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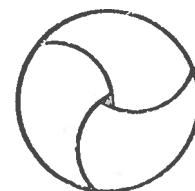
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Environmental Criteria for Ideal Transportation Systems

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Toward these ends, current research is directed to improving theories and methods of planning, to building models capable of simulating urban growth processes, and to formulating improved criteria for urban and regional development policies. Fields of interest to the Center include the development of new and established communities, housing and renewal programming, the effects of technological development on cities and urban life, metropolitan planning, the economics of city-building in the United States and in developing nations, and the social planning and human development issues that accompany urbanization.

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4. ENVIRONMENTAL CRITERIA FOR IDEAL TRANSPORTATION SYSTEMS

By Donald Appleyard and Rai Y. Okamoto

1.0 INTRODUCTION

This paper has two main purposes. The first is to propose a number of criteria for evaluating present and future transportation systems, or, to state it another way, to establish objectives for the environmental design of future transportation systems. The second purpose is to outline an evaluative model which could be developed into an environmental cost-benefit tool for use in transportation decisions.

The criteria are behaviorally-oriented. They have been derived from speculations about the requirements of people who use or who are affected by a transportation system. The ultimate aim is satisfaction of the population, but, given the field's limited knowledge about precise population needs, the criteria are necessarily subjective. While in cases such as stress due to excessive noise, research is beginning to focus on measurable performance standards in different situations, environmental needs such as the desire for personal control, for a certain level of interest, or for sufficient choice or information, have yet to be assessed in a systematic way. In consequence, they have been omitted from most transportation planning decisions. We consider this omission a serious one, and believe that there is sufficient general evidence about their importance to question the validity and potential effectiveness of several of the systems currently being proposed. We hope that by specifying these criteria and discussing them in some detail we will encourage their inclusion in future transportation planning, prior to their more precise formulation through research.

We were asked to consider esthetic criteria. We have interpreted these in the broadest sense--in the sense that Dewey defined esthetics--as a total experience, and have, therefore, included all the qualities that appear to affect peoples' satisfaction with their transportation system. The list, therefore, extends into questions of physical safety on the one hand and social issues on the other, since these are an inherent part of the personal pleasure or displeasure to be derived from the system. Economic questions of construction costs, personal expenditures, etc. have not been considered, although personal economic outlays fundamentally affect user satisfactions. The list of criteria,

then, will not allow complete evaluations until economic as well as other social values are included.

Criteria can be defined negatively as problems to be avoided or positively as ideals to attain. We have endeavored to emphasize the positive or ideal requirements for a system rather than regulatory minima. As a result, some new ideas have been generated. However, more are needed. More effort to maximize individual criteria could be very productive.

The specificity of criteria has been an important consideration. Values such as amenity, quality, and beauty are non-operational due to their generality. The criteria elaborated in this report appear to be measurable, at least on a "more or less" basis. At the same time, they are still general enough so that their purposes are clear, i.e., frequently criteria are so specific that they offer no alternative solutions.

The relative weighting of criteria and questions of overall optimization have not been considered. The weight given to the criteria by different user groups is discussed, but the relative importance and involvement of these groups will vary with the system and situation. This is not a serious defect at this point, however, since we are not designing any one system, and would, in fact, encourage several types of systems. It would not be easy in any case to arrive at a stable weighting.

Owing to the radically different needs of the system user and the abutter or bystander, the criteria are divided into two main sections, "On-System" and "Off-System." Conflicts occurring between criteria will only be discussed in a general manner. Conflicts between environmental and economic criteria are not discussed at all. Considering the frequent need for some kinds of concessions, both ideal and compromise positions have been specified in many of the criteria definitions, e.g., if the trip cannot have informative views of the city because achievement of views would conflict with local nuisance, the information must be conveyed through signs, tapes or other devices. This is an area in which compromise and ingenious design can often help to resolve apparently serious conflicts.

The criteria are intended to apply to all kinds of transportation decision-making, whether it is the evaluation of a whole new system, an existing system, or part of a system, such as a complete subsystem, a route selection, a detailed design of a transfer point, a channel or a vehicle. However, we were not able to study all the possibilities and focused mainly on metro-scale systems, with some consideration of mini-systems.

1.1 EVALUATIVE MODEL

Beyond the elaboration of performance criteria we have tried to develop an outline, non-quantified evaluative model--a kind of environmental cost-benefit framework--for the analysis and design of transportation systems.

