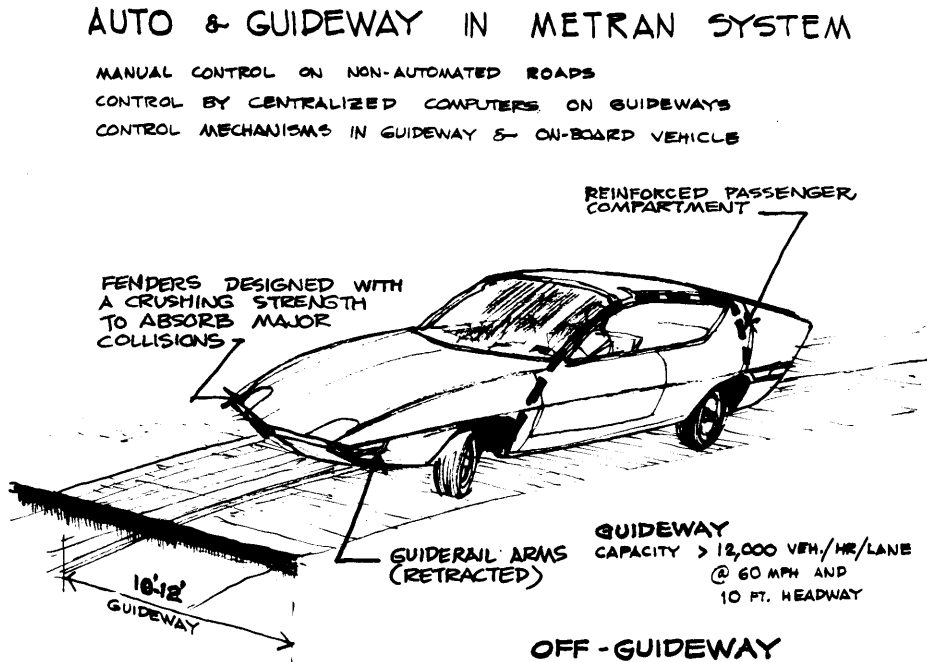
GUIDEWAY SECTIONS



require stopping the whole system and pushing the disabled vehicle off at the next off-ramp. However, the use of multiple "beam" guideways would allow routing traffic around the stopped vehicle on the other lanes.

A survey of the five proposed vehicle types indicates what, where and how they fit the system. We foresee the private automobile remaining as a basic component, but with economies in operation, greater passenger comfort, and improved safety (Figure 5.7).

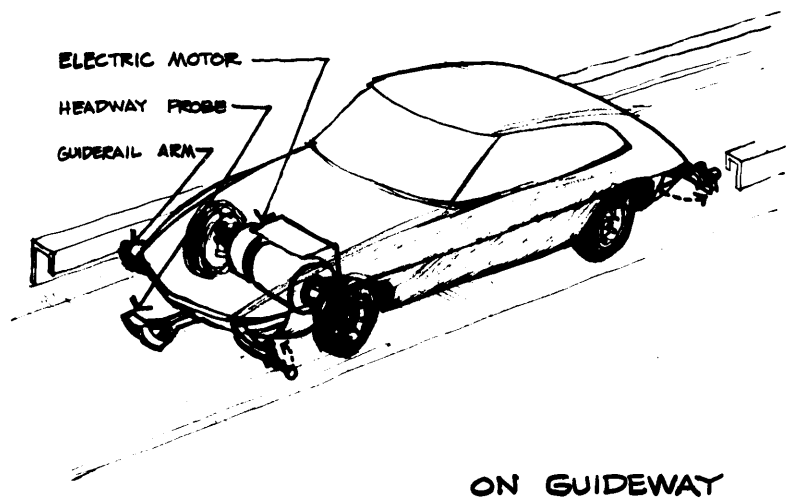
Figure 5.7



There would be guide-rail arms that would go out and lock into the guide-rail at the side of the roadway to provide mechanically

controlled steering and power pick-up for the electric motor (Figure 5.8). We would use electric motors, since the price of

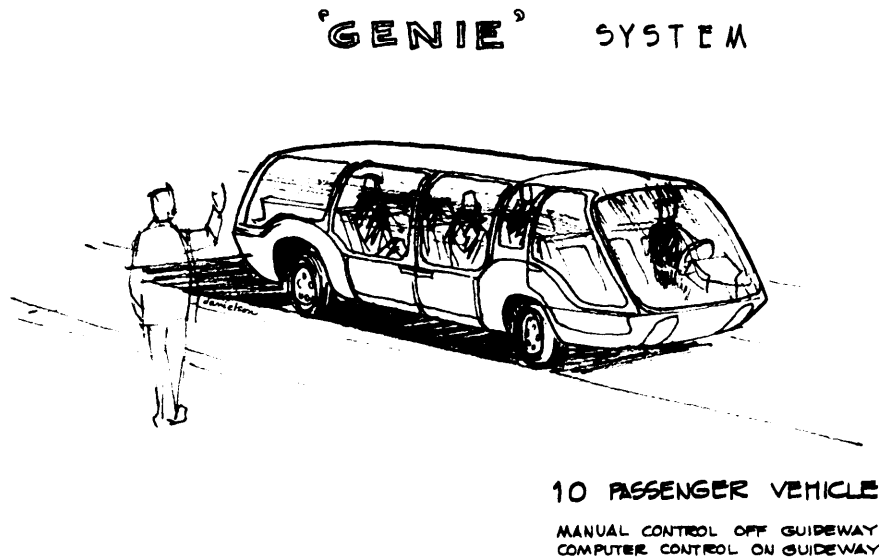
Figure 5.8



air pollution with continued use of gasoline engines is higher than we wish to pay. Electric motors and guide-rail arms would be standard equipment on all vehicles using the guideway. The automobile then, as today, serves all classes and areas, except for wider usage, better networks, and computer control.

One of the new systems proposed is nicknamed the "GENIE" system (Figure 5.9). This is a ten passenger vehicle which would be routed

Figure 5.9



by computers on a dynamic basis, going to pick up people as they requested it. This would be very much like calling a taxi to your door, except in this case, it would carry more than just one passenger. It would be manually controlled by an MBTA driver when it was off the guideway. However, the driver would get out at a guideway entry station and the GENIE vehicle would proceed by itself when on the automated network. This vehicle would operate in low and medium density areas - and in the gray areas of metropolitan regions. A few of the civil engineering students in the course began developing scheduling and cost models to see if such small

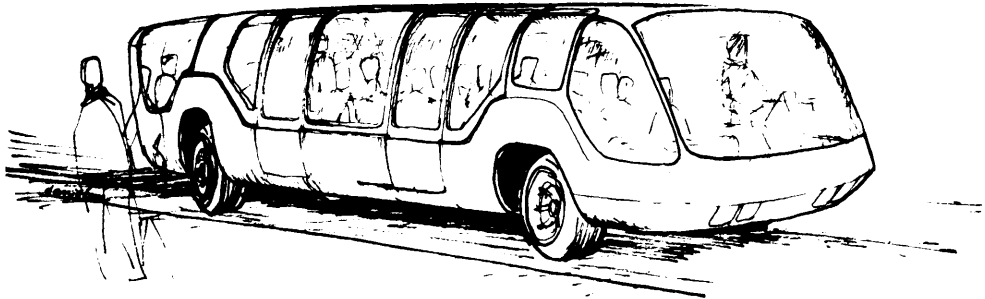
units could provide a satisfactory level of service to such a range of densities (minimum waiting, transit, and distribution time at an acceptable cost of vehicles and drivers). Conclusions prepared for a presentation made to General Motors June 3, indicated that such small vehicles, dynamically routed, did have the flexibility to operate both in the low and middle density areas. With full automation and the elimination of drivers from the GENIE vehicles the system's efficiency seems very promising.

In high density and downtown areas, you would have two systems. The first of these is the "BOS" system, standing for "Bus Only Streets" (Figure 5.10). These are forty passenger vehicles (very

Figure 5.10

'BOS' SYSTEM

40 PASSENGER VEHICLE
LOW SILHOUETTE - EASY ENTRY
MULTI DOOR - RAPID LOADING

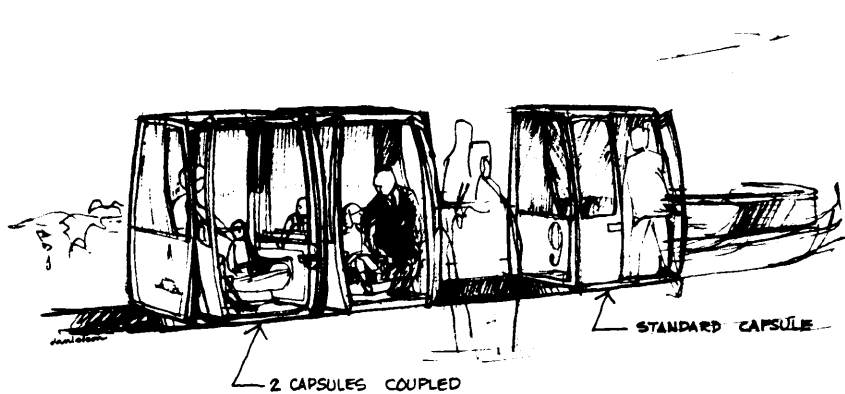


much like today's buses) which could be developed and put into service immediately. They would feature a low silhouette for easy entry and multi-doors for fast loading. These buses would circulate on streets for which they had exclusive right-of-way, operating at short headways, and providing fast service. The second system for high density regions, mainly downtown and commercial areas, is what we call the "PERC" system, standing for "PERsonal Capsule"

(Figure 5.11). These capsules are two passenger vehicles which can be attached to form four passenger or six passenger modules. They

Figure 5.11

'PERC' SYSTEM
2 PASSENGER CAPSULE



would ride on an aerial guideway attached to the facades of buildings. These vehicles run at a constant speed, and because they are

grade-separated, they would never have to stop for pedestrians. The only time any capsule stops is when the individual rider wants to get off. This happens by having the PERC unit pull off into a station lane, letting the rest of the capsules in the system pass on without stopping.

The fifth system is rail mass transit, which is envisioned as going through modification to phase-out by 1985. With the use of guideways and GENIE vehicles linked in trains, the unique capacity characteristics of rail transit are almost equalled, and total service excelled since the GENIE system allows distribution at both ends of the journey. The rail system is limited to its fixed-right-of-way and requires passengers to reach or depart its terminals by separate mode. In the interim, the rail system would serve two functions. First, rail cars would be modified to test a "container" concept for transit. The passenger compartments would be containerized allowing replacement by cargo units. Thus rail transit could carry cargo during off-peak hours using chasses (the expensive component of the rail vehicle) that would otherwise be idle. The second function is the continuing use of the subway networks and stations once the rail vehicles are phased-out. The-rights-of-way would be paved and converted to guideways to accept regular soft-wheeled vehicles. The stations would be modified to accept GENIE and rental auto service, in addition to the cargo role begun by rail and continued by GENIE vehicles.

ROAD NETWORK - 1975 AND PROTOTYPE TEST SYSTEMS

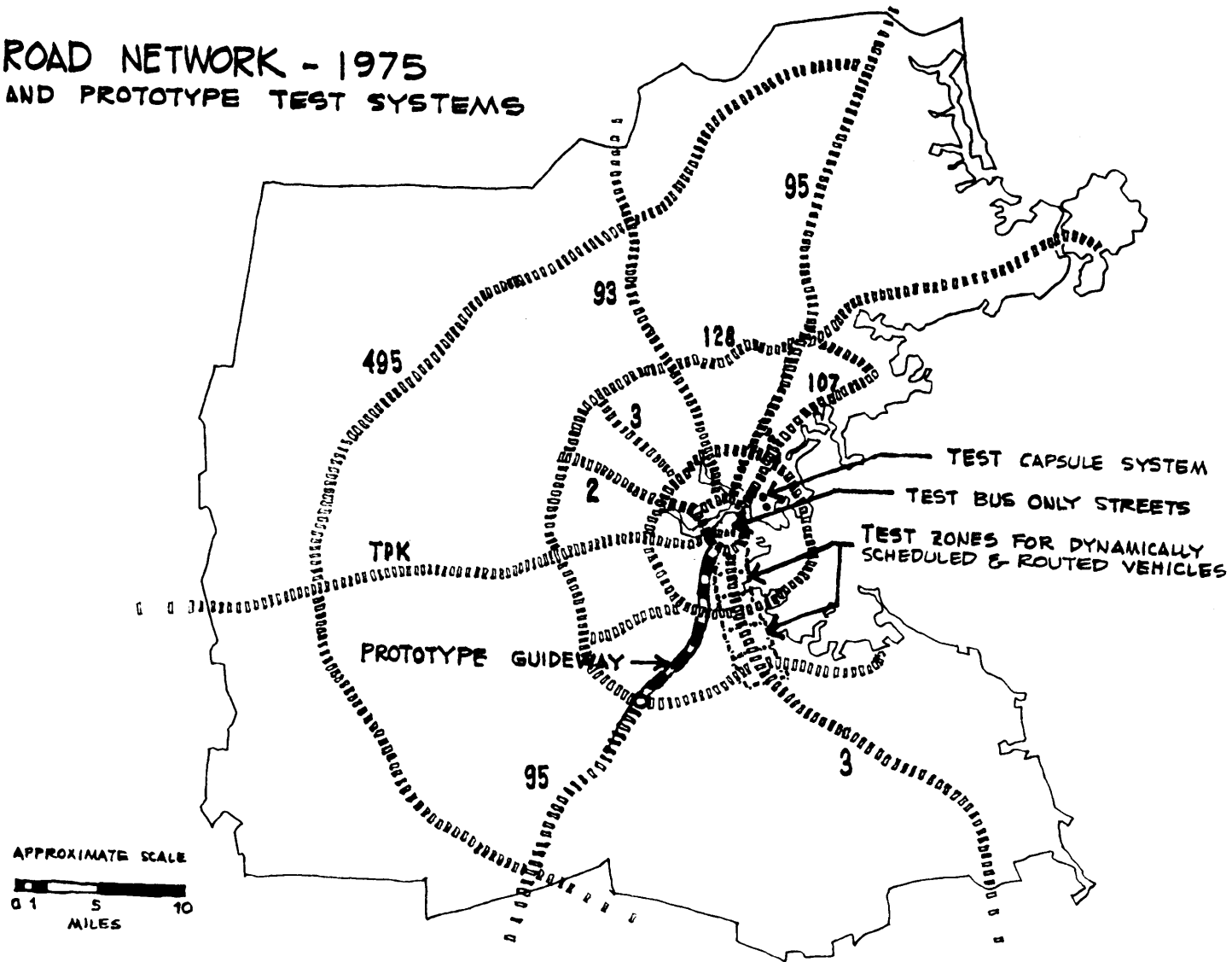
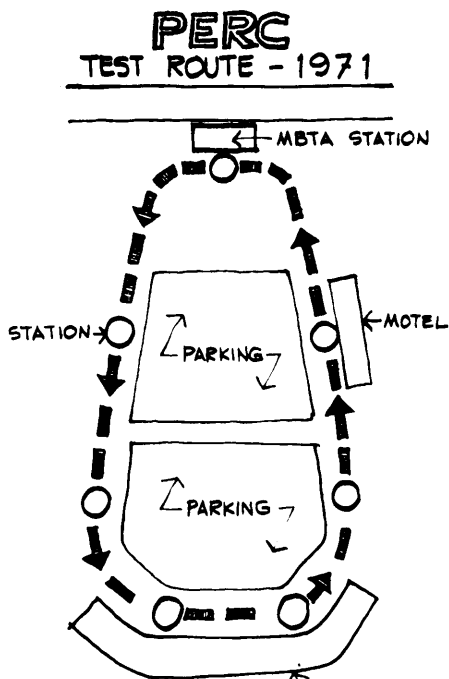


FIG. 5.12

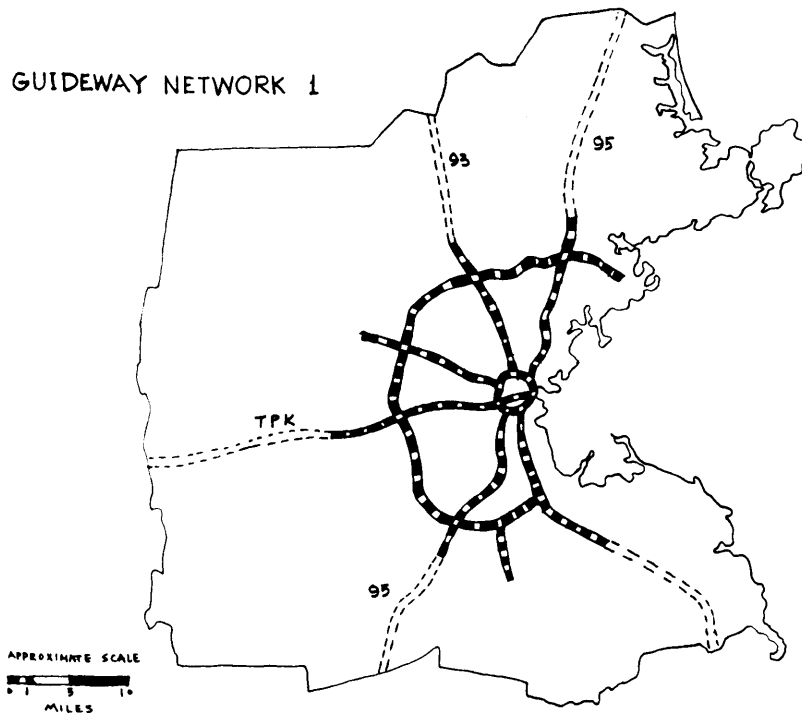
Now let's look where these systems could be tested in the region via demonstration projects. First, we would foresee by 1975 a test network involving all four systems (Figure 5.12). We would have a prototype guideway set up on Route 95, the southwest expressway which would go from 128 into the Inner Belt. Second, zones would be established around this expressway and the southeast artery for testing the GENIE vehicle, its dynamic routing and scheduling programs, and the efficiency and costs involved in the system. Third, there would be a test of the BOS concept in downtown Boston, with special interest in the effect of diverting private traffic from the BOS streets. Fourth, the PERC system would be tested at Logan Airport running from the MBTA station, past the motel and parking areas, and then distributing passengers to main terminal points, or possibly even to the boarding lounges (Figure 5.13).

Figure 5.13



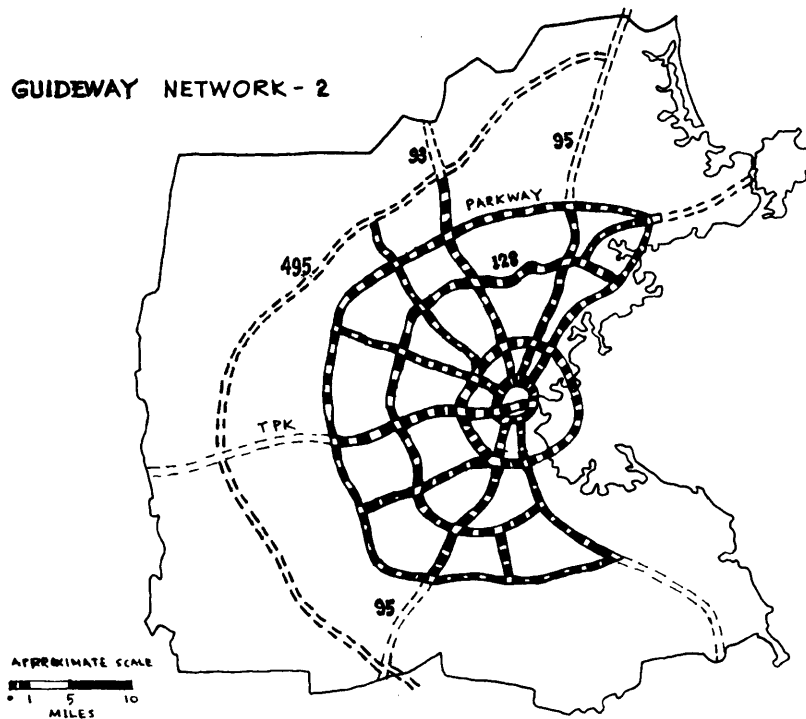
As the guideway tests proved the value of the concept, and money through federal and MBTA sources became available, a metropolitan network could be started which would involve the Inner Belt, 128, and a few radials (Figure 5.14). As the demand increased, an

Figure 5.14



intermediate belt could be built between the Inner Belt and 128 including a harbor by-pass over Long Island to take through-traffic (Figure 5.15). The region could also modify the parkway which is being developed as a regular roadway, and with the addition of several radials, develop quite a strong grid network. By 1990, Route 495 would be tied into the system, and the radials would link Framingham, Lawrence, Brockton, etc. into quite an extensive network

Figure 5.15



covering the area. Other roadways could be added as demands and plans warranted.