The three components of the model are:

1.1.1 User Groups

All those who use the system, abutters to the system and any others involved indirectly in system decisions.

1.1.2 Performance Criteria

For the analysis and design of systems, varying according to user group.

1.1.3 Relevant System Characteristics

Usually physical--which directly affect the achievement and maintenance of performance criteria.

The paper has been organized principally around the performance criteria, with subsections dealing with user groups and system variables. However, the definition of criteria depends heavily on the definition of the other two components. The set of characteristics describing the types of transportation system users together with the set of characteristics describing the users and uses of the land affected by such a system serve to define the context in which each criterion is applicable. The implications of these criteria are elaborated by noting the relevance of each criterion to the physical characteristics of the system. Interaction matrices are outlined as a means of demonstrating all the relationships between the components. Since time did not allow for any careful interaction runs, the matrices have been left blank.

1.2 SUMMARY OF ON-SYSTEM CRITERIA

1.2.1 Safety, Comfort, Convenience, Awareness

1.2.1.1 The system should be apparently as well as actually safe except for those groups who like a thrill.

1.2.1.2 The system should be physiologically comfortable and protective without causing undue strain or effort.

1.2.1.3 The system should be convenient and accessible to and from the outside and between subsystems.

1.2.1.4 The system should encourage travelers to be aware of environmental qualities, the sense of motion, space, climate if they so wish it.

1.2.2 Privacy, Control, Services, Responsiveness

1.2.2.1 The system should allow for personal privacy and lack of distraction from engagement in desirable activities.

1.2.2.2 The system should allow as much personal control of the vehicle and the system as desirable. The system should also be permissive and responsive to travelers, allowing errors, encouraging feedback and taking notice of complaints. Personal services of several kinds from equipment for personal spaces, to stewards and hostesses, should be provided.

1.2.3 Structure, Continuity, Predictability and Preservation of Valued Systems

1.2.3.1 The system should be well-structured. Each subsystem should have continuity of movement and character, a sense of direction and distance, and differentiated characteristics systematically related to the whole. Subsystems should in turn be well-connected to each other and to the rest of the city.

1.2.3.2 The system should have continuity and predictability over time.

1.2.3.3 Existing systems valued for any of the qualities described in these criteria should be preserved.

1.2.4 Information, Exploration, Instruction

1.2.4.1 The system should inform the traveler about places in the city that he should know as well as places of general or specific community significance.

1.2.4.2 It should also encourage exploration, both extensive and intensive.

1.2.4.3 The system could provide means of instructing travelers in the use and understanding of the city, in orientation techniques, in city government, economic and social structure, etc.

1.2.5 Interest, Choice, Identity

1.2.5.1 There should be more choice and contrast between types of transportation systems within any one city; between alternative routes for any one traveler; and between vehicle type, personal space, social space, service, and environmental experience on any one route.

1.2.5.2 Components of the system should have a distinct identity, for example, vehicle types, routes, transfer points, should each be coded in a definitive way sufficient for them to be known, recognized, and recalled even by infrequent users.

1.2.6 Social Interactions

1.2.6.1 Interaction at various levels between similar and different groups should be possible and encouraged if they so desire it.

1.3 SUMMARY OF OFF-SYSTEM CRITERIA

1.3.1 Local Nuisance, Stress and Pleasure

1.3.1.1 The system should not produce excessive noise or vibration levels in the areas adjacent to it.

1.3.1.2 It should not produce excessive glare, flicker, or lack of light for its surroundings.

1.3.1.3 Fumes, odors, and dust-causing nuisance on surrounding environments should be reduced as much as possible.

1.3.2 Local Fit, Mix, Privacy, Control

1.3.2.1 The system should not dominate, seem oppressive or authoritarian to the local surroundings.

1.3.2.2 The system should "fit" the local urban and natural environment and "mix," and, where desired, "fit" within other activities.