Tying into this guideway network would be the High Speed Ground Transportation system and various air terminals (Figure 5.16). The HSGT would follow the route of 128, forming a metropolitan loop for distribution. This loop would tie into Logan International Airport, to Vertical Take-off and Landing Craft Terminals in Boston, Medford, and Norwood, and to three or four interchanges (locations undetermined) in the metropolitan region. Logan Airport would remain the location for international and transcontinental passenger flight arrivals due to its central location. Air Cargo, utilizing C-5A aircraft, will become a significant mode for

INTER-REGIONAL TRANSIT

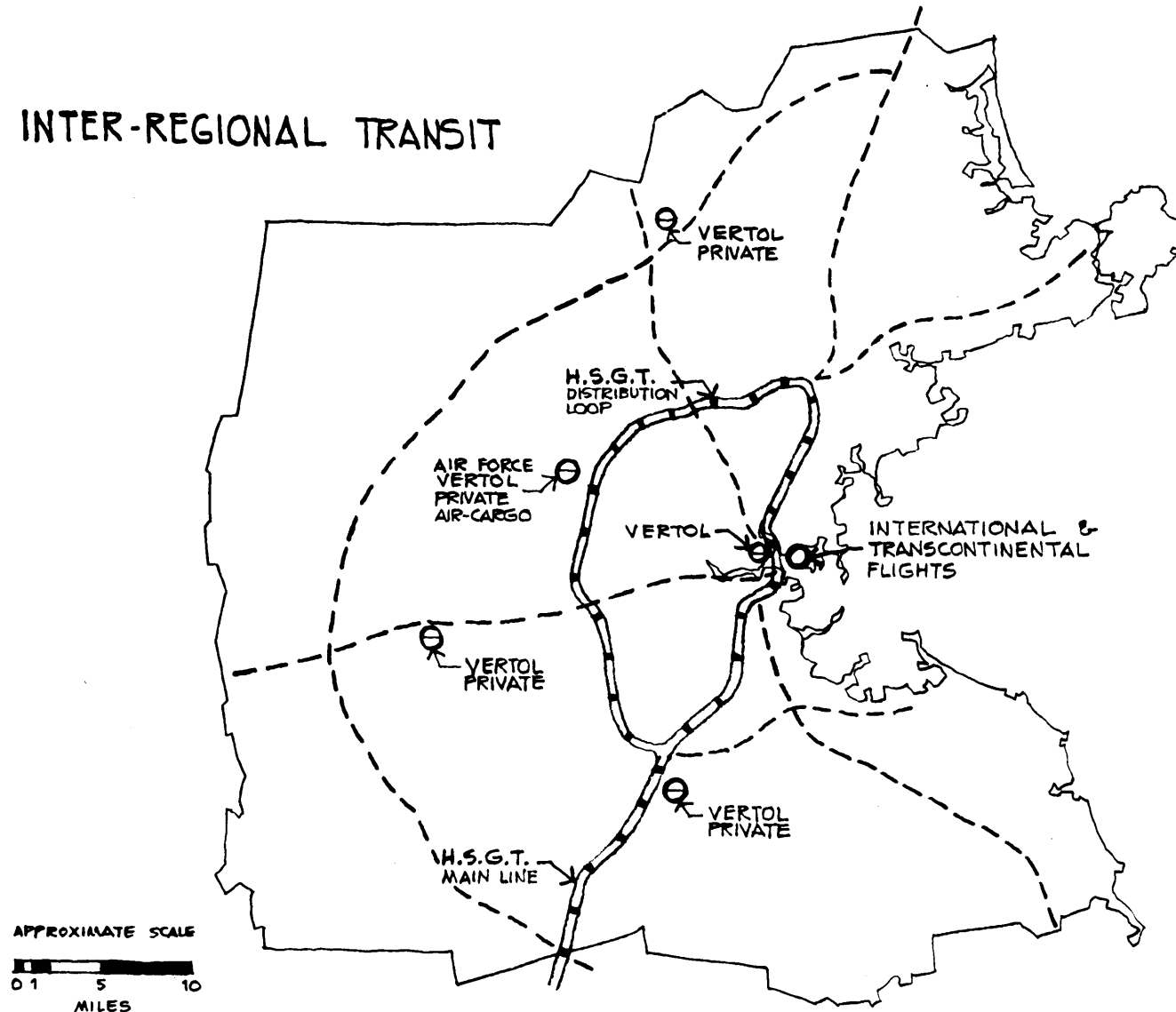


FIG. 5.16

shipping goods. A special terminal would be developed at the Medford Airport capitalizing on its proximity to guideway networks, HSGT, and the new warehousing and goods distribution complexes along Route 128. VERTOL and private aircraft terminals would be distributed throughout the region to service inter-regional and pleasure flights.

Based on public acceptance, the PERC system would evolve to a network passing from North Station to Massachusetts General Hospital, up along the Government Center, down Washington Street, across to the Financial District and the Harbor, by South Station, and then on to the Prudential Center and housing in the Roxbury area (Figure 5.17).

Having looked at the vehicles and the networks for a transportation system, some thought was given regarding storage of those cars you bring downtown. A study of parking costs is really quite informative. Based on costs of land downtown, the impedance of flow because of cars parked on the street, etc. New York City writes off its curb parking at a rate of \$1,700 per space per year. With an automated garage (in Boston) where the handling of cars is all done automatically - mechanically - the costs go down to \$200 per space per year. The current so-called automatic garages keep attendants working to start the cars and to drive them on and off the ramps of the elevators; this is a tremendous labor cost, which could be avoided by full automation. Costs for garages in

PERC SYSTEM - 1990
POSSIBLE NETWORK (PLUS AIRPORT)

LINE LENGTH: 6 MILES
NO. OF STATIONS: 30

EXTENSIONS AS DESIRED
TO AUTOMATED GARAGES,
OTHER INTERCHANGES

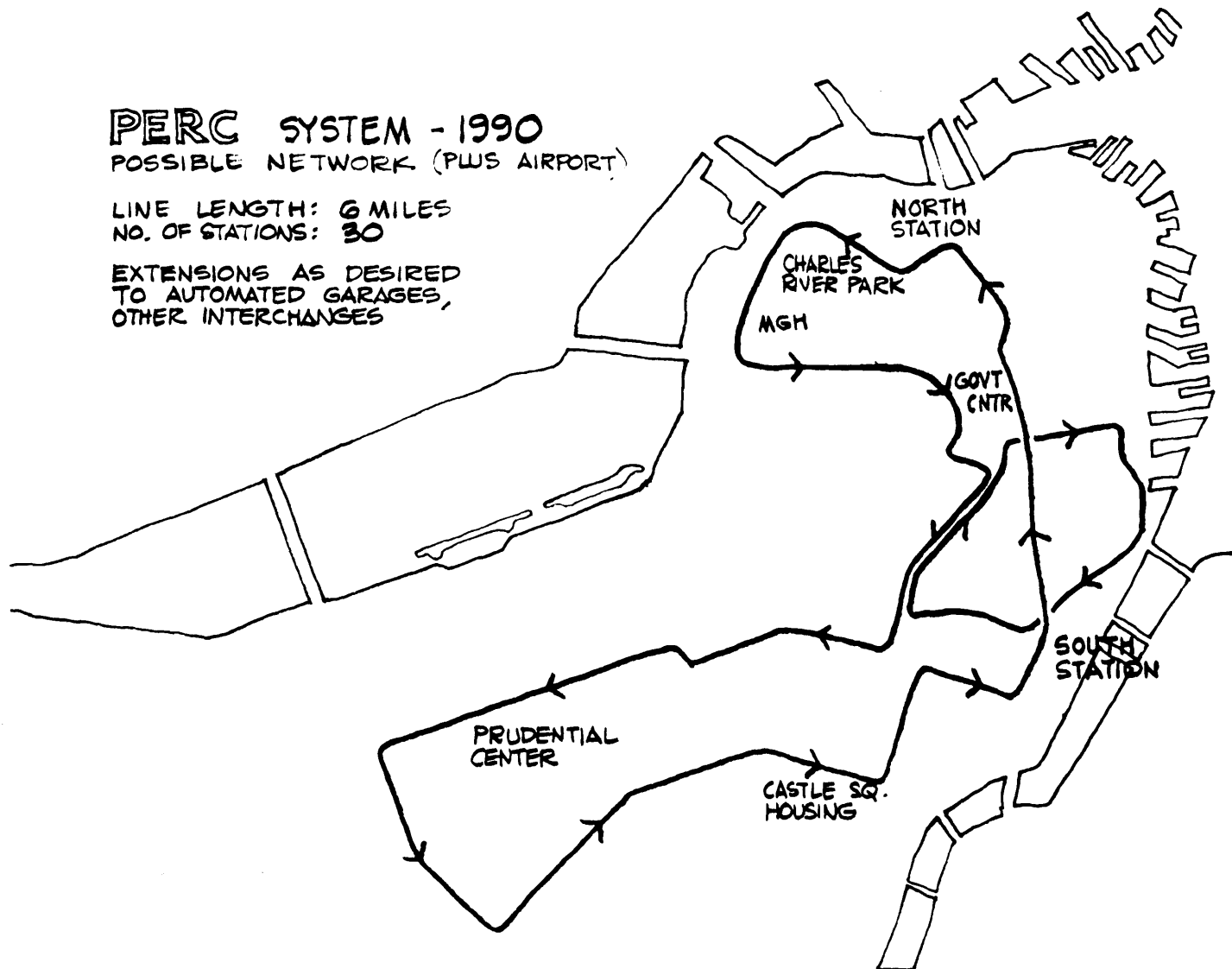


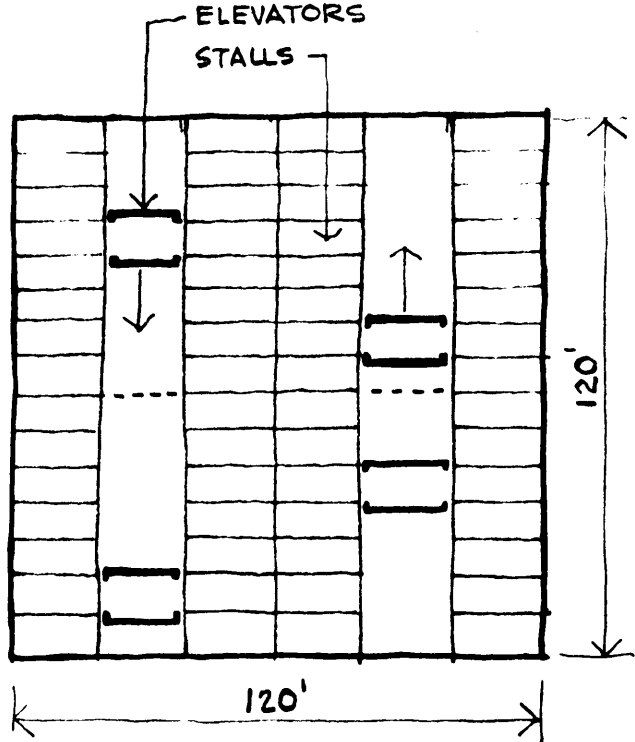
FIG. 5.17

medium density ^{areas} are as low as \$75 per space per year.

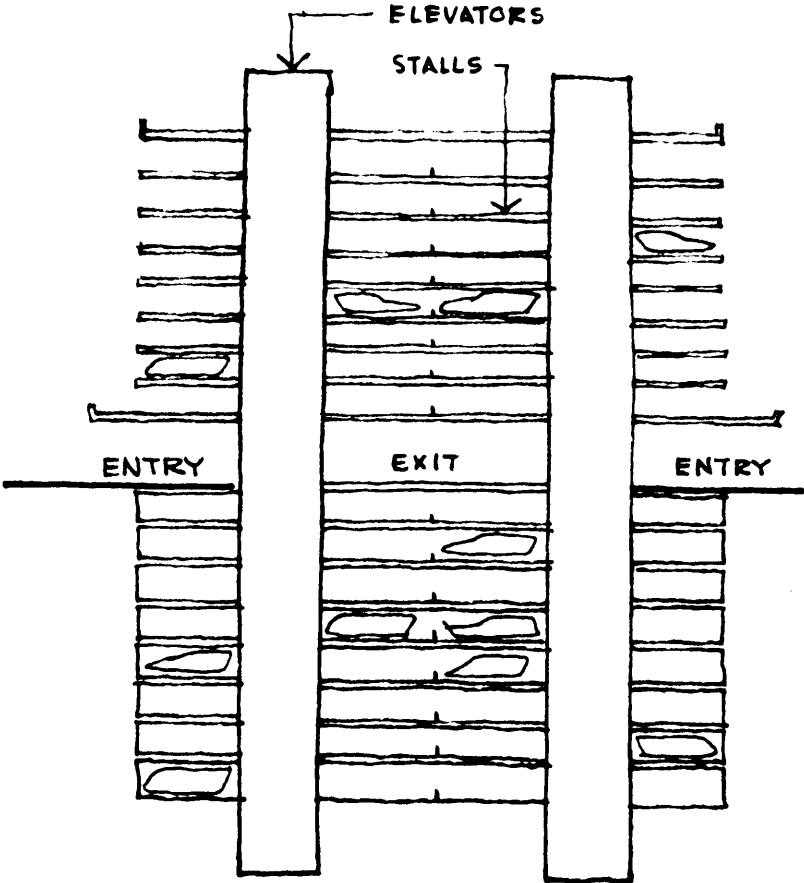
Besides such static storage, some thought was given to having the car circulate in the system. Such dynamic storage proved to be too costly. In the case of gasoline, there is a tremendous fuel expense, \$3,000 per car per year, and even though the use of electricity would bring this down to only \$300, you would still put on approximately 100,000 miles per year, which alone would be prohibitively expensive in wear on the vehicle. The best method would be never to store the vehicle at all; that is, to use the vehicle continually. This varies significantly from the dynamic storage idea in that the vehicle now has an economic use - if it chalks up 100,000 miles per year there's no loss as it will have been carrying paying customers (or goods?) not air. One answer would be the widespread use of rental cars: You'd drive a car to the destination, and leave it at a terminal, where some other person would rent it and take off.

But, barring a totalitarian state, individuals will be owning vehicles for longer than this study so that static storage is a problem that has to be considered. The automated garage has the greatest potential: in a 120' square block, 16 stories high, you can store nearly 1200 vehicles and accept or release a car every 2 seconds (Figure 5.18). This is possible by having four to six elevators operating in the garage. With entry points at the eighth floor, you cut the time to reach the farthest floor of the garage

AUTOMATED GARAGES



PLAN



SECTION

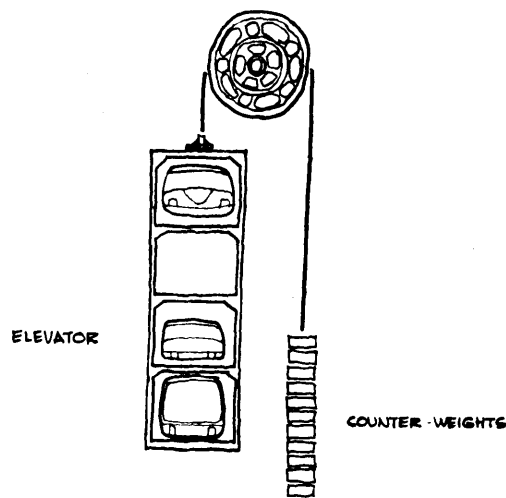
NO SCALE

FIG. 5.18

in half. And, by using multi-tray elevators (Figure 5.19), you could be loading a car at the entry point, while at the top of the elevator you could be unloading a vehicle into its stall.

Figure 5.19

MULTI-VEHICLE ELEVATORS



Summing up storage concepts (Figure 5.20): by 1970, you could drive from the point of origin to a suburban garage, park your car, take transit to the destination area, and walk the little way remaining. Or, you could drive your car all the way to a destination garage, park it there, and walk. In 1990, you could drive your car from your home, get on a guideway, proceed to the destination area, and either park your car in an automated garage, and walk, or take a subway tunnel to a station beneath your building where you would get out and send the car back to a garage

STAGING

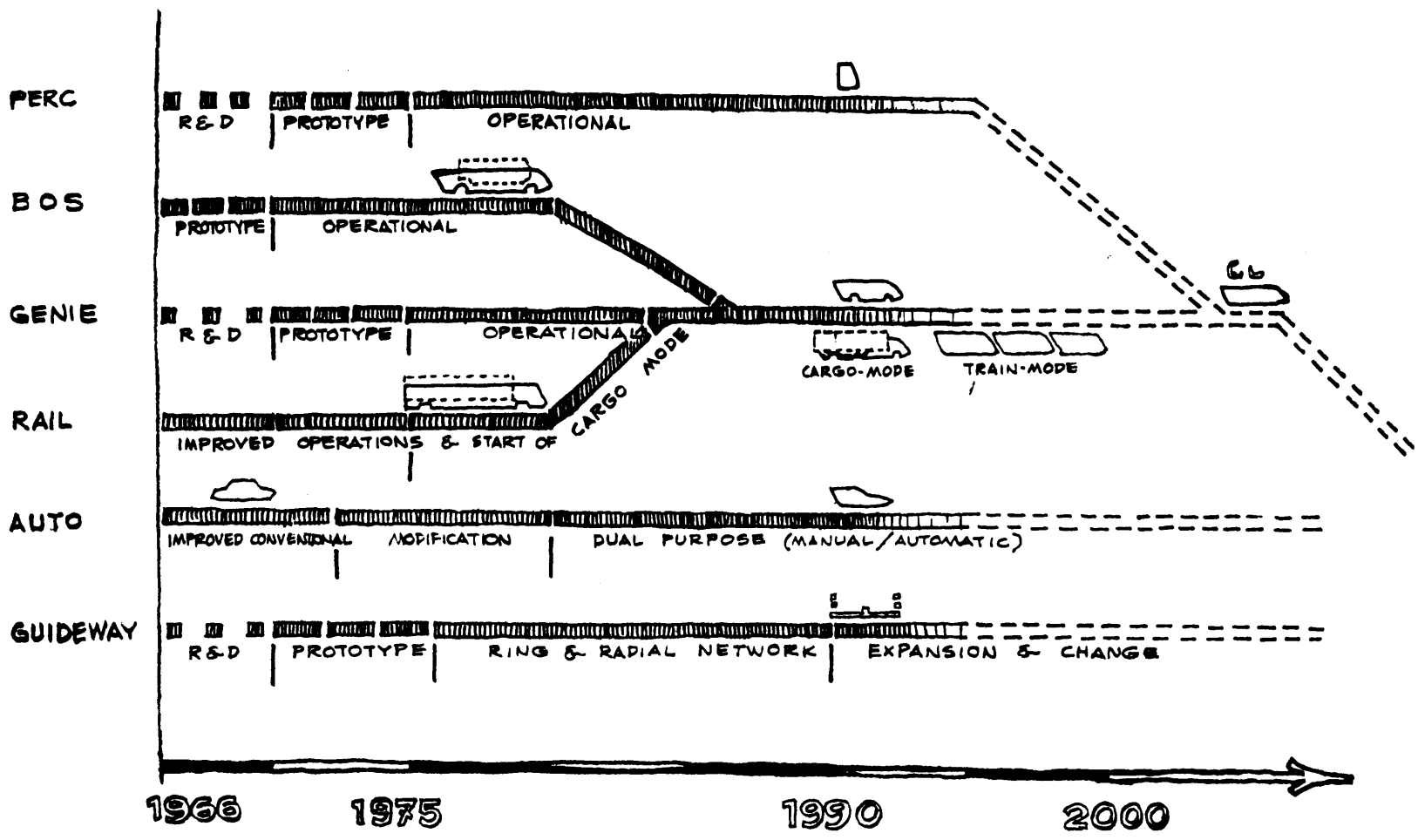


FIG. 6.1

IMPLEMENTATION AND EVOLUTION

The chart in Figure 6.1 indicates the staging of these five systems and their networks over time. From 1966, through the sixties, the guideway would go through a research and development period. After that, a prototype would be constructed along an expressway with testing to be completed by 1975, followed by the development of the rings and radials and other roads for the network. By 1990, a fully operational system would be in effect. This network would evolve and grow, and could eventually reach the street in front of each residence in suburban areas. The automobile evolves from an improved conventional vehicle to a vehicle which is modified for computer control as owners wish to

take advantage of the automatic roadways. Since the guideway is built mainly for public transit vehicles during the 1975 time period, private drivers don't have to use their cars on it, except by their own choice. However, by 1980, it is forecast that the advantages of automated travel would be sufficiently clear (and proven) to pressure the auto industry to change to dual control - automatic and manual - as standard equipment on all vehicles produced.

The rail system will develop improved service and methods of operation until 1980, when they would begin phasing in with the GENIE vehicle. The BOS system would go through a prototype development fairly immediately and would be operational through the 1980's, and then start to evolve into the GENIE system. As the GENIE became faster and more effective, in distribution and line-haul, it is felt that even smaller vehicles might be possible for distribution. The GENIE vehicle itself goes through an R & D program and a prototype development by 1970, and develops as the main public transit system by 1990. Finally, looking at the last system, PERC, there is an R & D program through the sixties, a prototype operating in Boston by 1975, and then continued development and operational use of the PERC system in downtown metropolitan areas. The vehicle developments after the 1990 period center on the possible integration of the PERC, GENIE, and automobile systems.

TYPICAL AUTOMOBILE TRIP - 1990

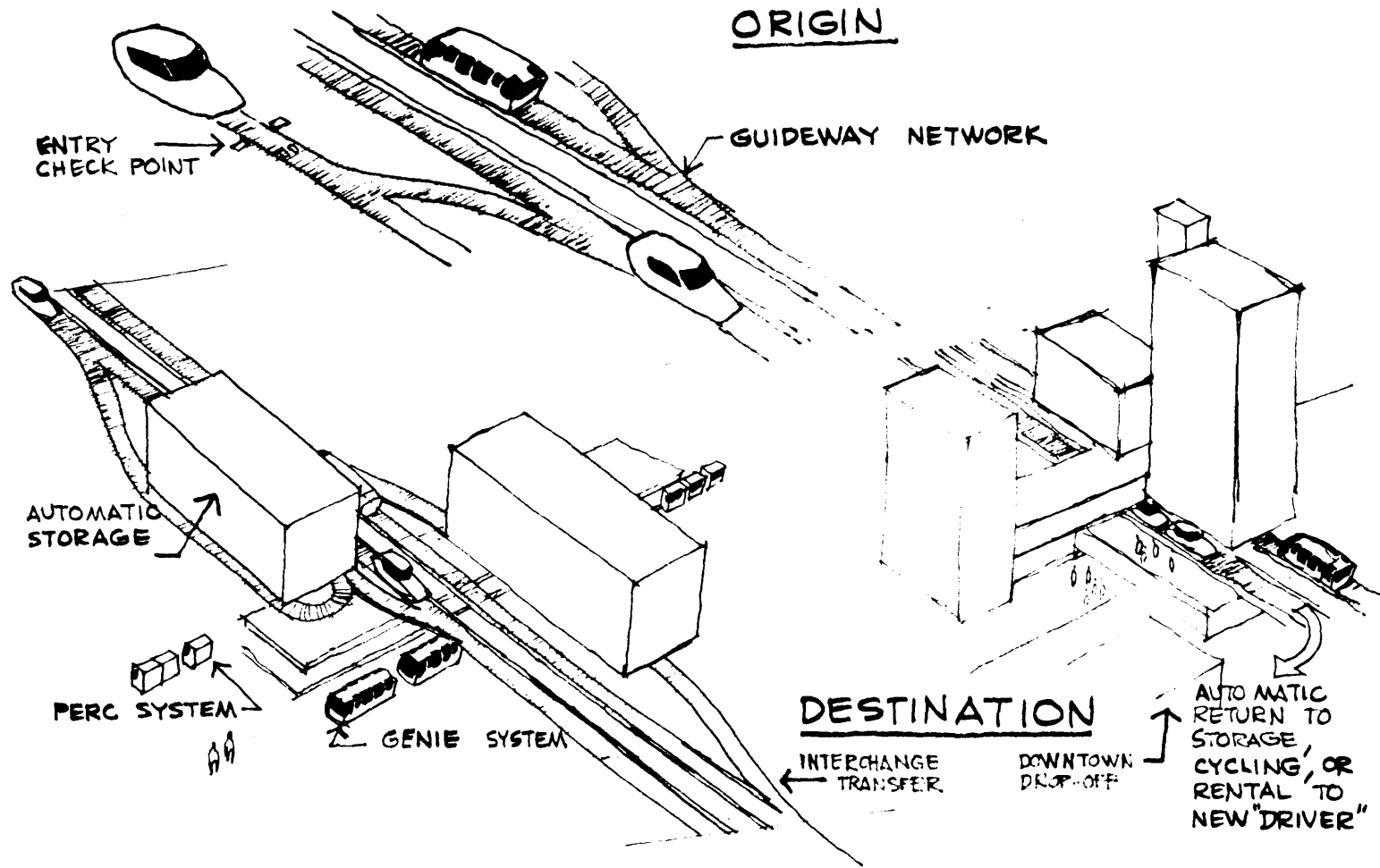


FIG. 6.2

A summary of typical trips in 1990 will illustrate the coordinated operation of the systems at that stage in time. From any origin point a private or rental auto (Figure 6.2) would be driven to a guideway entry, checked to assure its operational safety, and then entered into the network. Upon arriving downtown the auto could be parked automatically in a garage and the driver proceed by PERC or GENIE; or, he might get closest to his destination by riding his car into the subway, and getting out at a station. The car would then be taken by someone else if it were rented, or if it were owned, the car would be stored or returned home.

A look at public transit (Figure 6.3) involves the use of the GENIE, where the individual "rubs" his phone, and a Genie appears to take him down to the guideway entrance. There the Genie driver gets out and the vehicle continues on its way automatically. It might make intermediate stops and finally arrive in the downtown destination, where a driver would board the mini-bus to make the final distribution.

The evolutionary aspects of the systems include the following possibilities: Rail transit would begin to modify its stock into passenger containers and chasses so the passenger compartment could be removed and the chassis carry cargo in the off-peak hours. Also, it would be advisable to improve the speed and door-to-door travel time. This could be done by having the passengers transfer at speed. Two concepts are involved - one is where you

TYPICAL PUBLIC TRANSIT TRIP - 1990

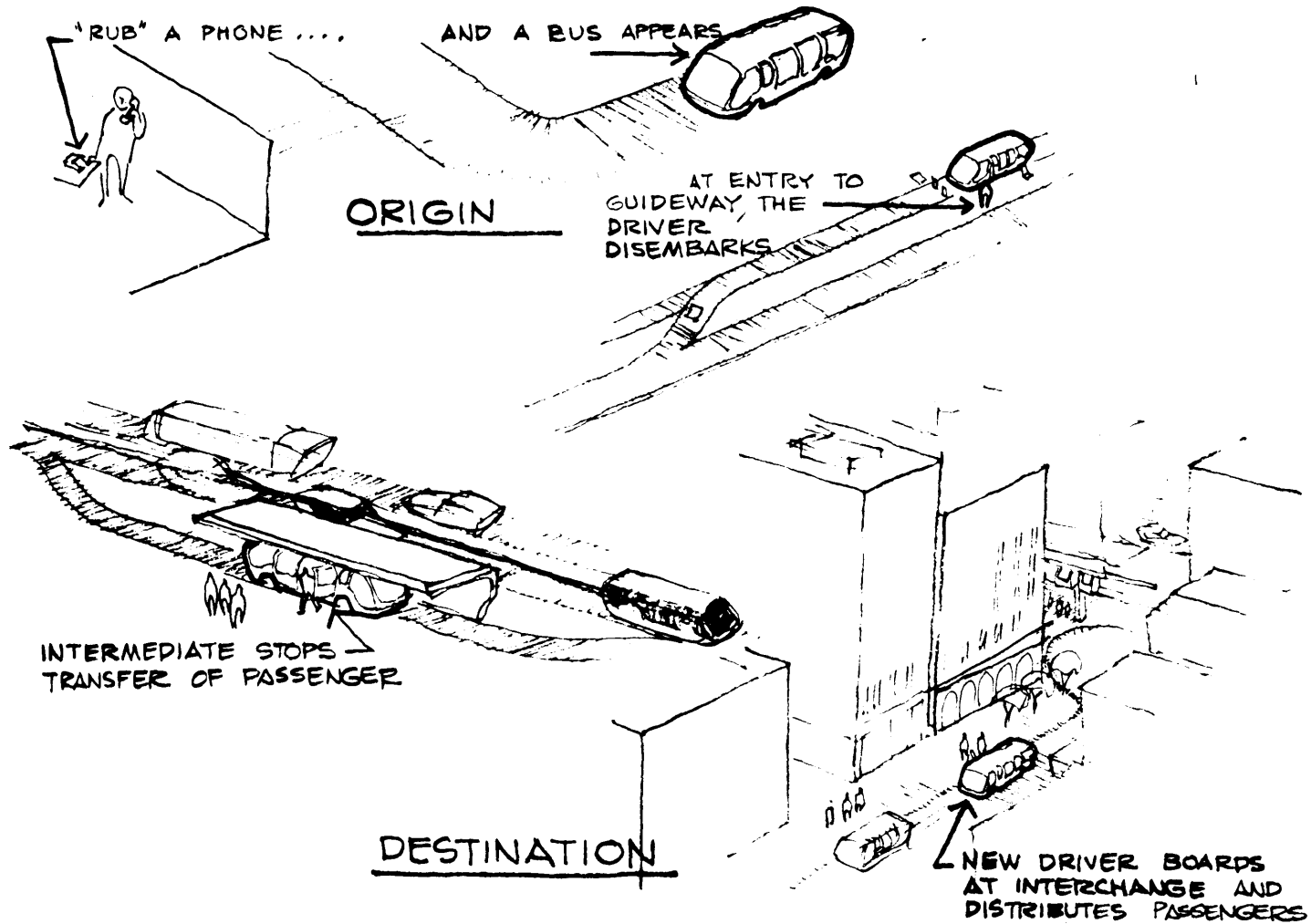
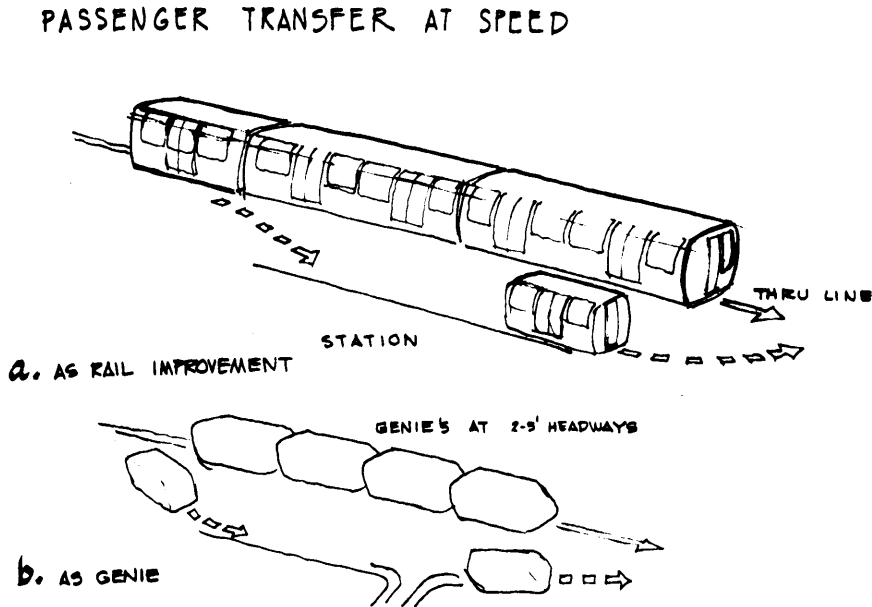


FIG. 6.3

have a caboose system (Figure 6.4.a), with a small unit attached to the regular train. When passengers want to get off the train, Figure 6.4.a,b



they walk to the caboose, the caboose detaches itself and goes and stops at the station. Meanwhile, in that station, people are loading another caboose, and when the train goes by, the caboose accelerates and locks on. Then the people who have just joined up with the train walk into the main compartments, and people who want to get off at the next stop fill the caboose, etc. In this fashion, the train could go at a constant speed and only those people who wanted to get off at any one station would have to

stop. The second prospect is to divide the train into a series of small compartments, and set them on an express chassis. There would be a station chassis that would come out from the station with other capsules that wanted to go on; these small containers could be exchanged, the station load shoved onto the express chassis, and the express load, wanting to get off at the station, shoved onto the station chassis and brought back for unloading. This alternative would be too expensive for the short time rails will be used, but the concept could be applied to the GENIE system without any special mechanism (Figure 6.4.b). The GENIE vehicle, being small, could be filled at a station with people who were going to one destination. The vehicle would then proceed on the express guideway in trains (to conserve headway space), and when it neared its destination, would pull out of the system by itself and stop.

The BOS system would be used for cargo as shown in Figure 6.5. The passenger compartment is removable and a cargo container carried in its stead. Such dual-purpose function would be true of the GENIE vehicle, where the control pod of the vehicle is detached from the passenger shell and attached to a cargo container (Figure 6.6). The design of this container should be integrated with the requirements of C5A type aircraft, and marine and trucking lines to achieve a truly flexible and economical container system.

Figure 6.5

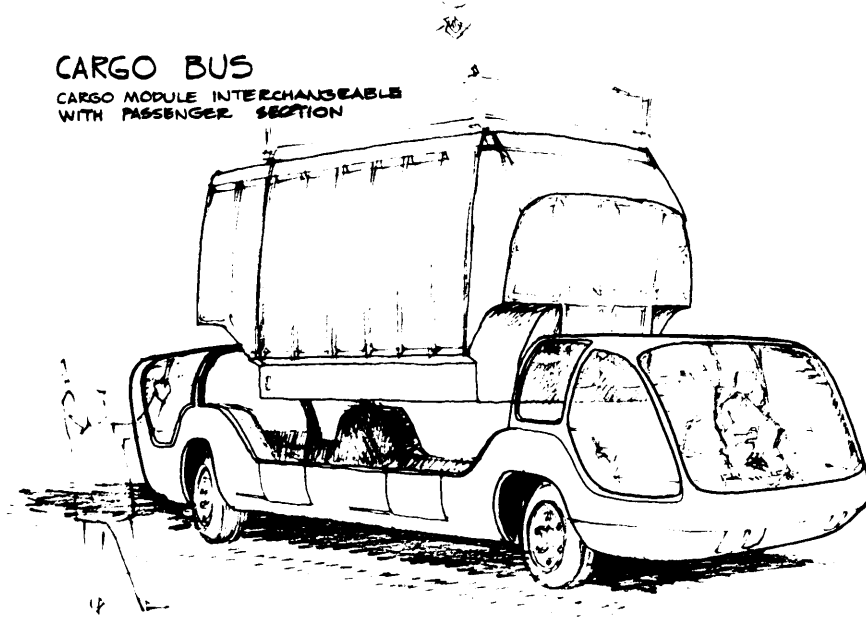
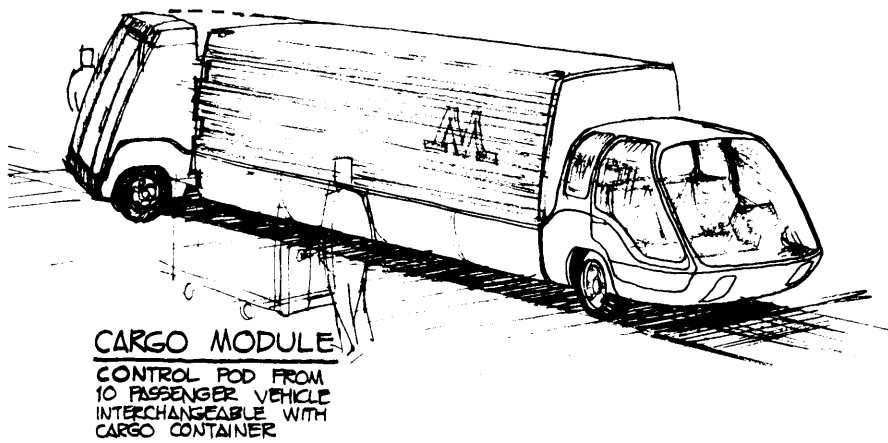


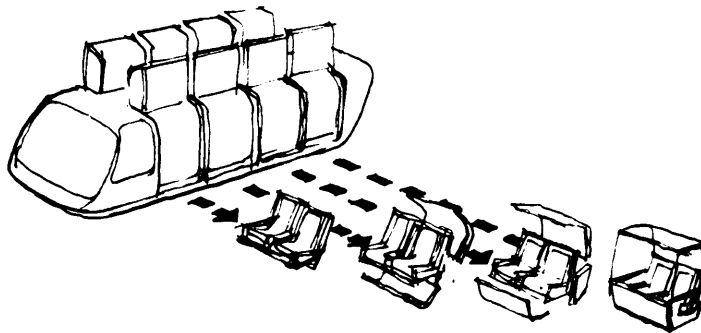
Figure 6.6



In the 2000-plus vision, it is conceivable that evolution would lead to the integration of the PERC unit with the GENIE and auto vehicles. The ejection and environment seats developed for the B-70 aircraft point the way. These seats have attached "leaves" that fold around the seat to form a protective capsule in case of loss of pressure or ejection. Such mechanized seat-capsules could become the regular PERC unit, folding up to fit inside the passenger compartments of GENIE and auto vehicles. As shown in Figure 6.7, a GENIE bus would pull into an

Figure 6.7

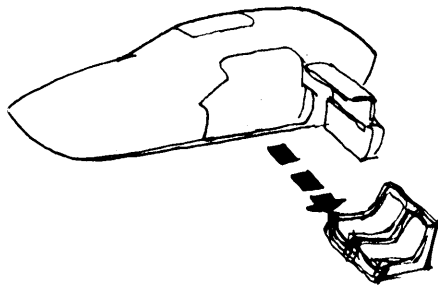
GENIE 2000+
INTEGRATION WITH PERC



interchange, the sides open up, and the PERC-seats slide out on tracks, unfolding as they go. The PERC-CAR would operate in a similar fashion (Figure 6.8), with over-sized doors opening automatically prior to the PERC-seats moving out.

Figure 6.8

AUTO MODULE 2000+
INTEGRATION WITH PERC



The technology is available for fabulous improvements in transportation. There are, of course, value questions about the limits of automation but none on man's imagination. With time and money, technology has the tools to fulfill the public's best interests and level of expectation.

ARCHITECTURAL IMPLICATIONS

From the earlier discussion of visual objectives comes the basis for defining the architectural characteristics of the system. This concern actually goes as deep as why transportation at all? to as detailed as what color are the transit tickets. Some of these questions are answered in the previous chapters since considerations such as: why transit? are not the exclusive quest of architects. Other questions are not attempted due to their minor role and the limited time available. The aspects which are discussed here consider how the guideways can be integrated into the urban structure, what kind of planning and forms are implied by the need for visual and psychological order, and what effect a

GUIDEWAY NETWORK -1990

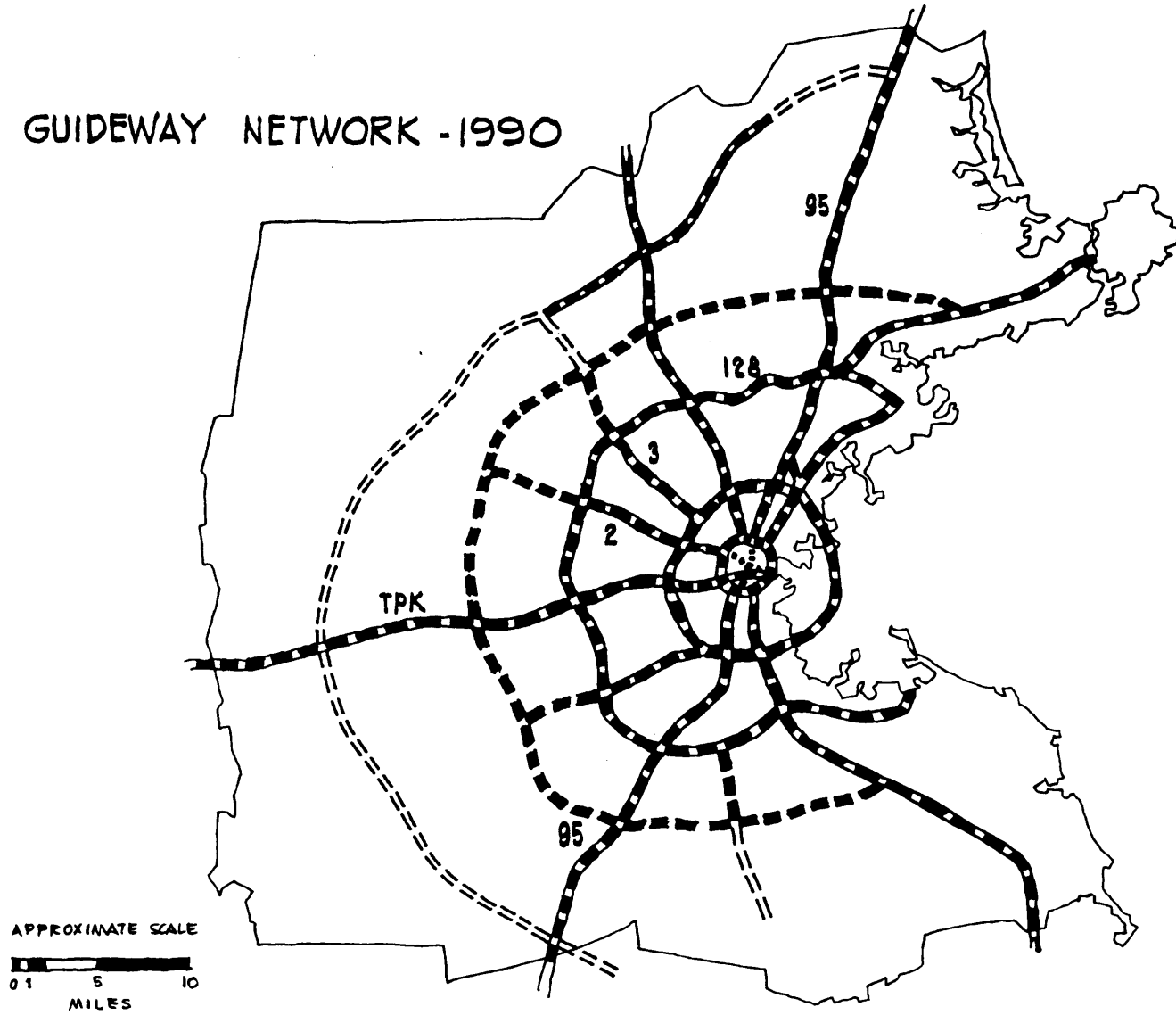


FIG. 7.1

mass transit system could have on the form and life of downtown urban areas.

The network in Figure 7.1 shows the extent of the Guideway system by 1990. Early success and/or gradual development of the automated system would probably lead to denser connections between the sub-centers. If this network is not thoughtfully laid out visually, it can have a totally disruptive effect, such as the Fitzgerald Expressway in the Hub of Boston Proper.

This example illustrates one of the major impacts of expressways, namely their influence as barriers between continuous parts of a city. The North End once had an easy relationship to the rest of Boston Proper through the West End and Scollay Square. Local traffic and pedestrians could move continuously between these sections. With the construction of the expressway, in addition to the two harbor tunnels, the North End was "walled off" by a tangle of trucks, parked cars and busy on-off ramp traffic through which the local traffic must perilously wind its way.