1.3.2.3 The system should not invade local privacy.

1.3.3 Valued Activities and Environments

1.3.3.1 The system should not destroy or damage valued activities or areas.

1.3.3.2 It should help to create new activities and environments of value.

1.3.4 Local Structure, Permeability

1.3.4.1 The system should not disrupt significant functional and visual connections.

1.3.4.2 It should also serve to reinforce the existing urban structure and create new valued connections.

1.3.5 Information, Invitation, Expression

1.3.5.1 The system should be clear, accessible, and informative, and expressive of its nature.

1.3.5.2 It should invite exploration.

1.3.6 Choice, and Local Identity

1.3.6.1 The system should help to reinforce the identity of local areas.

1.3.6.2 It should enhance the diversity, interest and richness of the city.

1.3.7 Social Interaction

1.3.7.1 The system should connect or run between diverse social areas.

1.3.7.2 It should serve the population in an equitable manner.

2.0 ON-SYSTEM CRITERIA

The organization of this section is based on the criteria. However, reference can be made to the main User Groups (see page 155), and to the Relevant System Characteristics (see page 156), which were taken into account.

2.0.1 Safety, Comfort, Convenience, Awareness

2.0.1.1 Safety

The system should be apparently as well as actually safe. The question of actual safety is the focus of a great deal of research. The question of "feeling" safe is a separate issue. Many people will not use systems such as airplanes or freeways because they "feel" unsafe despite their actually higher safety rates.

User Groups

The controller of the vehicle should be aware of danger or else he will become careless. The passengers, on the other hand, will usually prefer to be unaware of it. Long-distance commuters will be most concerned about safety since they use the system regularly and for the longest period of time. They want to be reassured that they need not worry about the safety of the system. Women might be more concerned with safety than men, needing more reassurance from the environment. Families (an adult with a very young child), the elderly and the handicapped should have special provisions made for them and would be most concerned about safety. Children and youths enjoy the thrills of danger, the speed, suspense and the unexpected. Sudden jerks and stops which make older people shudder produce joyful screams from teenagers. At nighttime when visibility is difficult and in wintertime, when weather is generally poor, concern for safety is greater than under optimum conditions.

System Characteristics

In order to satisfy the need for safety, the system could provide seat belts, headrests and padding inside the vehicle. The ride should be smooth, with visible emergency exits, fire fighting equipment, and means for immediately controlling the vehicle in an emergency. Representatives of the system should be aboard even if the control were automatic, and information should be disseminated about the safety devices of the system. Special provisions would have to be made for the safety of infants, children, elderly and handicapped, such as straps and handles at various heights, floor stops and hooks for wheel chairs to "grip" the floor, level entries, controllable door openings, etc. Some of the more psychological aspects of safety depend on the creation of secure enclosure--the feeling of being insulated and protected in a solid-walled container (probably with a limited view), ample padding and cushioning; the simplicity, cleanliness and newness of the equipment also contribute to the feeling of safety and well-being.

For those interested in the thrill of the ride, heightened awareness of sound, speed, vibration, and space will be necessary. Note how the tipping of aircraft wings on a turn heightens the concern of passengers in seats viewing them. A light vehicle with thin or perforated skin, large low windows (even in the floor), close-in channel walls, observation of the vehicle controller and other vehicles, suspension in the air, and sharp alignment changes reminiscent of roller coasters, all serve to increase the impression of motion and unpredictability.

2.0.1.2 Comfort

The system should provide for various needed physical comforts, and should not subject travelers to undue physical strain. The most severe of these on present systems are fatigue due to standing or waiting, especially unexpected waits, and lack of protection from severe climates and micro-climates. People suffer from these conditions reluctantly because there are at present no other choices.

User Groups

Long-distance commuters are greatly concerned about physical comfort, since commuter trips are made regularly and usually involve a substantial length of time. They would want to be settled as comfortably as possible to be free to occupy themselves in any way they wish. Short-distance commuters are more willing to sacrifice some physical comfort for the sake of minimal travel time. Men would be more likely to tolerate some physical strain than women. Families, the elderly, and handicapped should be provided

with facilities that reduce physical strain not only in embarking and disembarking but also during the journey.

For commuters, protection from climate is a most important factor. This may be the strongest element in determining the use of a private car instead of public transportation. Men are less concerned about being exposed to bad weather conditions than women, for whom this is a crucial element.

Families, the elderly, and handicapped tend to be extremely concerned about having adequate protection from the climate. At nighttime, the greatest amount of comfort and security should be provided, including protection from climate, since the elements are generally more threatening.