If roadway belts divide, then they can also serve a positive role in conditions where the definition and separation of land-uses is desirable. Thus expressways - guideways, in our system - could be arranged to define the boundaries between residential and residential, or residential and industrial, or industrial and commercial. By the use of roadway planting and landscaped rights-of-way (which might be sufficiently wide to become strip parks, or

GUIDEWAY & URBAN FORM

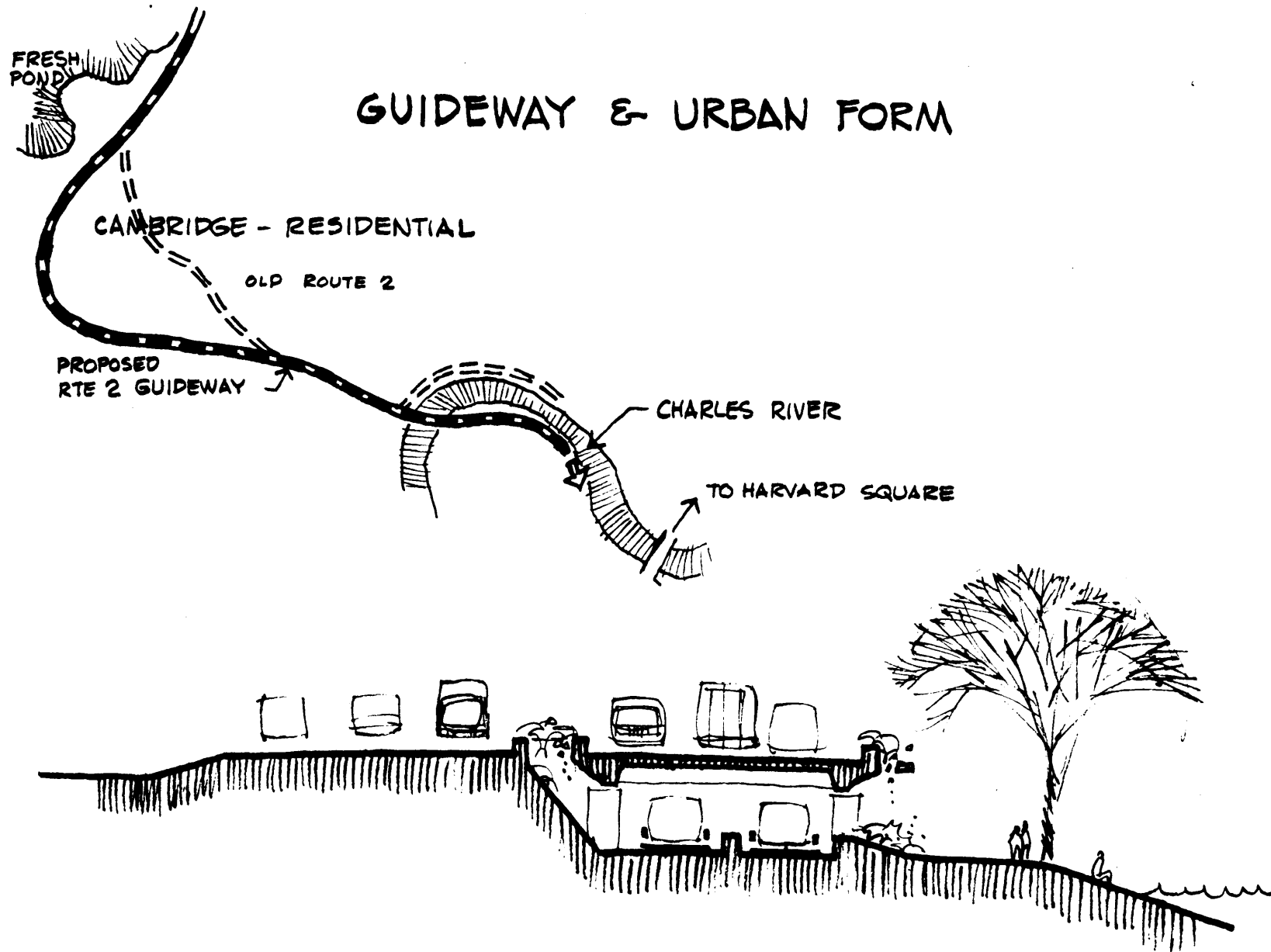


ROUTE 128

FIG. 7.2

expanded occasionally to become a major green space), the guideway network could serve as a green belt system in the metropolitan region.

A look at the network in the Boston area will illustrate these points. The Guideway section being only 8' wide brings an immediate saving in land area required. On Route 128, Figure 7.2, this means a reduction in the number of lanes from eight to six with an increased channel capacity from under 24,000 to over 72,000 vehicles/hr. This right-of-way remaining allows for more extensive planting as well as the installation of a High Speed Ground Transit loop to serve Metropolitan Boston. The HSGT system operating at 120 to 350 mph is shown raised above the ground for several reasons. First, it would be less expensive to attain a level alignment of track on a structure than ballasting at grade. Second, personal safety ("third rail") and protection from vandals is far superior. Third, by lifting these high speed vehicles above the ground and at the average tree and building height, you would reduce or prevent the blurring of objects in the near field of vision. Thus riders would receive a more coherent picture of the environment through which they traveled. Finally, it would seem advisable to separate vehicles travelling at 60 mph from vehicles travelling at 300 mph. The rapid passing of vehicles is amusing in a Keystone Cops movie, but would be less entertaining in actual practice where the flash of HSGT vehicles would be continual, their passing also might be



GUIDEWAY & URBAN FORM

FIG. 7.3

accompanied by buffeting from their shock waves, and one's own sense of speed would be reduced.

The lack of thought regarding the character of the area through which a major road will pass is demonstrated in Figure 7.3, along with a suggested solution. Currently, as Route 2 comes into Boston it passes through a very lovely residential neighborhood of Cambridge. The route breaks up the neighborhood, adds a significant noise problem, and creates a hazardous condition for pedestrians crossing and for local vehicles entering the traffic flow. In converting this road to automated travel the location could be shifted as shown in Figure 7.3 so that it divided Cambridge from Watertown rather than part of Cambridge from itself. Route 2 would then proceed to the Charles River where it could be developed below Storrow Drive. The manual lanes might remain above for local access while the guideway, requiring less space, could be constructed underneath, while still providing a view to the river and the Cambridge and Boston Skyline. Such a position would not obstruct the view of buildings behind Storrow Drive nor discourage pedestrians from reaching the banks of the Charles (a benefit perhaps not fully appreciated as long as the River is polluted).

The use of guideways in open-cut, or depressed channels, Figure 7.4, has advantages for both existing and planned expressways. The narrower width of the guideway means that if the center roadways

GUIDEWAY & URBAN FORM

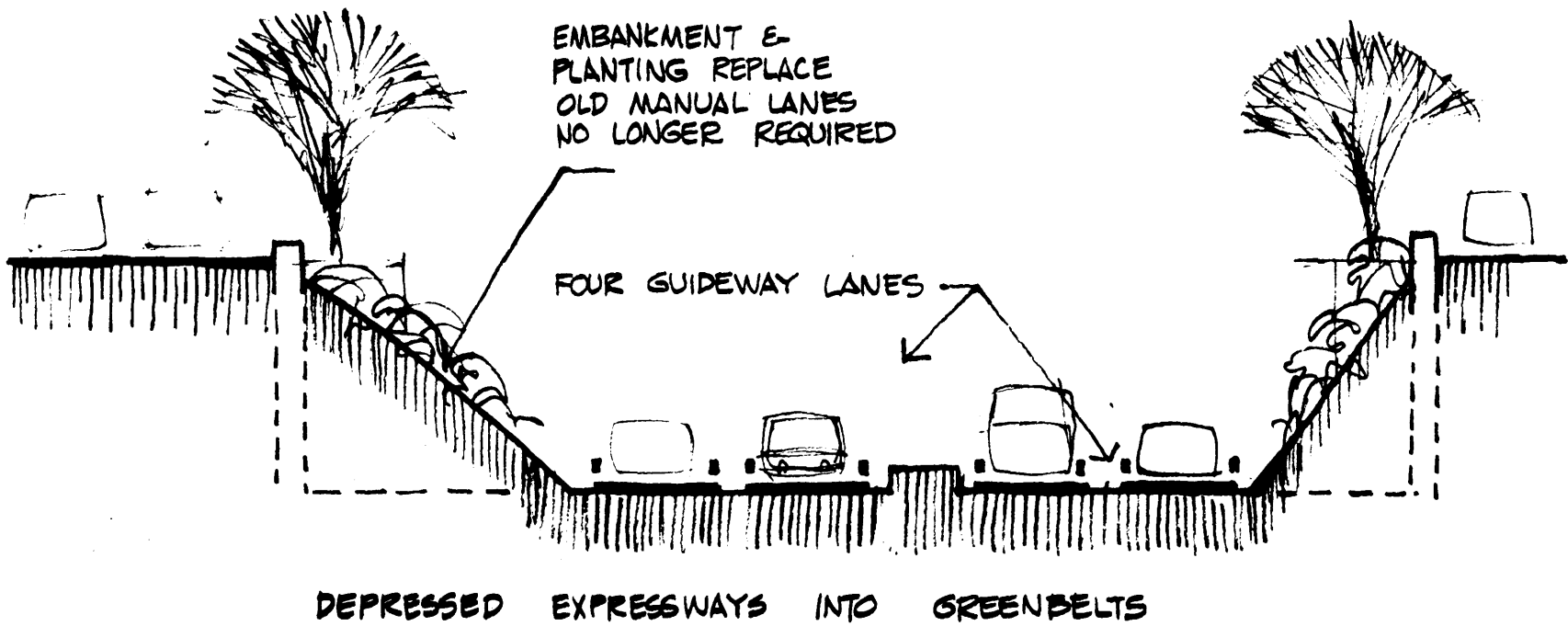


FIG.7.4

were converted to guideways there would be space left over that could be filled in for landscaping. This would not only provide a green belt but also improve the view of the city for riders. Where retaining walls are now used, the outside traffic lanes usually cannot see any of the city to their right.

For elevated roadways in downtown areas, there are other problems. Being elevated provides a view of the environment and permits the best understanding of the city - for the rider. But this has to be tempered by the needs of the pedestrian and the form of the city, and there's the conflict. Existing elevated roadways - the Fitzgerald in Boston and the Embarcadero Freeway in San Francisco, for instance, tend to cut off the pedestrian from the "other" side, and to ignore the buildings by and through which they pass. The design of the guideway with its smaller sectional dimensions, and the use of lighter vehicles, will permit larger spans and more flexible structures. However, real improvement to the visual environment can come only when the guideways are thought of as integral parts of urban structures. The land rights below and the air rights above roadways must not be considered inviolate - or worthless. Figure 7.5 is a section showing shops developed beneath an expressway - parking structures would do as well - with offices built above. By truly building the guideways into the city structure, they would be more useful arteries of movement and could enhance the pedestrian experience by providing arcades for various

GUIDEWAY & URBAN FORM

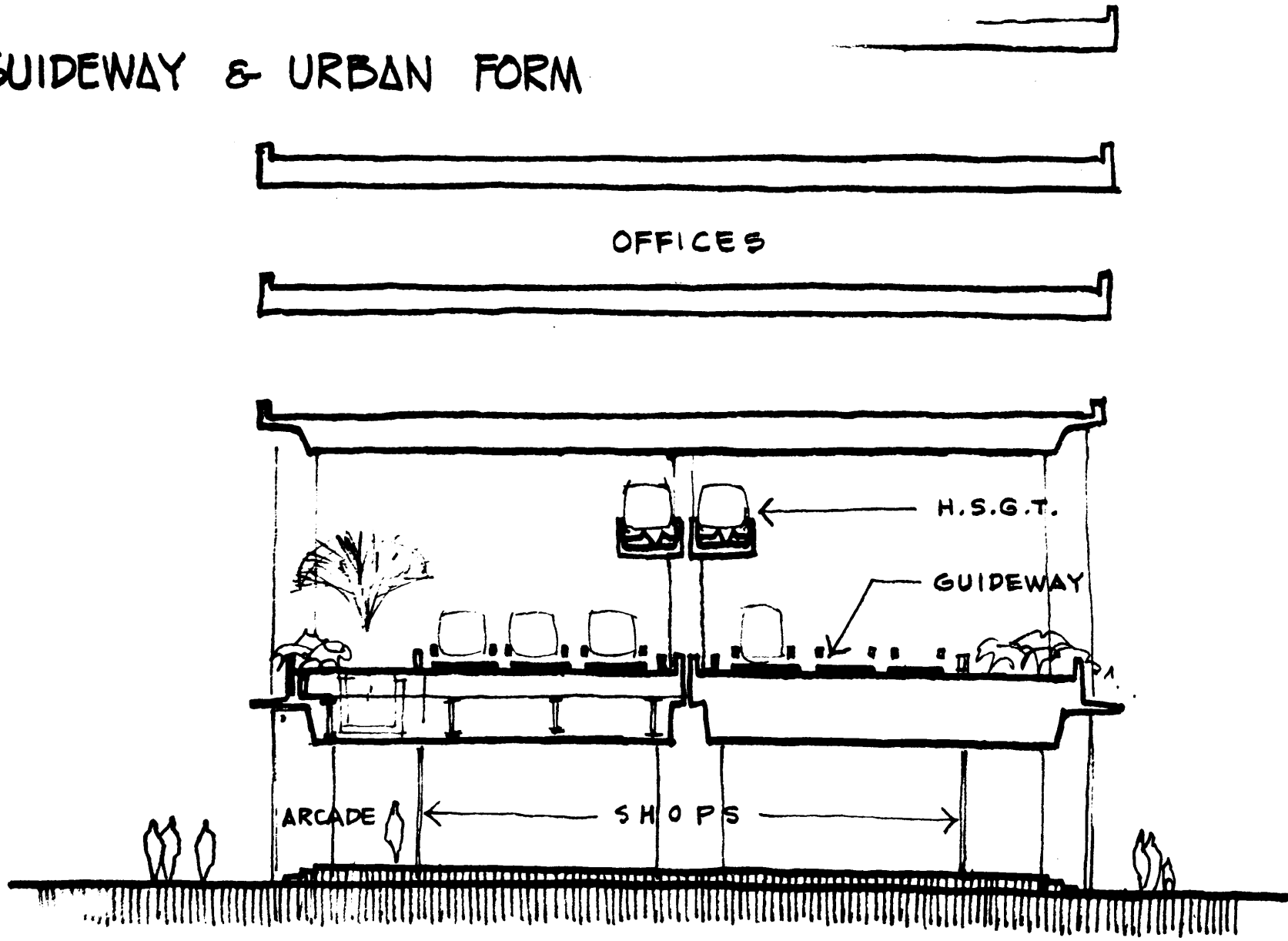


FIG. 7.5

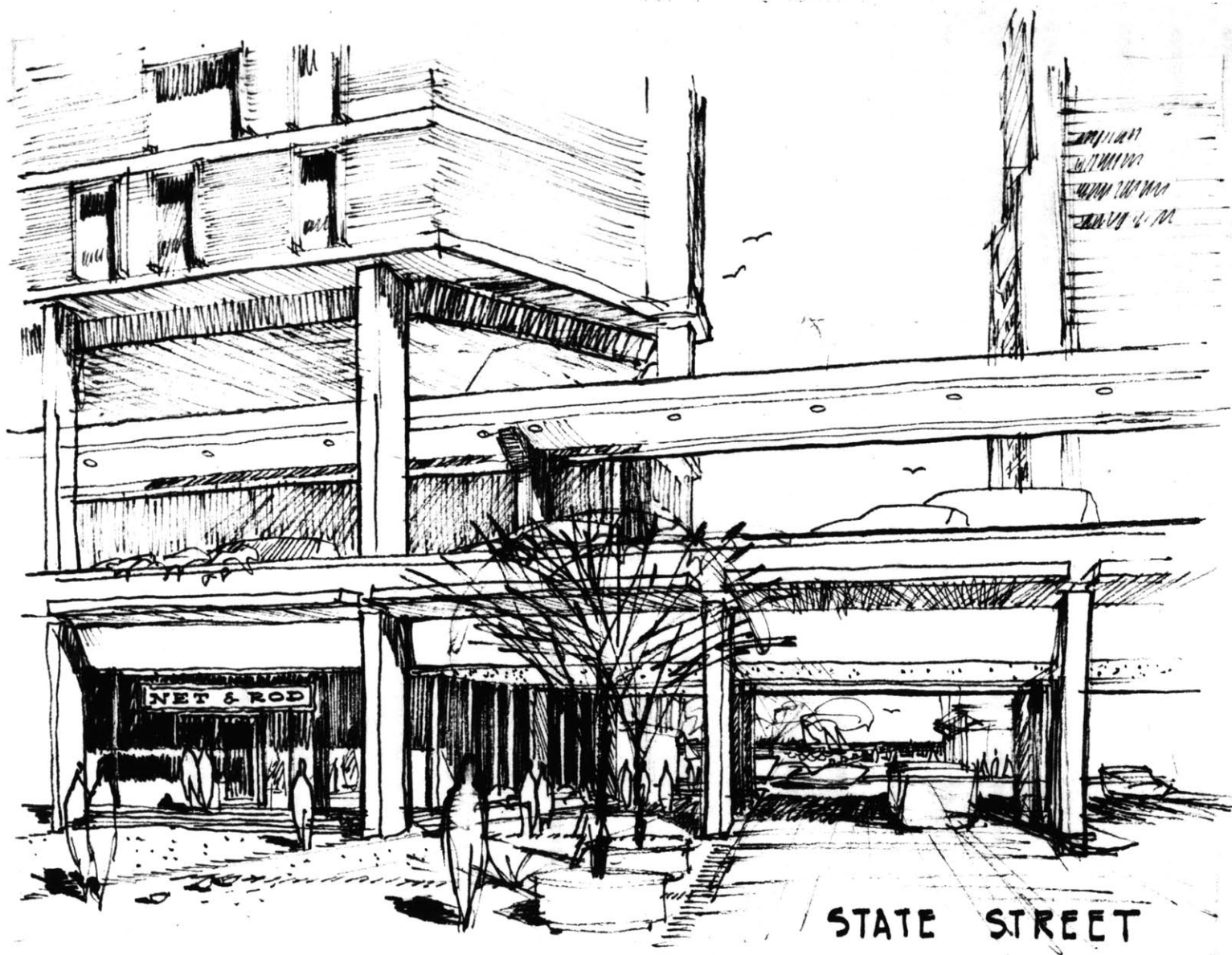


FIG. 7.6

activities, covered walks, and gateways to important views or spaces. The sketch in Figure 7.6 illustrates these points as applied to the Fitzgerald Expressway in Boston.

The work on garages has some fascinating possibilities, as can be seen in Figure 7.7. Where soil conditions require deep piles or mats, the latter should prove the most attractive since they could double as garages. With automated handling and the minimum dimensions required for a large volume of vehicles, the use of garages as floating foundations beneath tall office structures is quite feasible. Not only does it store cars without using up prime rentable space in the superstructure, but it uses normally difficult space - the basement - to turn a nice profit.

So far the emphasis has been on the outside looking at the system, how it appears in the city. Now we would like to take a closer look at some of the visual and psychological considerations for the rider in the system. We've already mentioned the importance of being above grade as the clearest way of understanding the form of the city. By properly orienting the guideway, views of the skyline, of sections of the city, of historic areas and the harbor can be skillfully introduced to the rider. Another problem of orientation arises when we look at the subways.

Subways serve a major percentage of commuter traffic and have the least contact with the environment. Since the travel segment of the

GARAGES & URBAN FORM

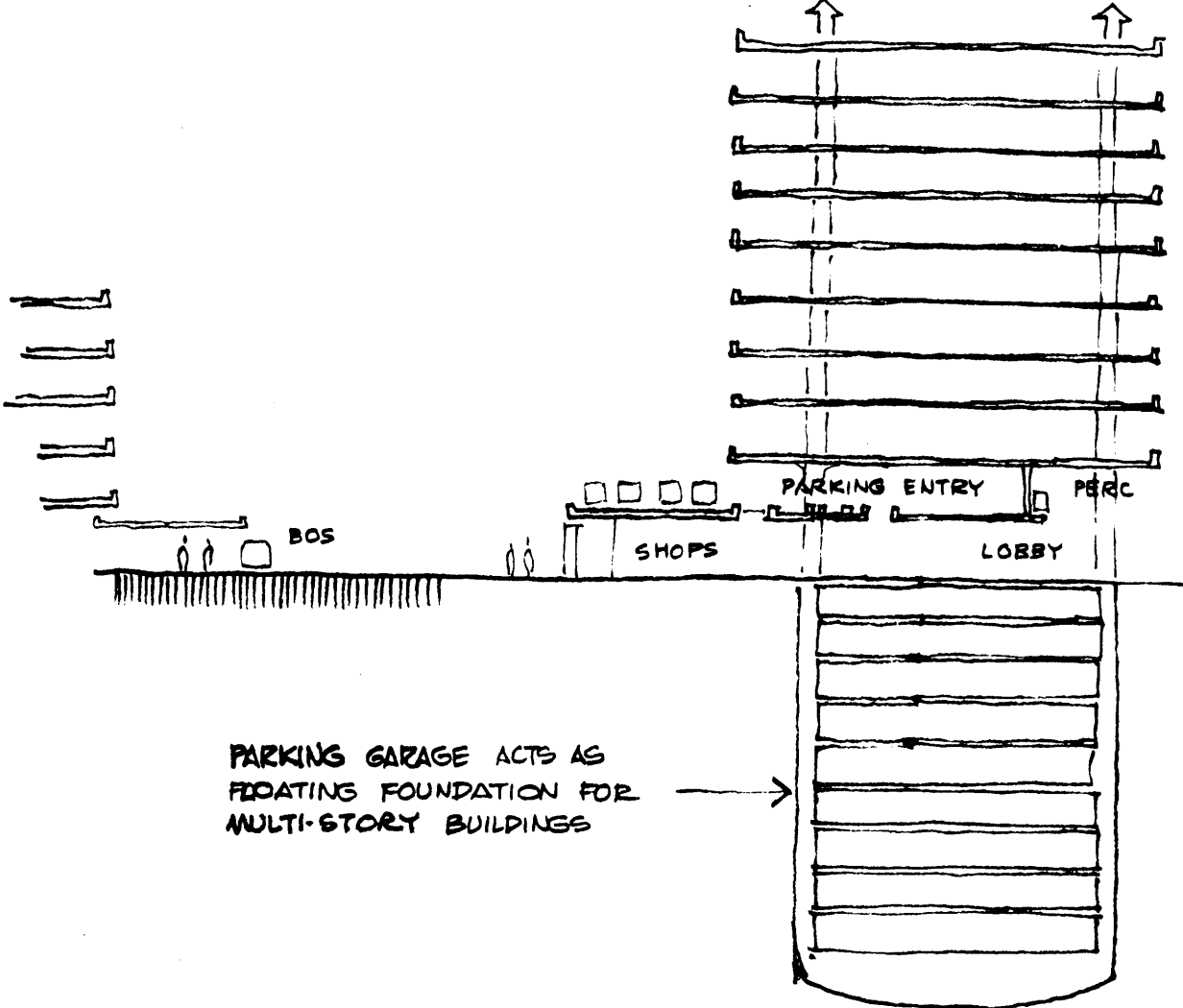


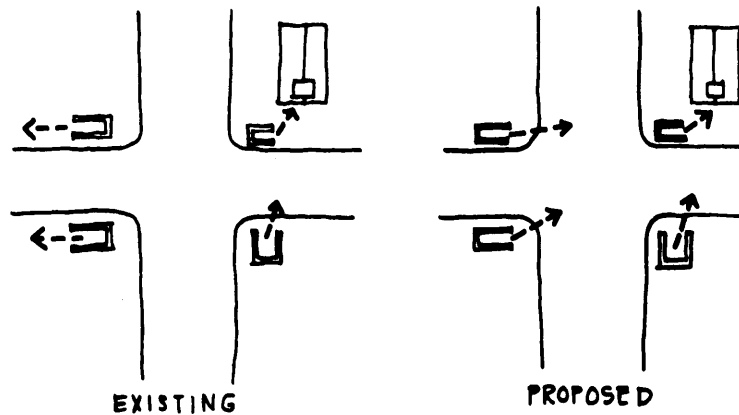
FIG. 7.7

journey presents little or no information to the rider, the origin and destination points - the stations - must convey the information about where you are going and where you are. Regretably, most stations are silent, or a cacophony which leaves the rider dazed.