System Characteristics

Ample space for both personal and social activities should be provided. There should be comfortable seating which can be varied for different user groups; for example, on French trains seating for the elderly and handicapped is located near the entrances. Ambient conditions such as light and air should be adjustable to individual variations by means of personally controlled mechanisms--air jets, lamps, etc.

Seating space at fatigue-prone locations would seem an obvious requirement, except that it is not to be found on many present systems. Complete enclosure from outdoor climate, or at least a filtering of its more discomforting qualities, is essential. Accessible toilet facilities for different groups, infant-changing tables, first-aid, quick-drying areas, etc., add to comfort.

Comfort may not be appreciated, however, unless possible discomfort is present. Also many reject too much comfort. Rigorous alternatives should be possible for the tougher travelers.

Access to outdoor climates, provision for exercise and standing must be maintained, some windows should be individually controlled, open-air vehicles should be available.

2.0.1.3 Convenience and Accessibility

The system should be convenient and accessible. Besides the question of minimum total travel time, which has also been the subject of extensive research, there is the question of convenient access to entry and exit points and at transfer points between systems.

User Groups

With respect to minimal travel time, all commuters would probably place this criterion very high, but of all commuters the short-distance ones might place it the highest, since the short commute does not really give them as many opportunities to use the time to other advantage. The long-distance commuters, on the other hand, might be willing to sacrifice some time if this would mean a more comfortable or more interesting ride. Men might be more concerned about minimal travel time, assuming that their time is more valuable. Considering that job opportunities are less open to the lower income groups, this factor may become of critical importance for them, so that they can reach their jobs easily and quickly.

System Characteristics

The ultimate convenience would be instant access to and from the system at any point in the city. To some extent the automobile provides this at the cost of disrupting the surrounding environment. Easy and protected walking distance would be the second best choice. Waiting times at entry and transfer points should probably be less at the smaller interchanges than at the more interesting larger ones. Predictability of vehicular schedules through forewarning devices could help minimize usual irritating frustrations.

Here again the present automobile freeway system fares very well with its dynamic scheduling and smooth transfer at on-and off-ramps. Vehicle storage, however, is an increasingly serious issue that would be avoided on several of the proposed impersonal vehicle systems.

2.0.2 Privacy, Control, Service, Responsiveness

2.0.2.1 Privacy

The system should provide for a desirable degree of personal and family privacy. Privacy is one of the great assets of the automobile. Personal privacy includes: not being pushed, pawed, stepped on, looked at, having one's activities monitored by others, particularly if they are seen regularly. It also means not being forced to pay attention to the activities, sounds, or other evidence of the presence of others. Although this may conflict with the goal of desirable social interaction, it may, in fact, be the only way for different population groups to use the same system.

User Groups

- The vehicle operator requires sufficient privacy to perform his task. The long-distance commuter would probably value the chance for privacy because he has the time to concentrate on personal activities. It is also more of a middle-class value, and women may desire it more than men. Nighttime travelers could be more fearful of privacy than daytime travelers.

System Characteristics

Compartments with complete personal privacy and control of the internal environment could be provided: a comfortable chair with adjustable positions, a writing table, sound proofing, atmospheric control, light control; space for eating, drinking, smoking; ample space for moving around, standing up, holding or storing packages; and viewing out as well as tuning in to internal or external communication systems. The ultimate in privacy might be an enclosed booth with its own locked entrance, personal storage space, and nameplate. These compartments could vary in size to accommodate from one person to a group of four. This is what the private automobile offers but without the freedom to participate in many activities.

2.0.2.2 Control, Service, Responsiveness

The system should not dominate the traveler; it should be permissive and responsive allowing him as much personal control and service as possible. Present-day transportation systems make travelers feel that they are just cogs in the system: directive signs have become more terse and authoritarian; simple errors--missing the freeway off-ramp or catching the wrong train--become costly and time-consuming mistakes.

The sense of mastery over one's personal environment is an important desideratum for mental health. The power to make decisions and to be served are aspects of the system that may help to restore the self-esteem of travelers. Control and service can range from adjustments to the personal environment, a relatively passive control, to active control of the vehicle and complete choice of where to travel on the system and at what speed.

User Groups

Long-distance commuters would be most concerned with self-adjustments to their personal space conditions, but may prefer to hand over the arduous job of control on a regular trip to "the system." Short-distance commuters are likely to be less involved and less concerned about controlling their immediate internal environment.

Women may be more concerned about the environment being "just right" for them and about being able to control it. This would include such things as "atmosphere" and interior decoration, whether the vehicle "feels" warm or cold, cozy or hostile, whether the light is flattering, etc.

Men, especially teenagers, may prefer to have more actual control over the system, and may feel more resentful of authoritarian comments than women. Irregular travelers with varying trip types may prefer active control over the system. Strangers will be too unsure of themselves to want it; they will demand a higher level of permissiveness. Long-distance commuters would prefer many choices of personal or group activities ranging from napping or having breakfast, to having a haircut and massage, to physical exercise or conducting business. Both men and women would be interested in activities of all sorts. Busy housewives might have a variety of personal services offered on the system, such as beauty salons, sauna baths, gift cars, etc., thus giving them more free time when they reach their destination.

System Characteristics

Control of personal space conditions is now highly developed on aircraft, where lighting, air, service, radio, tapes, movies, music, writing tables, window shades and so on are at one's disposal. Of course, the view is limited usually to a stretch of the wing. Provision of these services on metro systems is very desirable, and could be extended to direct dialing telephones, teaching programs, ticker tapes, etc.

Personal control of the vehicle is more difficult to achieve especially when density on the system is high. Yet there are many groups who would like to drive if allowed--the young, the unskilled, the handicapped. If a system could be developed in which personal vehicular control were never dangerous, then these currently deprived groups would be satisfied.

If personal control is difficult, then automated control may well be preferable to the human errors of public vehicle drivers. The sense of personal control or mastery of the environment is also affected by the traveler's position in relation to the world around him. Views over the city encourage this sense. The tunnelling of major metropolitan transportation systems can lead to serious deterioration in the quality of transportation unless extensive efforts are made to compensate for the oppressiveness of underground travel. Also, width of channels (wide freeways), size of vehicle (jumbo jets), numbers of other travelers or vehicles visible at any one time (a congested freeway) are all character-

istics that affect the personal sense of dominance by the system. Architects call it feeling "out of scale."

Beyond the personal space most transportation systems offer few services, and some of the new proposals seem to preclude their use owing to the small size of the vehicle.

A permissive system should include ways of compensating for errors. Ideally one would like to be able to drop-out at any point and return to the last decision point. Short distances between transfer points would satisfy this need. Adequate and polite information and signing would help avoid or ameliorate this kind of error. Possibilities of personal contact with system representatives, even if only by phone or television becomes increasingly important, e.g., the videophones at EXPO '67.

Other services could include: stewards and stewardesses; dining and drinking facilities; newspapers and books; hairdressers, barbers, shoeshines; dentists, optometrists, psychiatrists; movies, music, television, educational booths; games rooms for chess, cards, billiards, Ping-Pong; traveling gymnasiums and golf practice. Some families, of course, might want to live on the system in campers or houseboats. Many of these services are now provided at transfer points, but for long-distance commuters why should they not be provided on the vehicle itself?

2.0.3 Structure, Continuity, Predictability, and Preservation of Valued Systems

2.0.3.1 Structure

The system should be well-structured, so that the traveler is well-oriented in the system and in the city.

Orientation in the environment becomes crucial as metropolitan areas get larger, more complex and fluid. Orientation is needed in order to help people feel competent while moving in their environment.

The function of the transportation system in the orientation and understanding of the city structure cannot be overemphasized, e.g., there is some evidence that those who only travel by rapid transit receive a very fragmented and limited view of the city compared with those who travel by automobile. Travelers should know where to enter subsystems, should be able to "place" themselves at critical decision points, find the best routes, and predict and recognize their destinations.

User Groups

This criterion is obviously of great importance to the stranger who needs all the help possible in orienting himself in a strange environment. All commuters need to be well-oriented in the environment but the short-distance commuter especially needs clear clues since he has a minimum amount of time to become oriented. Through practice, however, commuters can learn to find their way through any city. Predictability may be of greater importance to women who need a greater sense of security and consistency in their environment. It is more needed at night when visibility is poorer and in the winter when other clues are not present to orient the user.

For the less-educated groups who appear to have greater difficulty in mentally structuring the city, orientation aids may be extremely important.