Taking the example in Figure 7.8, the Arlington Street Station has

Figure 7.8

ORIENTATION OF STATION EXITS

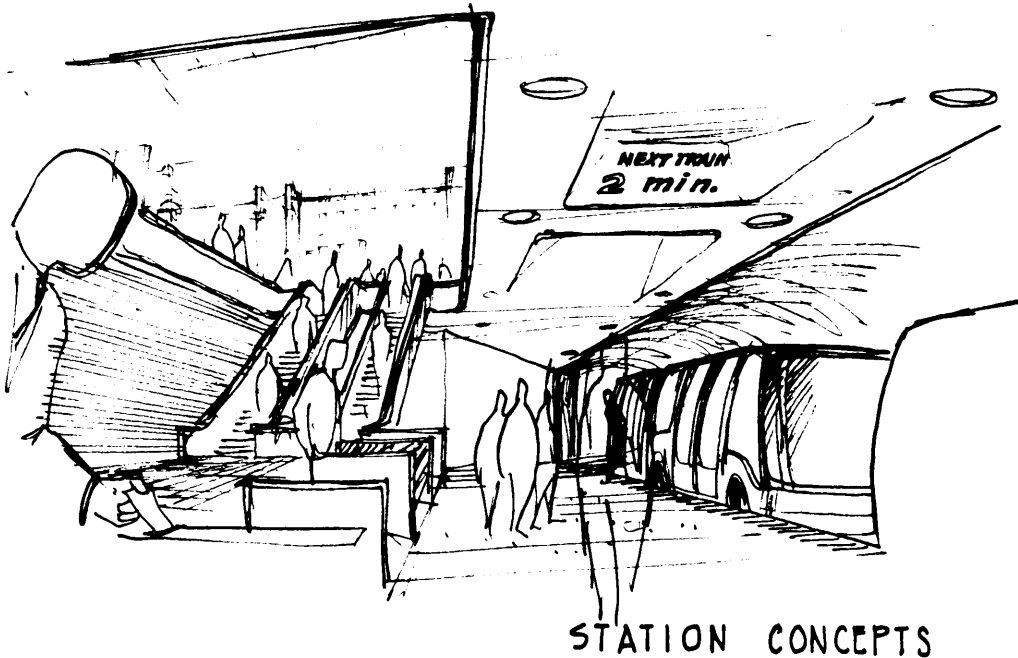


half of its entry and exit points facing away from the intersection. One is often confused coming out of these points since immediate orientation to any prominent building or intersection is possible only after taking a few steps, turning around, and establishing bearings. Though orientation is done automatically by the commuter, I contend that "automatic" in this case is not the same as "natural", and that such effort contributes to an environmental pressure that

limits freedom and spontaneity in urban living. This could be alleviated by orienting the openings to the Arlington Street Church, as shown in the right hand side of the figure, so that as you came up from the landing the sight of the dominant landmark would identify where you were.

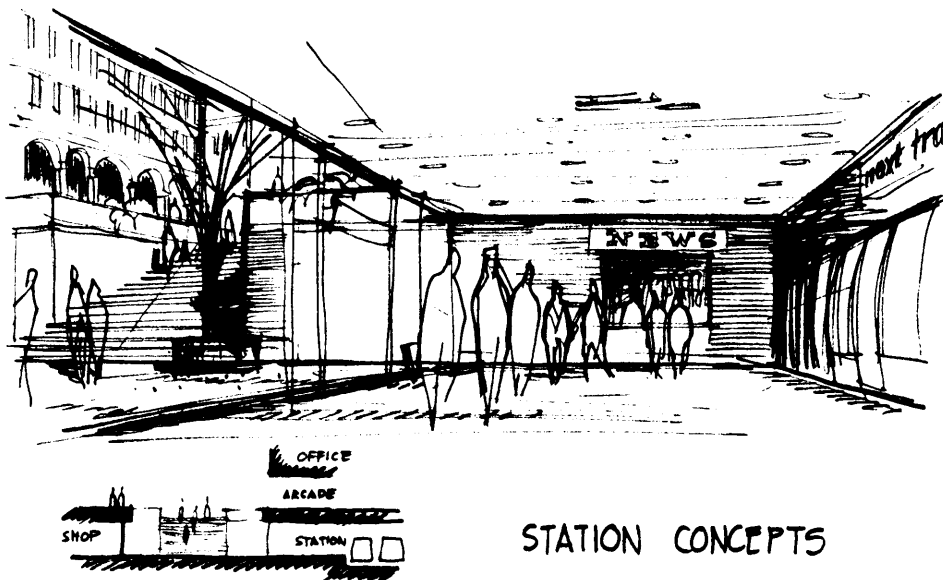
A look at the stations themselves shows how a sense of openness, freedom of movement, and orientation could be achieved. Figure 7.9 indicates the effect of using escalators or stairs in a generous opening which welcomes both light and air as well as visual keys and riders. The larger openings would allow a view of the city above;

Figure 7.9



or, by feeding into the lobby of a building, become part of a sequence of indoor spaces through which you passed before entering the outdoor urban space. The sketch also shows the use of signs giving arrival (or departure) times for the next train in order to reduce the frustration or anxiety of not knowing when to expect to begin and end one's trip. Figure 7.10 is an alternate possibility

Figure 7.10



for stations in highly dense areas. Here the landing opens onto a depressed shopping court ringed with shops. Upon arrival you would look out into the courtyard and be able to relate to activity, shops, and trees. Such multi-level shopping areas increase the usable retail space (linear feet of shop fronts with

pedestrian access) without increasing the number of streets at ground level.

Finally, we shall look at the impact of the PERC system in downtown areas. The system provides an opportunity for high accessibility in a large urban area, with capability for spontaneous stops - shopping -, and a mobile view and experience of the city. The PERC guideway where attached to the facades of structures could act as a unifying element in streets where chaos reigns today. It could bring in shoppers to an area with ease and in sufficient numbers to strengthen downtown retail business. It would also supply a volume of people sufficient to justify pedestrian malls on selected streets. With the streets clear of vehicular traffic, outdoor restaurants, kiosks, concerts and civic events should flourish, Figure 7.11.

Where the PERC system was free-standing, benches and plantings would be arranged underneath, and awnings for outdoor retailing could be set up, Figure 7.12. The lightness of the structure - 100' spans possible with 2 modified 14 x 27" steel H beams - would cast a negligible shadow when free-standing, and would be most inconspicuous when placed against buildings. Existing 2nd story windows would have to be closed up partially or fully if the PERC system ran flush with the building. However, the majority of retail stores do not need or use full windows above the pedestrian level, and offices could use the wall space beneath strip windows for files.



FIG. 7.11

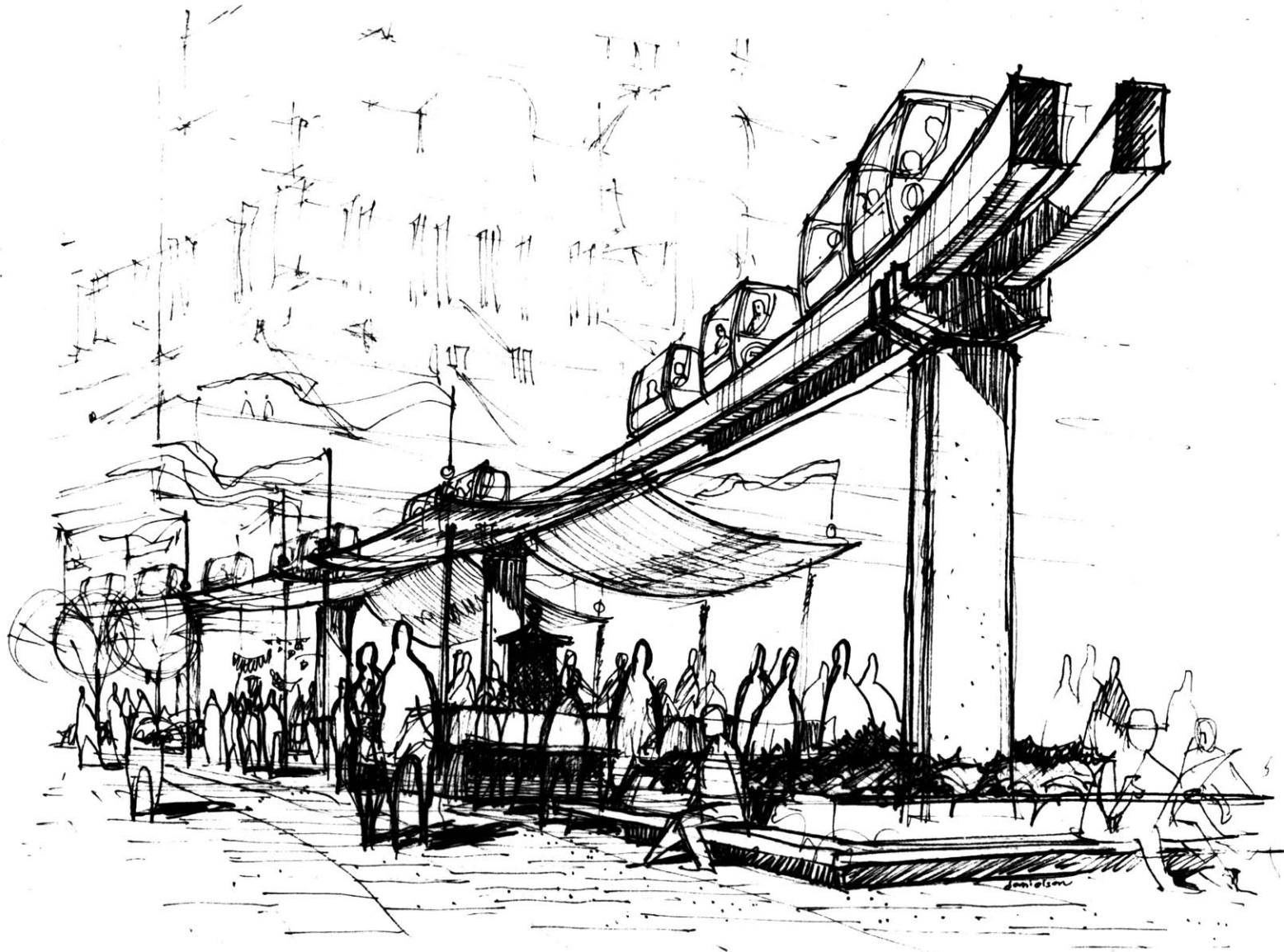


FIG. 7.12

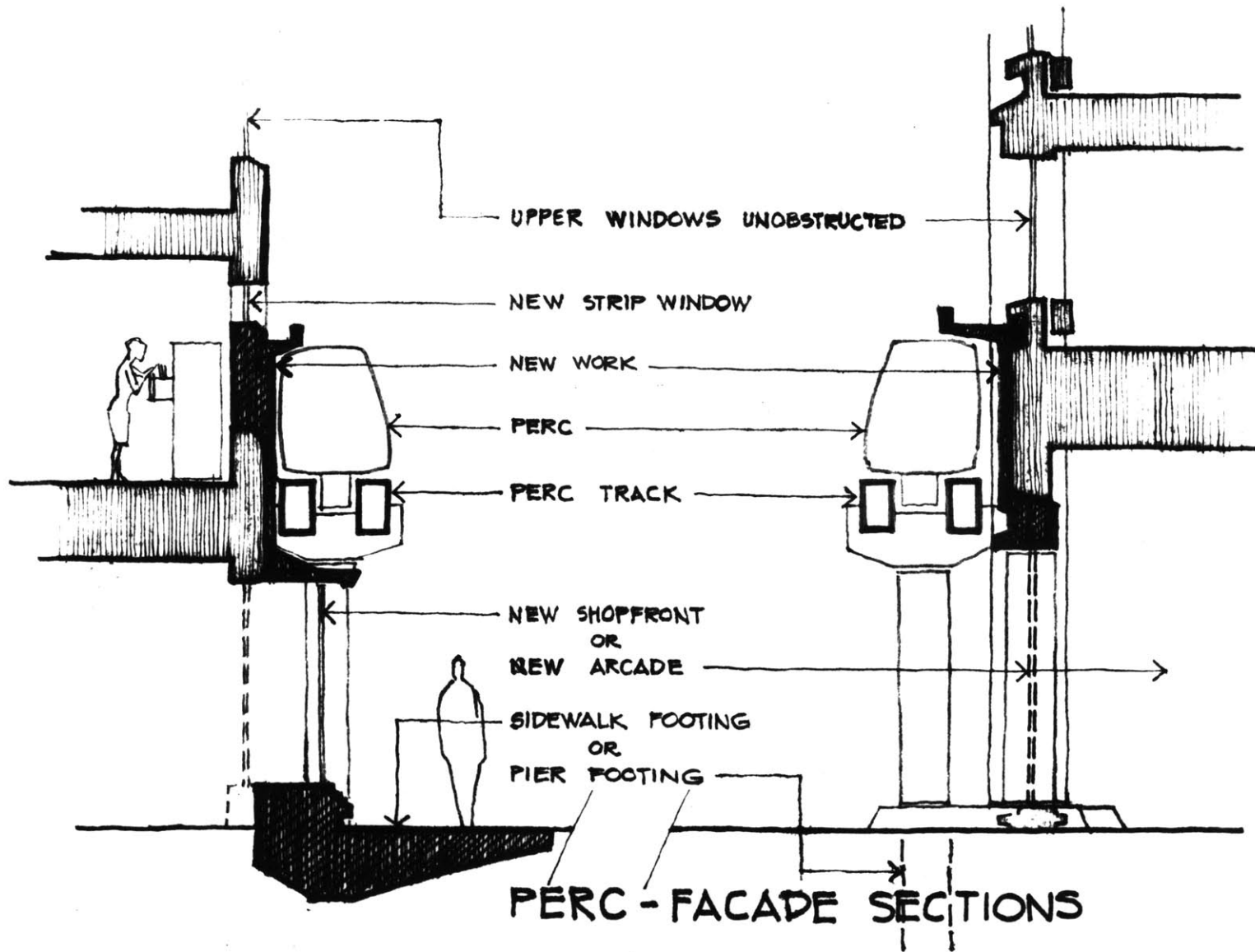
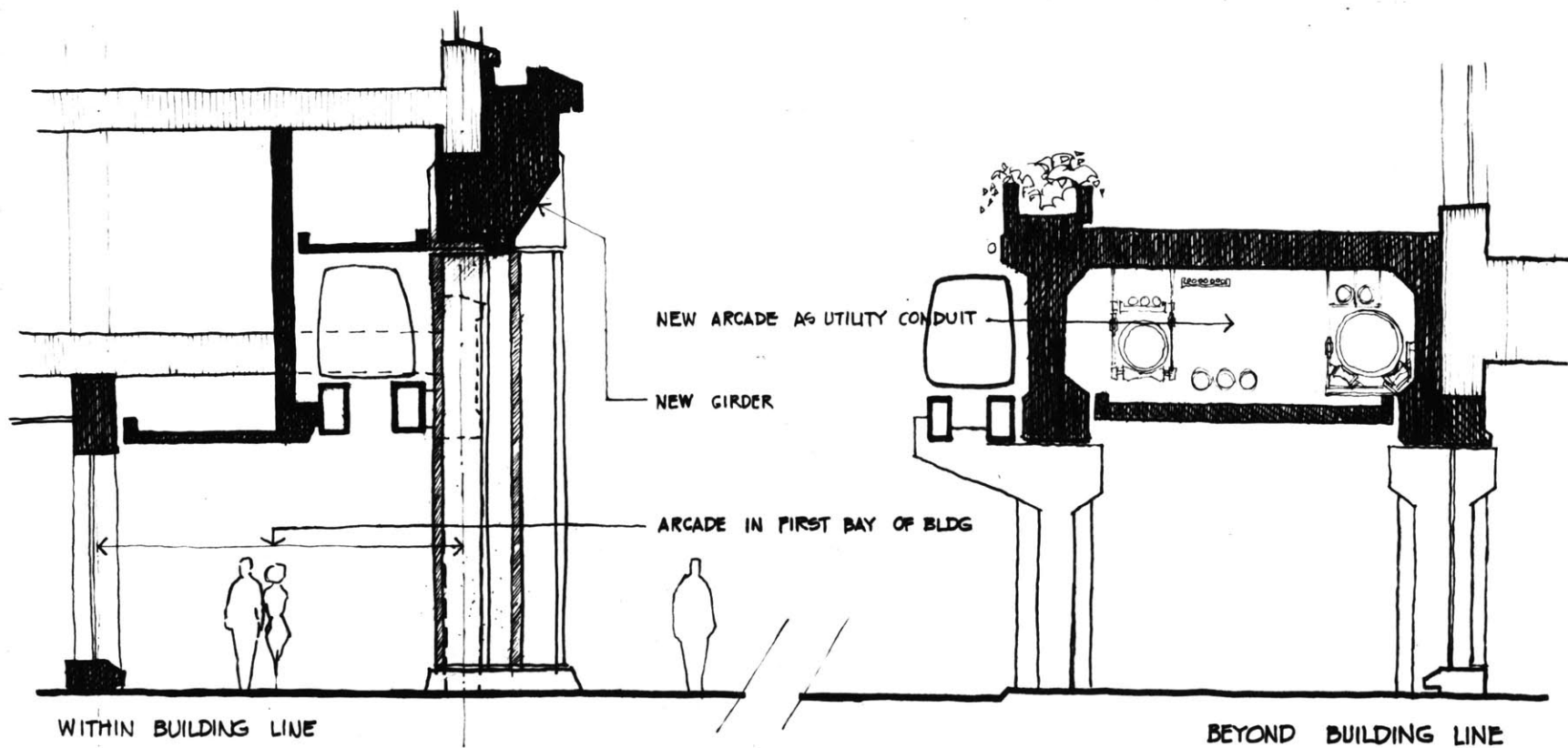


FIG. 7.13

In other conditions where the spandrel depth was 6-7 feet, no obstruction would occur, Figure 7.13. The PERC network could be held 15 or 20 feet away from the sides of buildings so that covered arcades could be constructed (shop fronts could be set in a bay to form an arcade where PERC is flush), allowing protection from the weather for the pedestrians, Figure 7.14.

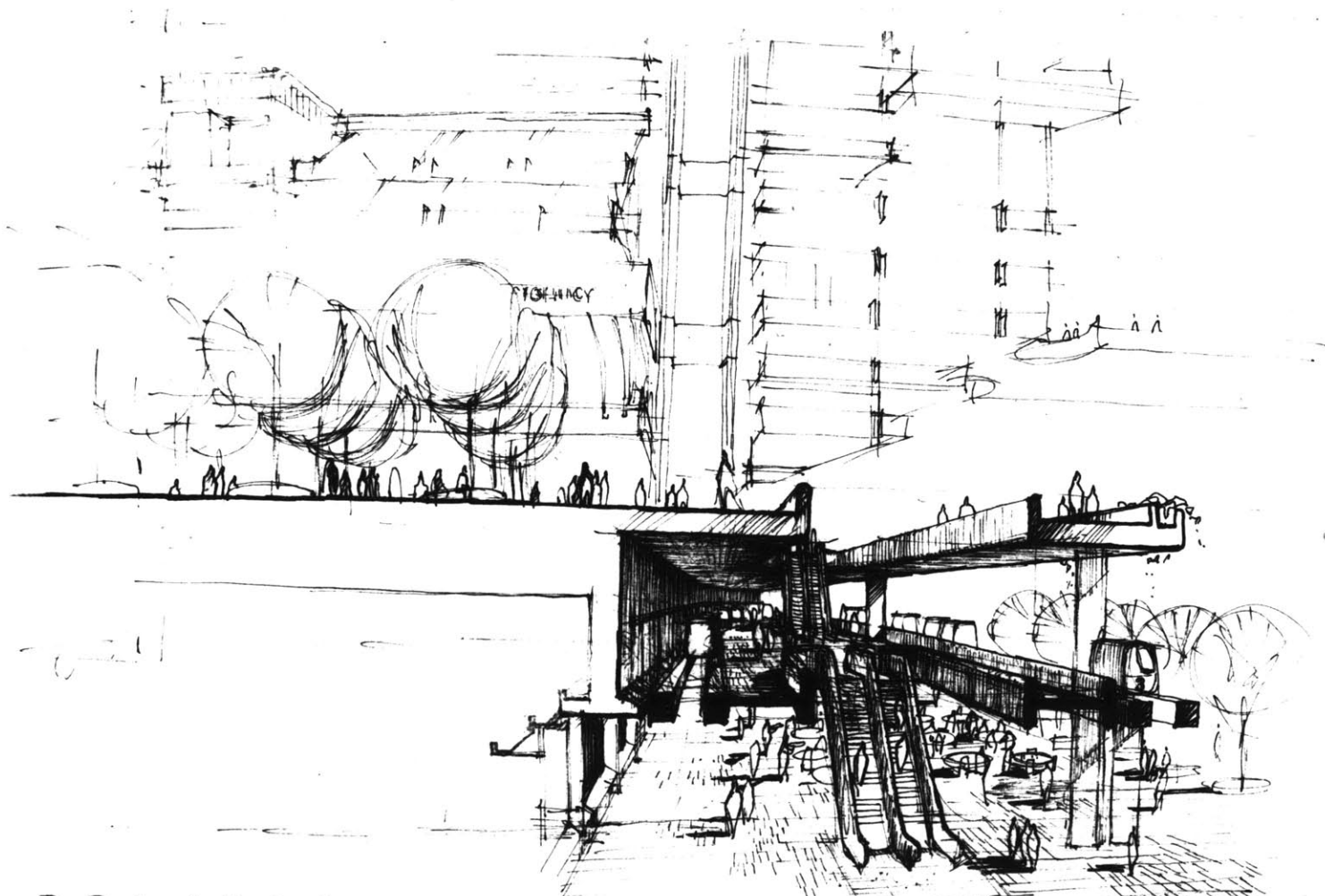
The network would also provide a transition to multi-level pedestrian streets. It's conceivable during the 21st Century that various urban centers will reach ^{such} a density ^{that} ~~where~~ a single level of pedestrian movement cannot carry the volume of people coming to those centers. With the PERC system it would be just as easy to have escalators go one story up to a new activity level, as well as down to the existing level, Figure 7.15. The network itself could be modified owing to the lightness of the elements. Where an old building is torn down behind a PERC guideway, the guideway could be moved, left free-standing, or integrated into a one story base with a tower set back from the existing street, Figure 7.16. The opportunity for a richer street architecture and the support of new urban open spaces are major goals supported by the PERC system.