System Characteristics

There are three principal ways for riders to orient themselves on a transportation system: through recognizing continuous routes and joints--the topological method, through patterning--identifying and placing elements in patterns, and through positioning--using directional clarity and spacing. Most people use some combination of these methods depending upon the characteristics of a particular city. Therefore, for good structuring, the desirable characteristics of a transportation system should include: continuity of movement and character along major routes; the clear organization of transfer points; systematizing character relationships between different parts of the system including rhythms and progressions (making all east-west routes have a different character from north-south routes, or making transfer points increase in intensity of character as they approach major centers); establishing intervisibility between parts of the system, consistent directions and clear changes of alignment.

These qualities are affected mostly by the clustering and distribution of all system characteristics. Any quality can relate one part of the system to another, e.g., the vehicle, channel characteristics, signs, names, or the environments through which the system passes. The alignment of routes, however, is the most crucial factor in clarifying the structural image of the city, revealing relationships between land-uses, transportation routes, major districts, the geography of the area and so on. The relationships of all these elements must be taken into account, as

well as the views which would be possible with a particular horizontal and vertical alignment. If the road is mainly tunnelled or depressed, views of important landmarks or important districts should, nevertheless, be available periodically. Also, width of the right-of-way should be conducive to easy orientation, e.g., 12 lanes of freeway are likely to have an effect of isolating the driver from the environment.

The most obvious means of satisfying this goal are the provision of clear and consistent signs and signals (including forewarning signals) and clear station names and symbols. Maps of the city and system routes should easily be available. With new communication techniques, other aids and attractions could be provided. Personal tapes describing the journey and elements in the environment could be provided for those who wish them. Continuous multi-screen, periscope, or television viewers showing views on all sides of the vehicle simultaneously should soon be possible. Remote sensing devices such as radar might become available for the individual traveler.

The need for orientation does not imply that all views should be emphasized, or that views have to be provided all the time. There is enough leeway in this criterion to allow for tunnels and masking of views in undesirable areas. Also, the provision of orientation is not a single act which lasts forever; it needs to be continuously studied and preserved as the city changes. The transportation system should have some control over construction along its right-of-way, so that this development can be consistent with the desirable views.

2.0.3.2 Continuity and Predictability

The system should be predictable. Changes in the transportation system can fundamentally disrupt people's concept of the city. Changes, detours, and new additions to the system should not occur so rapidly or abruptly at any time that the users feel extremely disoriented and insecure. Changes should be explained and interpreted beforehand and, if possible, public hearings should be held.

User Groups

Elderly people, commuters, and more frequent travelers will be most disrupted by system changes. Strangers, however, will probably not care about changes unless the structure at any one time is incoherent.

System Characteristics

The same qualities for structuring must be maintained through change. Too often the transitions are not sufficiently well-con-

ceived and continuous disruptions can occur over a period of years. The construction of any new transportation system is a harrowing experience for most cities. Information about change allowing travelers to make secure predictions may be needed the most. Changes in the system should be clearly announced in advance and continuously updated. Information about the general operation of the system should be available at all times for first time users and strangers.

2.0.3.3 Preservation of Valued Systems

Valued existing systems should be preserved. There is a utopian tendency in current transportation system research to reject existing systems in favor of entirely new ones, but we already have a heavy psychological investment in present transportation systems. To change them completely may be psychologically taxing.

The evaluation and improvement of present systems, which in parts are satisfactory, should certainly be one of the major efforts of the next stage in the nation's transportation planning. New systems which can easily be fitted to existing channels or even vehicles which can be adapted to these channels may also impose less psychological strain on users, although this depends on the level at which present systems are valued.

User Groups

Older residents are more apt to be concerned with this criterion of continuity and preservation.

System Characteristics

For new systems to fit existing ones, flexibility of characteristics will be the most important quality; the use of similar rights-of-way, channel, and transfer points should be considered. Even present vehicles might be adapted.

2.0.4 Information, Exploration and Instruction

General information on the city's history, social and activity patterns, economic base, ecological facts, local and national news should be available to interested travelers. The system could even provide means of instructing travelers in the use and understanding of the city. The system could invite urban exploration for those who are not usually mobile, by presenting a welcoming atmosphere and stimulating curiosity.

It is not an exaggeration to say that most city facilities are under-used compared with their potential. Lack of knowledge sometimes pre-

vents the unemployed from knowing where employment centers or educational facilities are located. The presence of cultural and community facilities or open space resources is frequently unknown since they are hidden or inaccessible from the transportation system. The transportation system directly manipulates the urban knowledge of city inhabitants. It should therefore assume the responsibility for filling this information gap.