All these possibilities, from movement in the region to mobility in downtown areas, would increase the use of the city, enhance the degrees of choice - unique to the urban experience -, and give metropolitan regions new life and vitality. Architecture can serve no higher purpose than to see that this is fulfilled with beauty of design as well as function.



PERC - ARCADE DEVELOPMENT

FIG. 7.14



PROJECT METRAN - PERC NETWORK
MULTI-LEVEL ACCESSIBILITY

FIG. 7.15

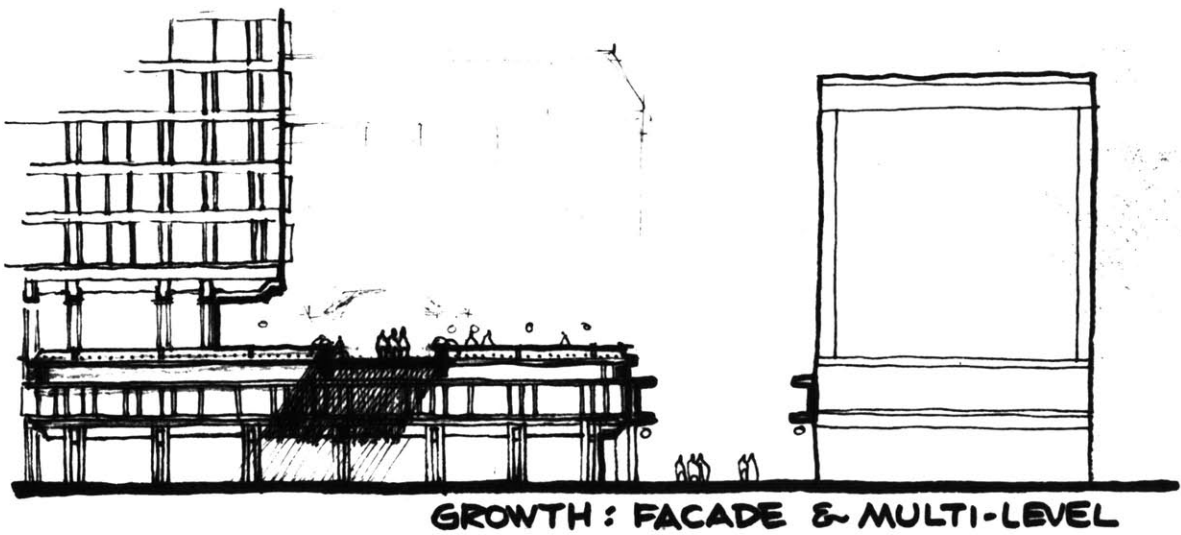
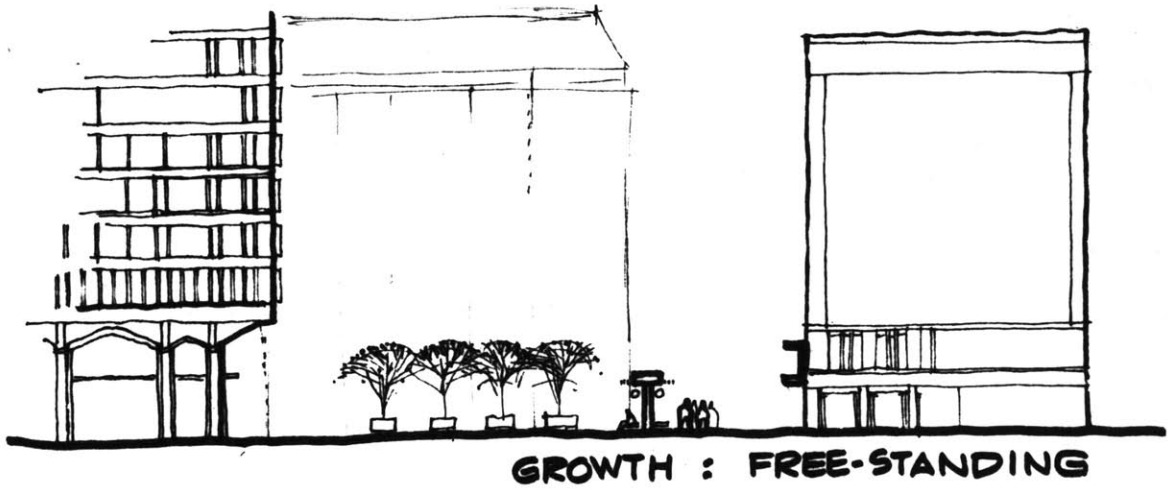
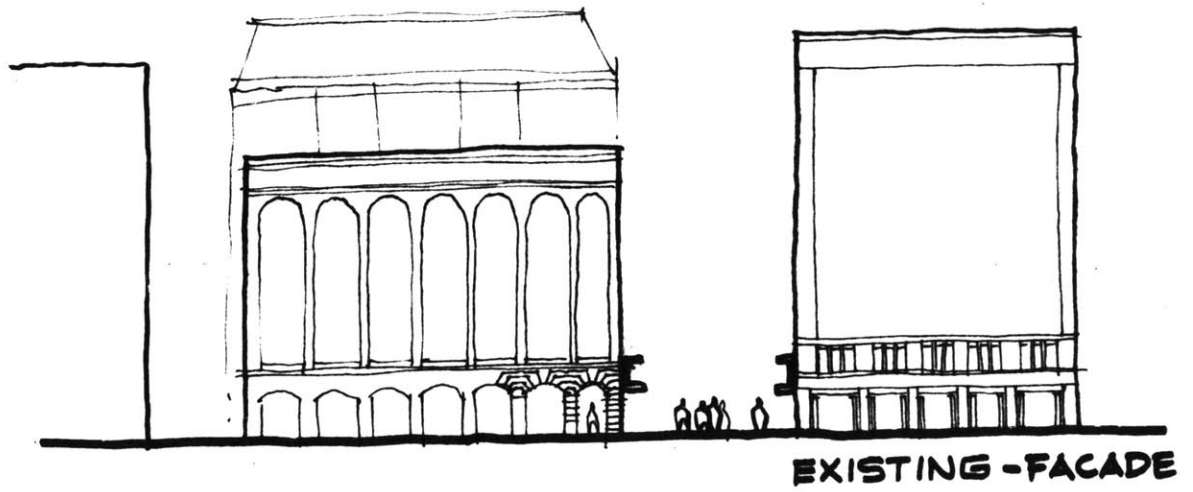


FIG. 7.16

FURTHER STUDIES

This is an introduction to the final drawings that will be presented July 15. Since the course ended 24 May, I have been involved first, in pushing deeper into the total scope of the project as a team member for special presentations (see Postscripts), and secondly, in taking a closer look at course objectives and hardware as an individual architect. This approach has generated three special interests. The meaning of dispersion, its link to new warehousing and distribution facilities, and their connection to transit was expanded in the Components Chapter from ideas I'd not had a chance to follow during the term. The implications for

generating new city sub-centers over these merchandise handling complexes are quite exciting and barely touched upon. Since they would have excellent transportation out to other centers, they would have excellent transit in. Thus, they would have high accessibility. Its supply facilities would be geared for flexibility and growth, making a good base from which to build a city.

The definition of environmental pressure and human crowding form a second field of intense interest. If we could devise ways of measuring or recognizing the effect of learned responses to visual and physical obstacles it would give architects more convincing evidence of the importance of things esthetic, and more material for better plans for action than picketing the razing of Pennsylvania Station in New York. Besides orientation problems, there are the effects of poor apartment planning, of the lack of scale in huge renewal housing projects, and of the benefit of usable outdoor spaces. Another way of thinking about this is: how much spontaneity do you inhibit or lose in people when they must constantly erect psychological screens to block out glaring signs, shoddy buildings, constant noise, or overcrowding (Zushi Beach outside Tokyo became a classic during the summer of 1965 - see Life magazine, 13 August 1965).

The third concern, and that which the final drawings will cover, is the impact of the PERC system on existing urban form. One area is the use of the system at Logan Airport and the possibility of using it as a direct link to and from the boarding lounges. A

second is its use in old and historic areas: how would it skirt Faneuil Hall and yet participate in Government Center? how does it go down Washington Street without blocking the Old South Meeting House? This last question will take the major portion of study as it became linked with problems of utilities and the ultimate growth of the city.

The PERC system could set the stage for a major renewal of existing downtown areas. One of its operating objectives is that vehicular movement should be grade separated so as not to conflict with free pedestrian movement. If the PERC system is elevated to the second floor it achieves the objective, but the mall below does not, since it would still be cut on grade by service vehicles at cross-streets. The alternatives are to elevate the pedestrian mall or sink it. The first alternative would force development of entries at the second floor level. This is not very feasible, since the ceiling heights are not very high, which is bad commercially; and the facades would require extensive remodeling to achieve a sense of entry, which is bad economically and visually. Also an elevated mall would block the setting of great and/or historical buildings.

The second alternative has powerful visual arguments. With the pedestrian mall sunk in the earth, you create new entries in the basement - a practice already tradition in several downtown department stores. Ceiling heights would be greater, and little remodeling would be required to the above grade structure (except to re-do most of the chaotic signs so there is some minimum of design).

The treatment of the new ground level would be freer, having only to deal with the basement-structure rather than superstructure-schmaltz. The existing street level would be articulated by a continuous band of planters and low walls, leaving the basement - now Mall - elevations architecturally free of their historical upper stories. Famous buildings would be respected, being left at grade on plazas that bridge the new Malls. Cross-street vehicular traffic also bridges the Malls, leaving the pedestrian experience uninterrupted by incongruous movement systems. Other advantages are listed in the preceeding chapter.

Few things in life are free, however, and the price tag on this one has felled many noble concepts: utilities. If you depress the street you uncover the inferno of urban utilities. Their relocation involves a staggering sum of money. For a transportation system to have to bear that cost is suicide, but it does not kill the idea. As urban centers expand, old buildings are razed and new multi-story buildings are erected. This new construction often necessitates rennovation of the utility system in that area and possibly elsewhere. Why not rennovate the entire system by placing utilities in large grids of concrete conduits? Then as new loads were generated, the services could be easily reached and modified. Why not have these conduits flank the Malls, forming covered arcades - and a fascia on which the PERC guideway could be mounted!

With Federal funds for PERC from the Commerce Department's transit demonstration projects program, and for utilities from the Demonstration Cities program of HUD, these ideas could become reality. It is the intention of the drawings in Appendix A to show that it would be worth the effort.

P O S T S C R I P T

Public reaction to the group study has been very gratifying. The guests at the course presentation May 24 were quite complimentary, as well as astute in their questions. On the 27th of May, three of the course professors, another student and myself were invited to meet with representatives of the Massachusetts Port Authority, the MBTA, and Traffic Research Corporation, Boston, for further details of the project. The Port Authority representative expressed interest in the PERC system and the MBTA in the GENIE vehicle and concept. If these openings could be followed up with more definite proposals, it is possible that tangible results could be accomplished.

On the 2nd of June, 10 students and the 3 professors were flown out to Detroit by General Motors for a presentation to approximately 50 members, various executives and division directors of the Corporation. Currently the "tour group" is scheduled for a trip to Ford Motor Company in Dearborn on the 14th of July. Such trips have been pleasurable, but also good experience in seeing a little of corporate operations, and in offering the possibility for dialogue between the universities' concern for values and research, and business' commitment to products and profit (There is obviously not such a black-and-white dicotomy, but for effective achievement of ends, some such specialization is required).

The full report of the course is currently being compiled and will be printed by the M.I.T. Press sometime in October. A copy shall be included as Appendix B of this thesis as soon as it is available.

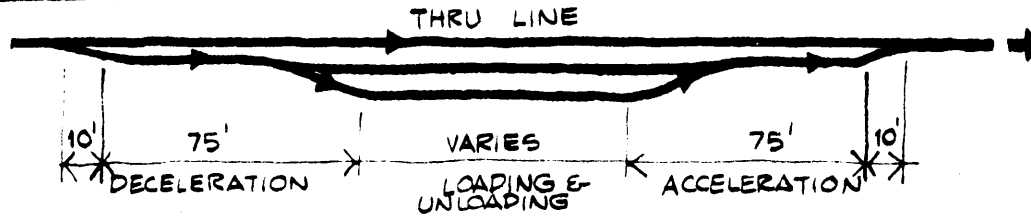
A P P E N D I X A

Final Drawings

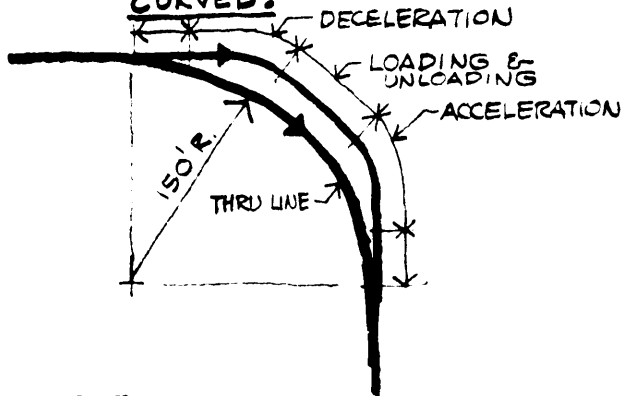
STATION CONFIGURATION

DECELERATION & ACCELERATION OFF GUIDEWAY

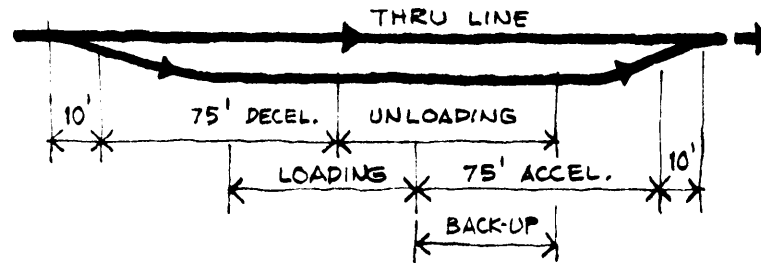
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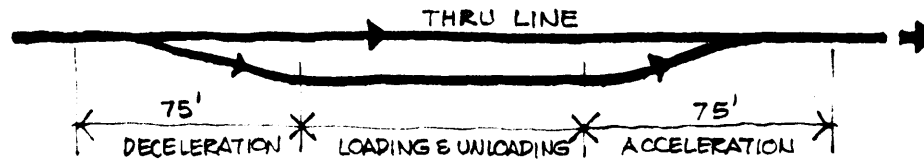
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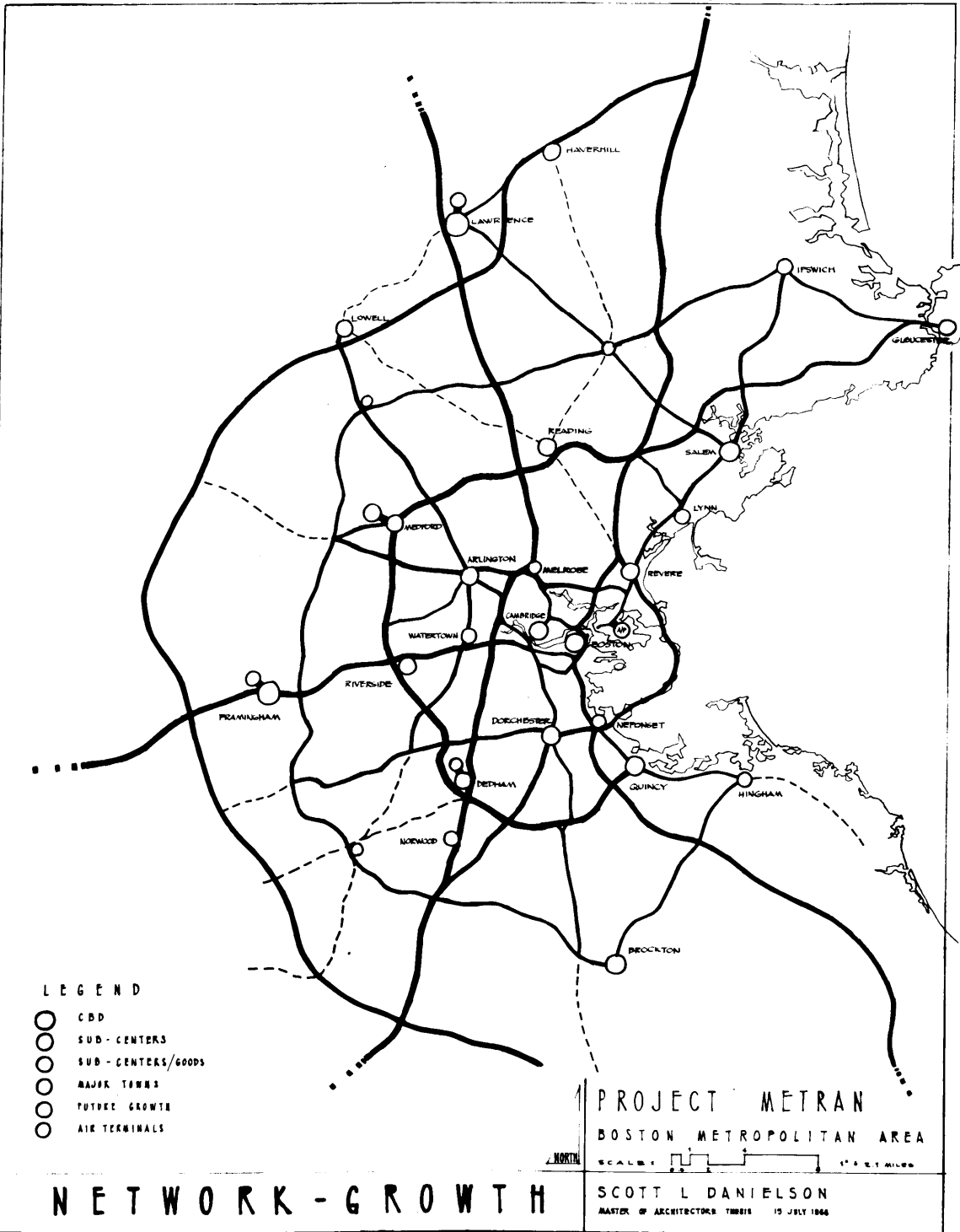


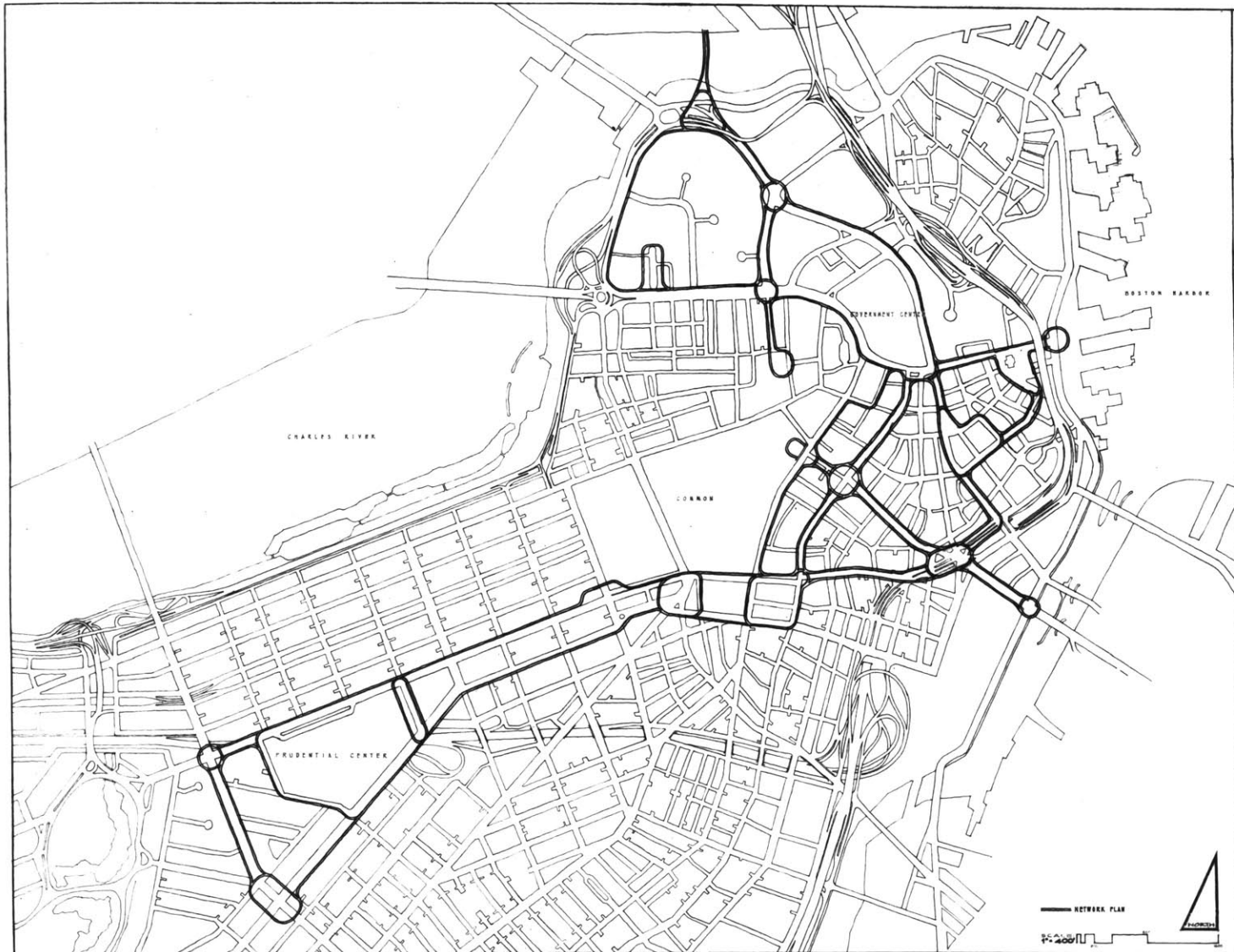
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DECELERATION & ACCELERATION ON GUIDEWAY

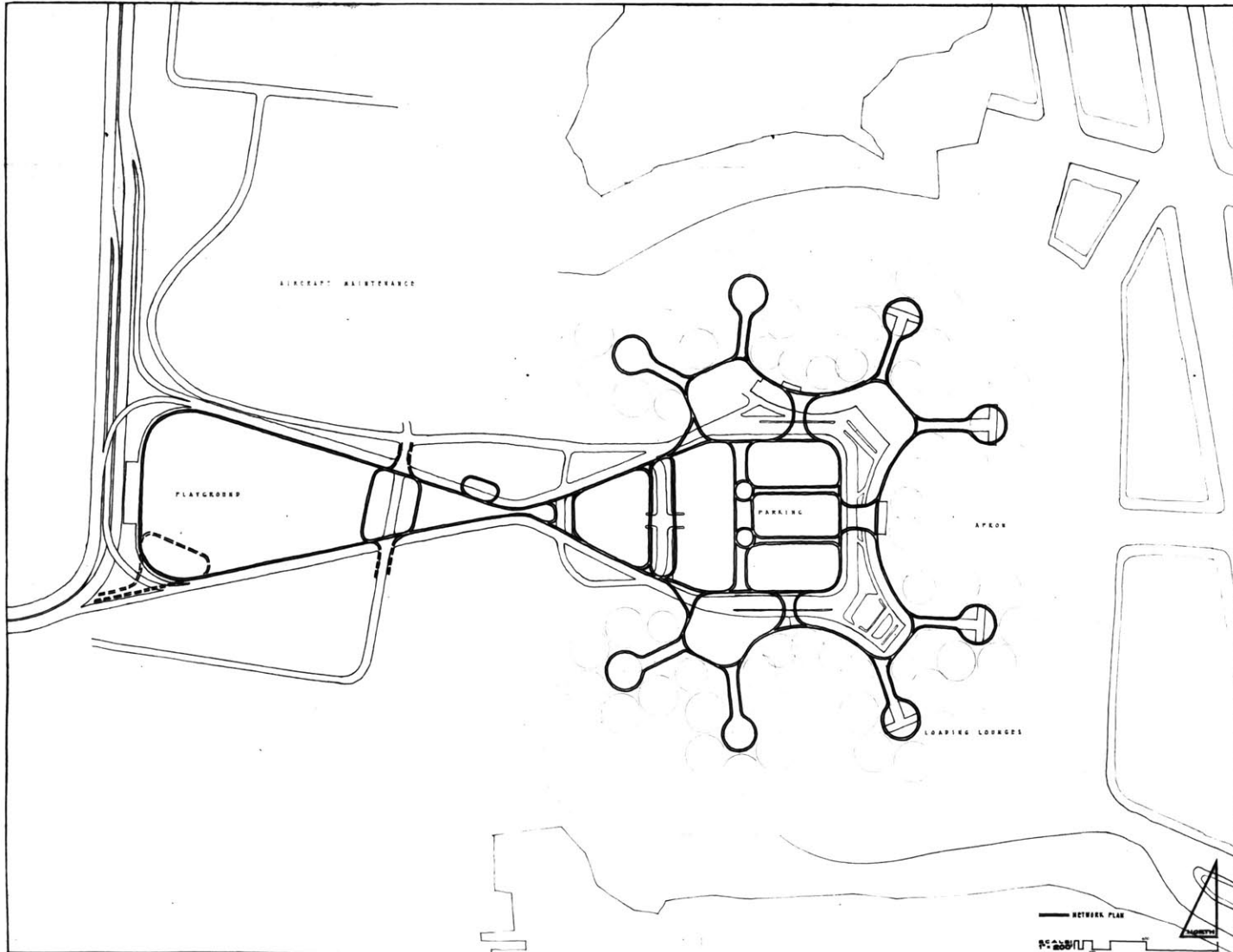






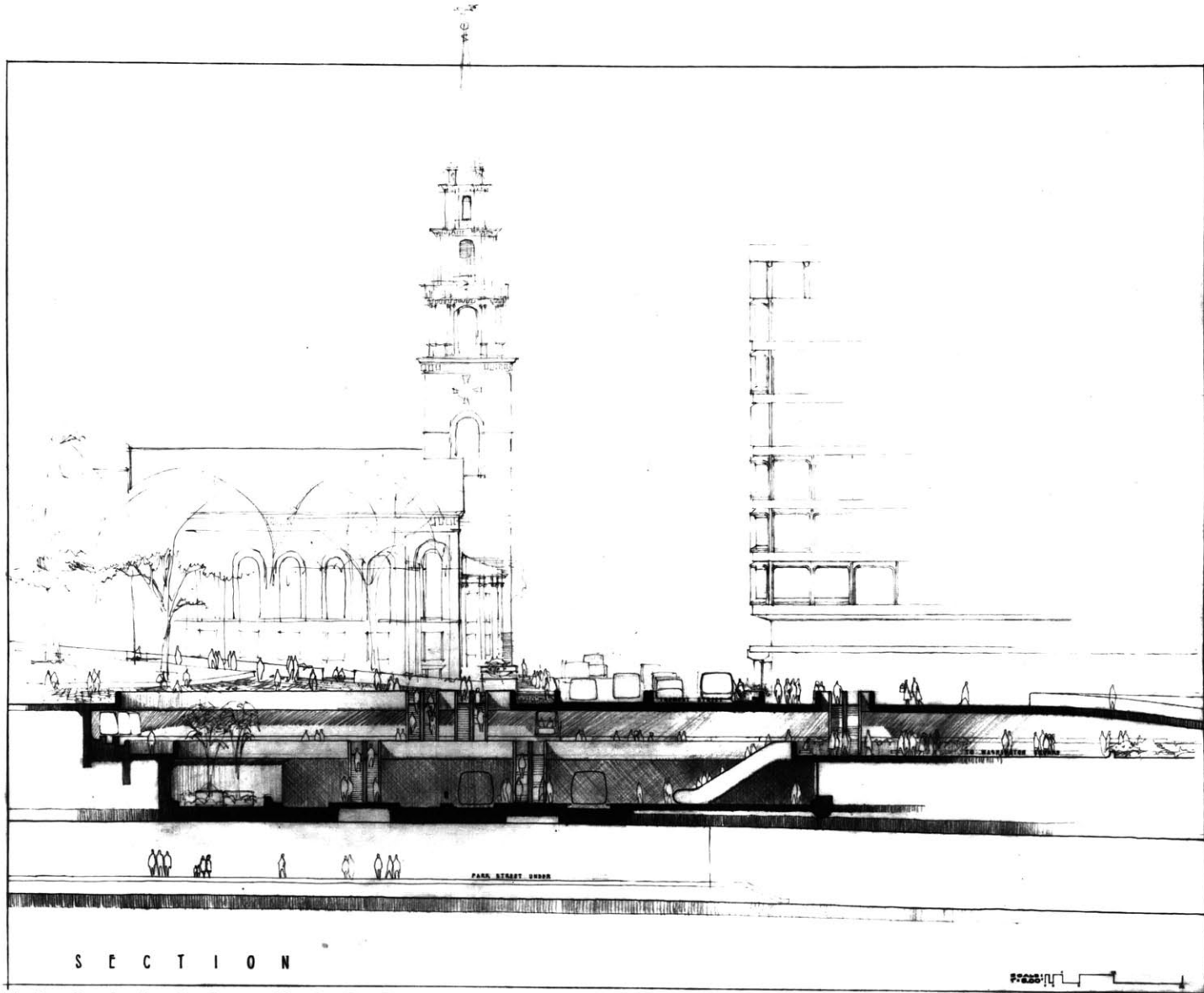
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BOSTON CENTRAL BUSINESS DISTRICT

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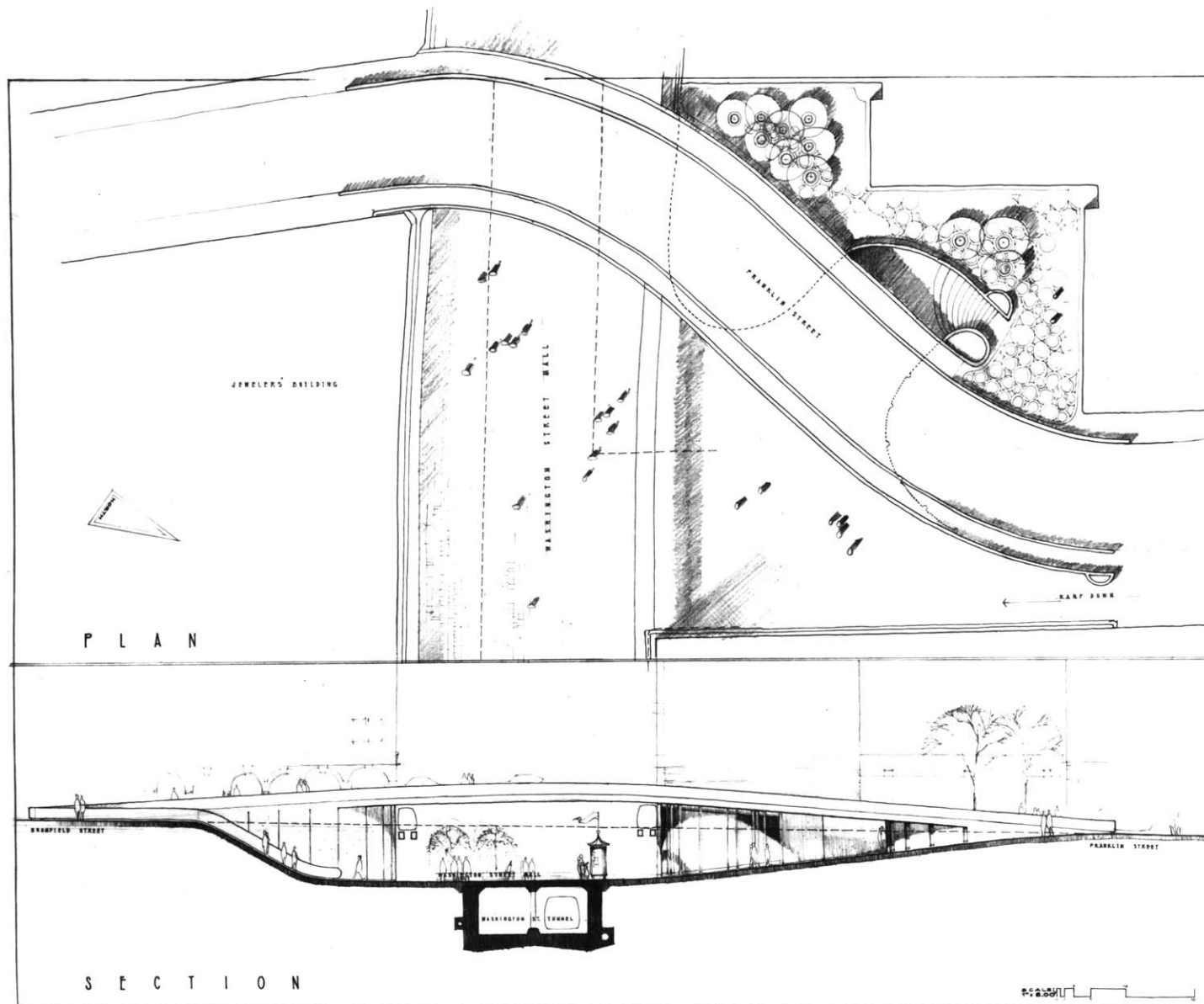
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 LOGAN INTERNATIONAL AIRPORT

NETWORK PLAN
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SECTION
PROJECT METRAN - PERC NETWORK
PARK STREET INTERCHANGE

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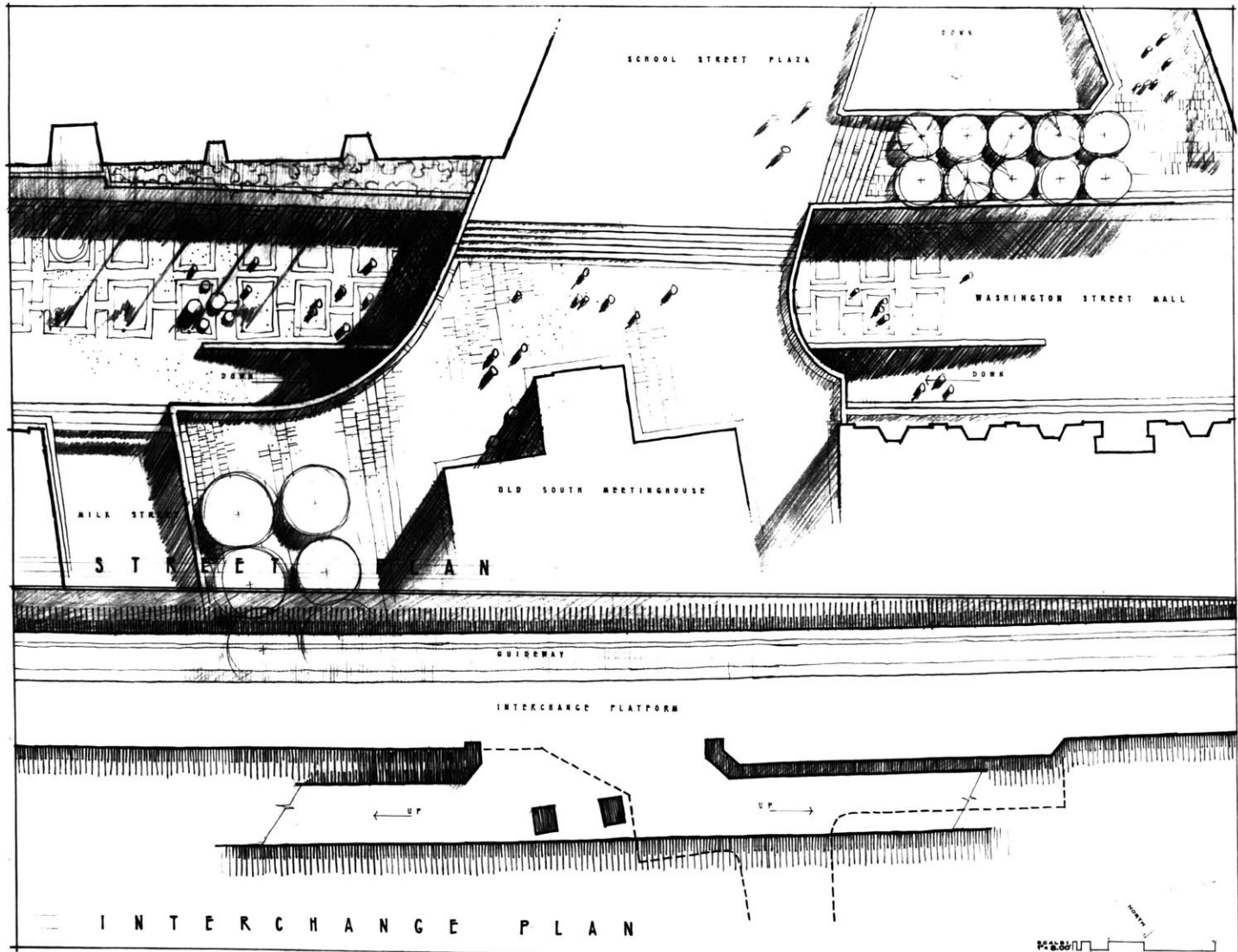


P L A N

S E C T I O N

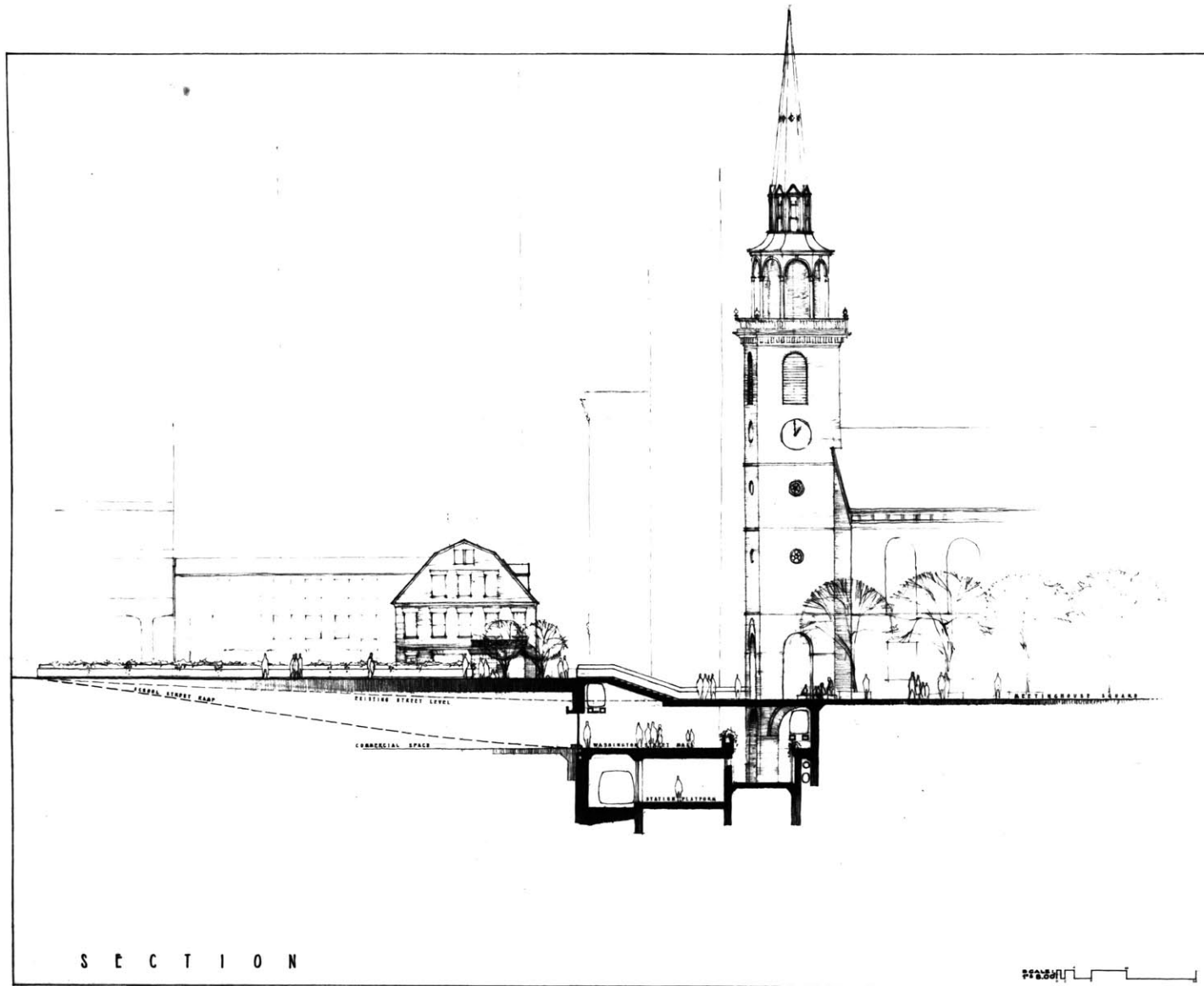
PROJECT METRAN - PERC NETWORK
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PROJECT METRAN - PERC NETWORK
 OLD SOUTH MEETINGHOUSE INTERCHANGE