User Groups

All user groups would be interested in information. Commuters and men in general would be more interested in news, whereas strangers, women, children and youths, the elderly, and handicapped might be more interested in general information. The most receptive group probably would be children and youths. The most deprived groups are probably those whose income renders them immobile and whose lack of education prevents them from knowing the best ways of finding out about the city.

System Characteristics

Information about the city can most obviously be conveyed by routing major channels near significant, valued and interesting parts of the city. One of the most difficult questions is what information to convey. Methods of determining levels of significance are discussed under Off-System Criteria (see Valued Environments, page 166).

Other ways of conveying information are through views of significant places but the success of such views depends on the distinctness and uniqueness of the form of these places. Efforts may first have to be made to emphasize their form.

Views are limited too in their depth of information. Sign systems, tapes, maps, and other devices would necessarily have to be provided. It is crucial to coordinate these with views and experience of the real environment.

2.0.5 Interest, Choice and Identity

Choice is one of the emerging values of our society. People do not want to feel restricted in their choices. They like to experiment, to encounter new situations, to be surprised and to exercise choice. One of the serious consequences of much transportation system design is the monotony of the experience which reduces travelers to a state of apathy, boredom and sleepiness. There should be sufficient choice and contrast between alternative types of transportation in any one city, between alternative routes for any one traveler, and between vehicle types and environments on any one route.

Choice and interest operate at all levels. For a system to present more choice there should be different ways of traveling on it. Rather than any single transportation system, a choice of subsystems would be preferable. Within one system, some variation in routes should be possible. Within any one route there should be a choice of vehicular type, and varying sequential character.

User Groups

The question of choice in general is particularly important for the commuter and especially the long-distance commuter. The latter, who spends a substantial amount of time traveling, wants to spend his time in different ways according to mood. The short-distance commuter, on the other hand, might be willing to forego some choice. Middle class travelers might appear to value choice more highly because they can afford it more in time and cost, but to our knowledge there is no evidence of real class differences in levels of curiosity.

System Characteristics

The existing metropolitan transportation systems are restricted mainly to cars, buses, walking, and, in some cases, trains. The addition of any new system would increase choice. Highway systems include a wide choice of routes, but mass transit systems are usually restricted in their choice of routes. Subway or tunnelled systems of the future will suffer from the same problem. They might compensate by increased choice of activities and environments in the vehicles, at exchange points, and in channel design.

One of the chief factors leading to transportation system monotony is the application of unvarying standards, codes and other regulations to whole systems. Regular right-of-way widths, curvatures, interchange spacing, lighting distribution and even the latest Highway Beautification Regulations for Billboard Spacing at regular distances all encourage monotony. Deliberate variation of standards to suit the particular context would effectively increase quality.

Merely increasing choice and interest could become a marginal factor, however, unless choices are structured. The esthetic quality of drama depends on achieving and maintaining a level of engagement and interest. So it is with transportation systems. Travelers develop sets of expectations and react emotionally when these expectations are confounded. Too many minor choices on a system will quickly become monotonous. Choice does not so much depend on the number of choices as on the relative degree of contrast between choices and their individual uniqueness. Choice on existing transportation systems could therefore be increased by

more emphasis of present differences and the thoughtful addition of a few new and unique alternatives.

An increase in choice over the whole system will be the only way to fit the satisfactions of diverse user groups. For instance, to satisfy needs for apparent safety and for excitement on the same system, there must be a choice of vehicle, route or other factor. But for the system to provide choice for each traveler, choices must be accessible to that traveler. There is no point in providing choices so far apart that they do not occur within any one person's use of the system. A fine scale of choice, for instance, within a metropolitan sector, is needed.

2.0.5.1 Identity

Components of the system should have clear identity. If parts of the system are distinct and unique in some way, they will encourage local and personal identity. They can anchor the system to particular locations, be easily recognized and recalled and, consequently, develop in value, provided they satisfy other criteria also. This is the quality of imageability.

User Groups

Identity may be most required by strangers, migrants, youths, and all newcomers to a particular transportation system. It may also be more important to the less educated who do not read maps and who are less verbally oriented than the middle class.