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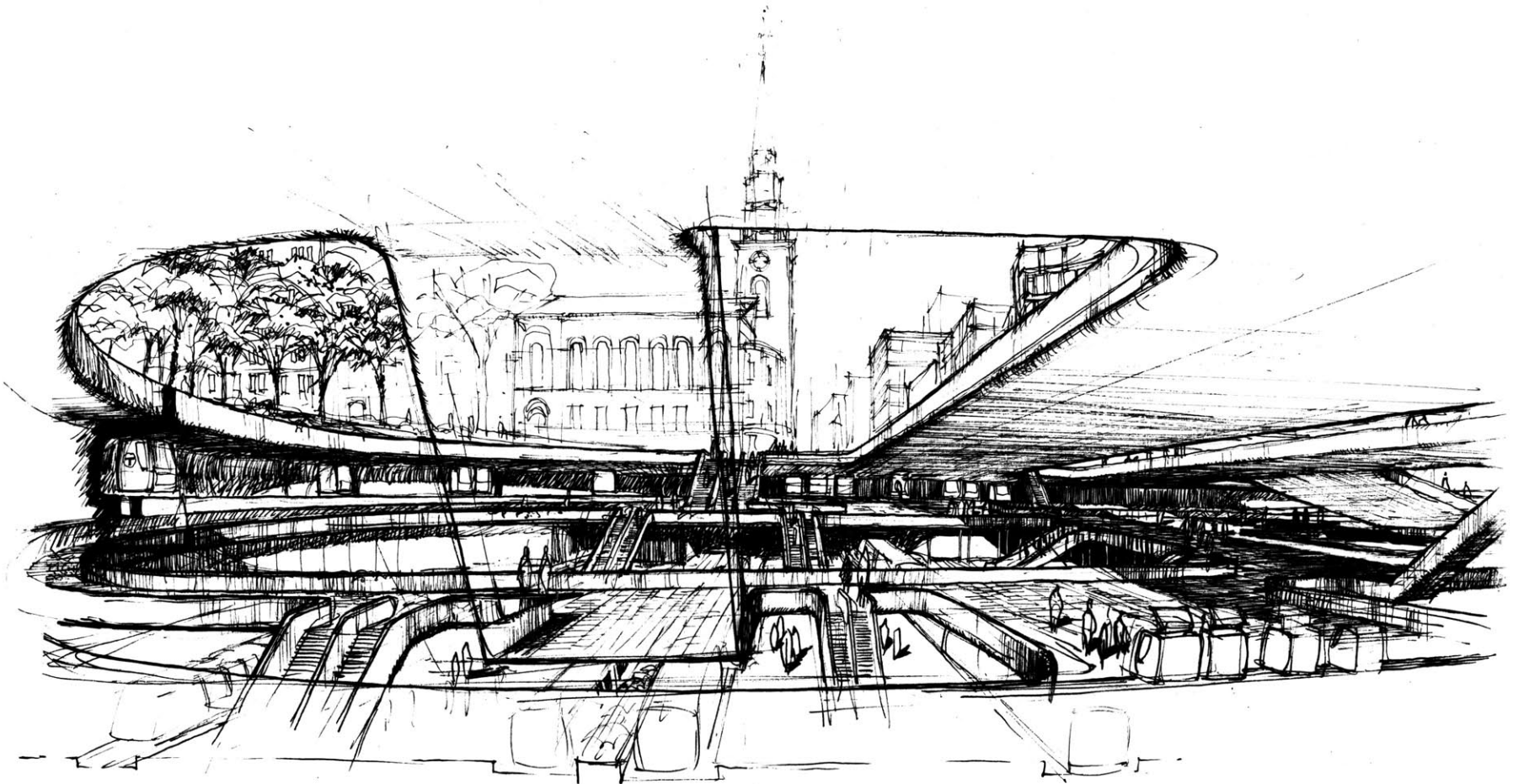


S E C T I O N

P R O J E C T M E T R A N - P E R C N E T W O R K
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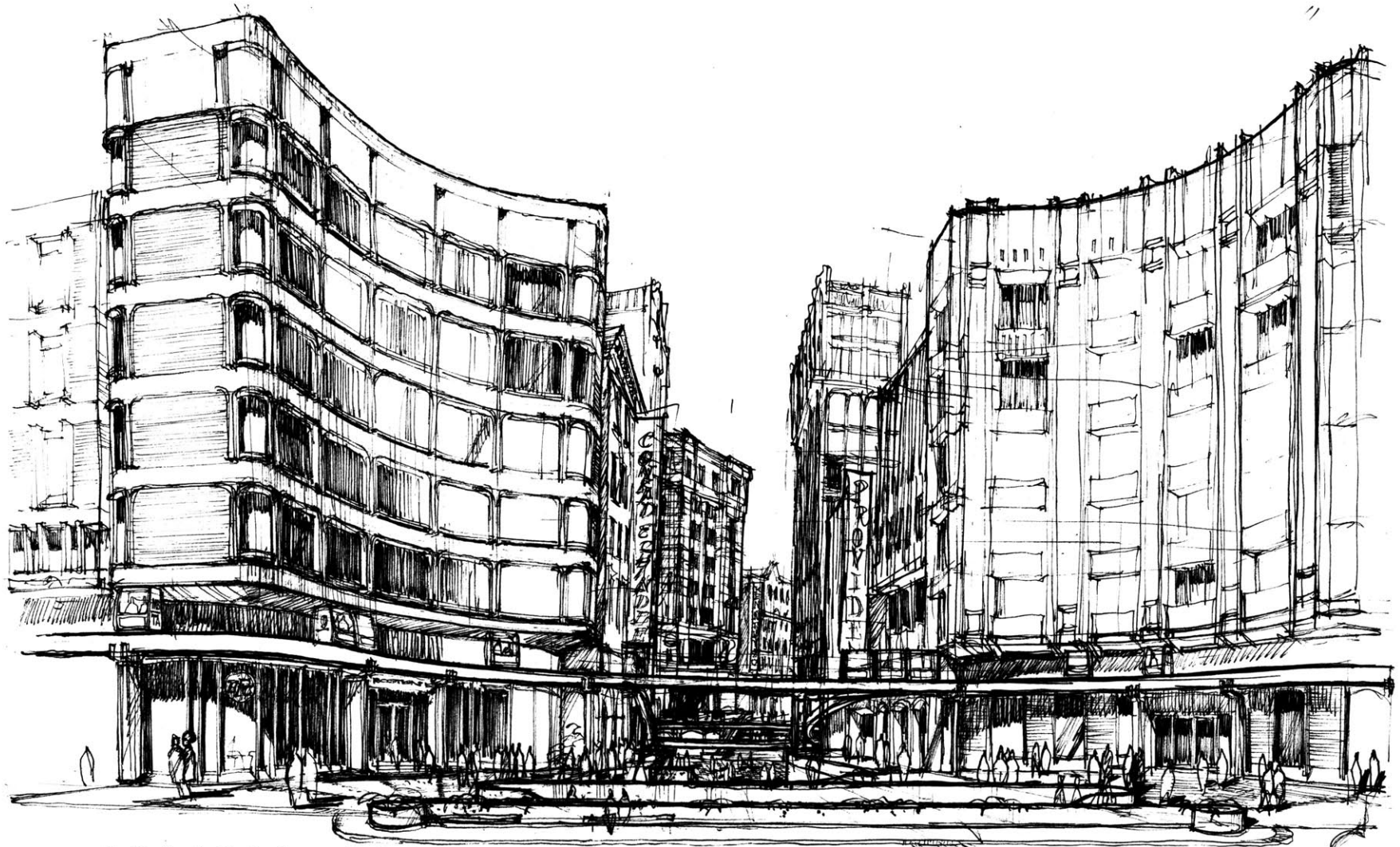


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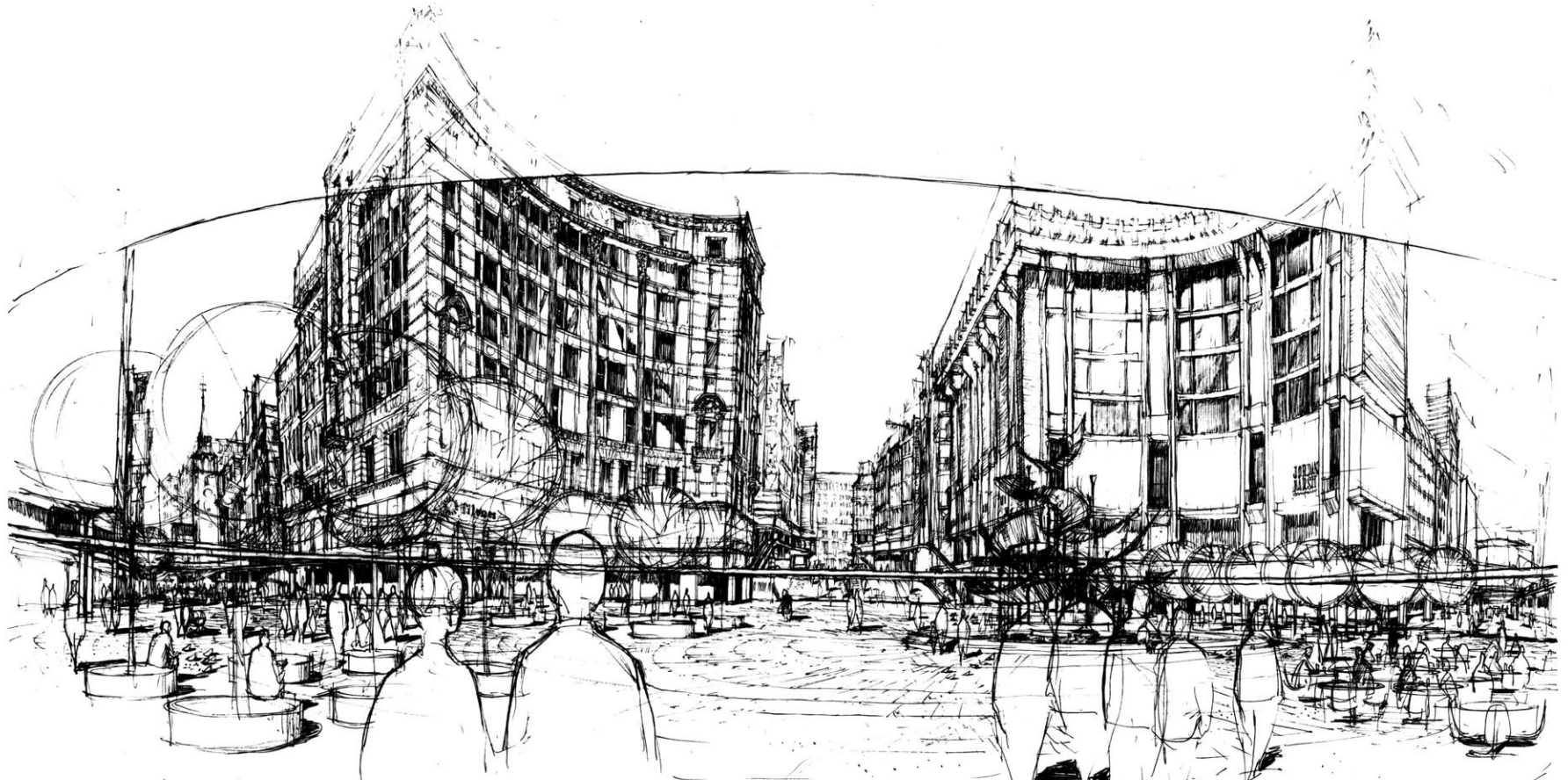
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NEW PARK STREET STATION

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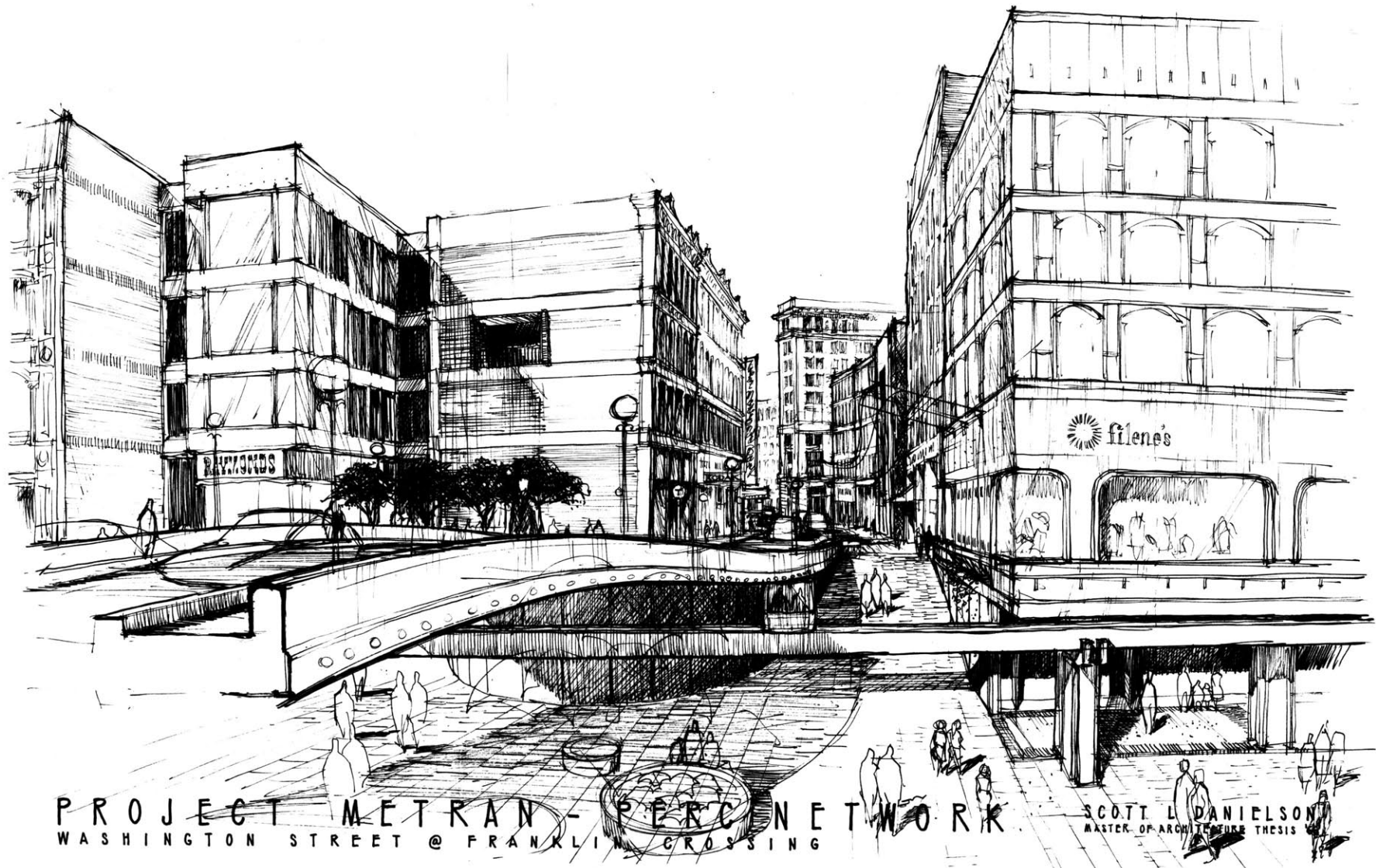
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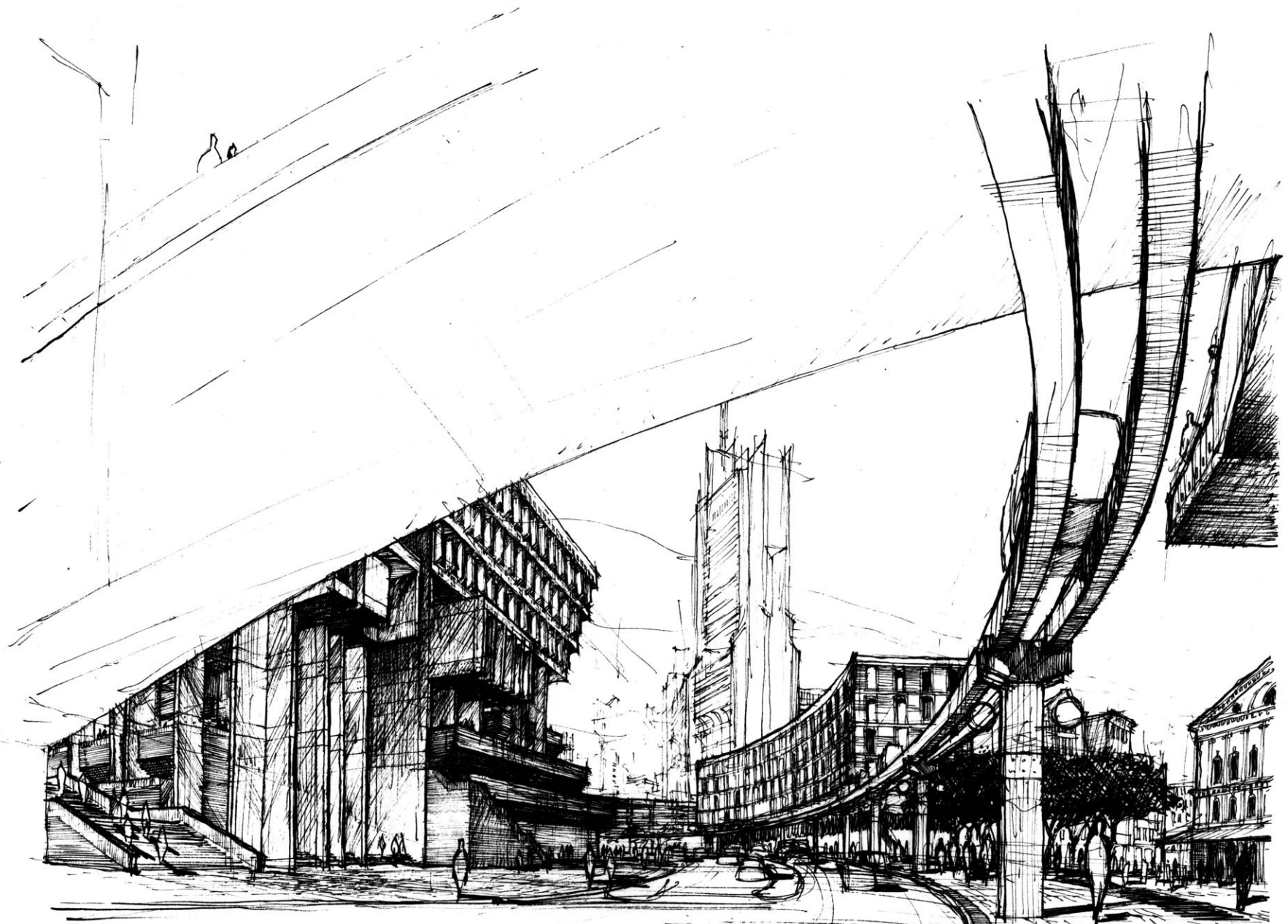
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PROJECT METRAN - PERC NETWORK
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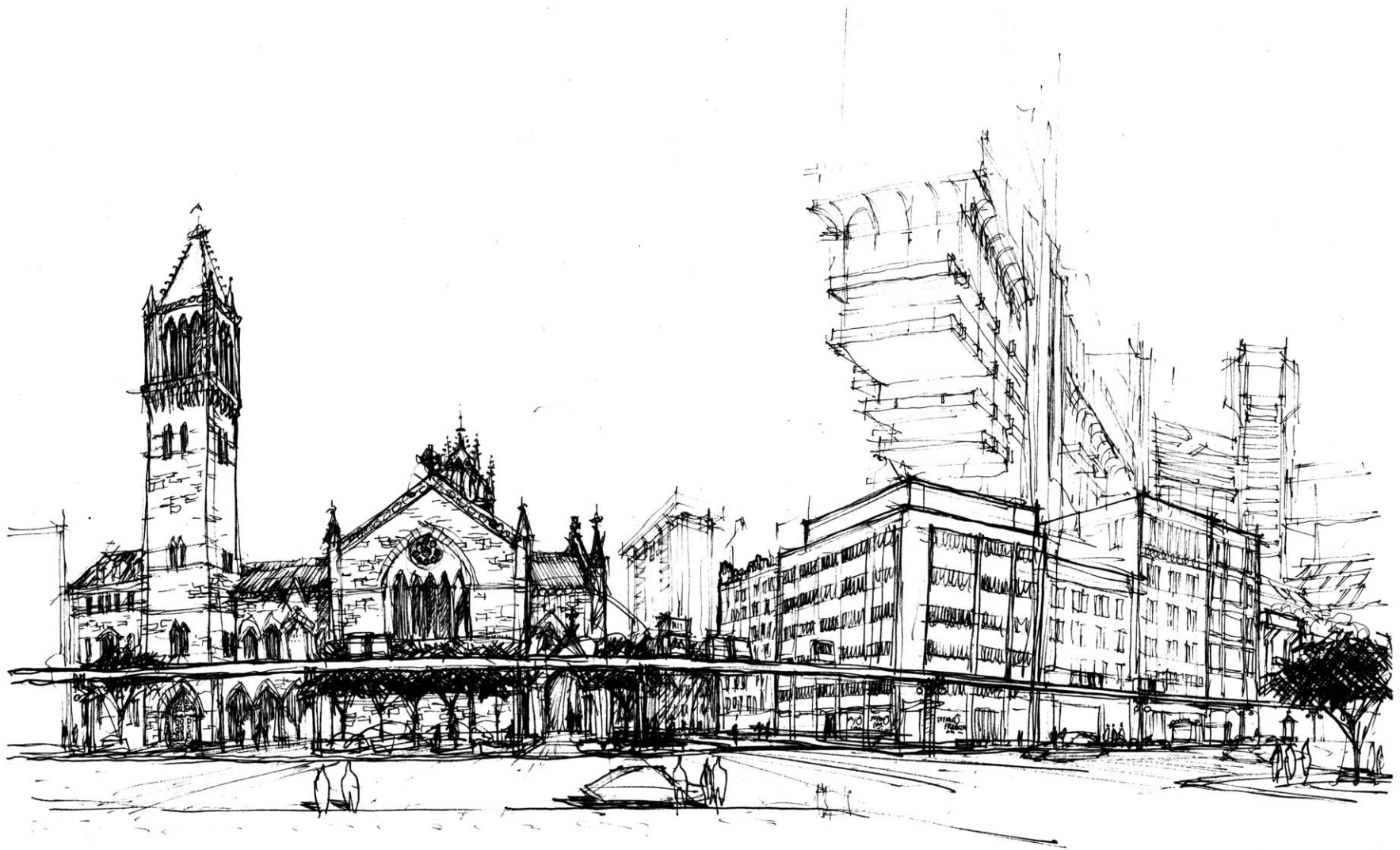
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NEW PARK SQUARE - BOSTON

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PROJECT METRAN - PERC NETWORK
BOYLSTON STREET & DARTMOUTH

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A P P E N D I X B

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