System Characteristics

Identity can be achieved through any combination of characteristics so long as they are clustered to form a distinct entity different from adjacent ones, and preferably unique in the system. Then the part will take on its own flavor. It may emerge from the type of user, the environment, the vehicle, channel or route design, or the name of the station or route.

2.0.6 Social Interactions

The system should provide an environment in which a range of social interactions is possible, a range extending from complete privacy to intense group interaction. The user should not be forced into very close contact with others if he does not wish it. However, the system should make contact possible. This is not necessarily a privately held goal of the user, but an obvious social goal.

The transportation system is a kind of neutral territory in the city, where different social groups meet on a more equal footing. Although

there is still income segregation in the use of metro systems, contact between diverse groups does exist. Even though intensive social interaction is unlikely, the importance of visual contact should not be underestimated. Stereotyped prejudices may be reduced.

User Groups

Strangers would be most interested in having the opportunity for a casual chat with fellow passengers. Long-distance commuters may be the least interested in this, having established a routine for the twice daily trip. However, this group may be very interested in meeting fellow travelers if special group activities were offered, such as bar and restaurant, stock exchange reports, complete programming course, etc. The other groups who would be interested in some kind of social interaction would be women, the elderly, and the handicapped. Social interaction would be desired more at nighttime but people may also be more suspicious and reserved at that time. In wintertime social interaction may be more desired, as well as a greater degree of all the services and stimuli offered on the system.

System Characteristics

Apart from attracting a diversity of patrons by offering varied qualities, the system could allow for social interchange among patrons in the following ways: first, indirectly, by increasing apparent security through the humanization of the system, by introducing more personally related qualities, such as more space, better lighting, more color, comfortable seating, and agreeable temperature. This in turn may relax attitudes of self protection and inward orientation of the individual user, and encourage social interaction. Direct social interchange could be encouraged by providing a whole range of seating arrangements to give the user a choice. And, by the provision of various group activities, users would tend to separate themselves by mutual interests.

2.1 USER GROUPS

This section tries to identify the main user types or roles. Needless to say, any one person can be a member of more than one group. Each category could be identified as a sub-category under other ones, e.g., instead of males and females, children and adults, we could consider separate male children, female children, male adults, female adults. We have not gone into this in depth.

2.1.1 Control:

Controller
Passenger

2.1.2 Trip length:

Long-time/distance travelers
Short-time/distance travelers

2.1.3 Familiarity:	Strangers, irregular travelers
2.1.4 Sex:	Male, female
2.1.5 Class/income/education:	Middle, lower
2.1.6 Age	Children, youths, elderly and handicapped
2.1.7 Time of day:	Day, night
2.1.8 Time of year:	Summer, winter

2.2 SYSTEM CHARACTERISTICS

2.2.1 Vehicle

2.2.1.1 Movement:	Apparent speed, acceleration, alignment change
2.2.1.2 Control:	Personal, driver/pilot, automated, combination
2.2.1.3 Personnel:	Visibility, frequency, availability
2.2.1.4 Suspension:	Type
2.2.1.5 Personal Space:	Size: individual, shared Density Skin permeability: thickness Perforation: doors, windows (internal, external) Services and equipment: controllable seating, mass media, tapes, telephone, remote sensing (radar, periscopes), dictation, learning, office equipment, etc. Ambience: micro-climate, lighting, sound, smell, etc.
2.2.1.6 Social Space:	Size, shape, location Skin permeability: thickness Perforation: windows (side, overhead, below, ahead, rear) Services and equipment: seating, safety equipment, mass media, ticker tape, lecture/

	seminar/office equipment, etc. Snacks, dining, bars, kiddie korral, jungle gyms, gymnasias, barbers, drug stores, toilets Ambience: intensity and dis- tribution of micro-climate (lighting, color, sound, smell, etc.)
2.2.1.7 Storage Space:	Luggage, perambulators, etc.
2.2.1.8 Exit:	Size, distribution, controlla- bility, etc.
2.2.2 <u>Channel</u>	
2.2.2.1 Width, elevation:	
2.2.2.2 Vehicle position:	Height (above, below) central- ity
2.2.2.3 Enclosure:	Height, completeness, length, frequency
2.2.2.4 Enclosure surface:	Distribution of materials, col- or, texture, etc.
2.2.2.5 Signs:	Directional, informational, ad- vertising
2.2.2.6 Planting:	
2.2.2.7 Ambience:	Type, intensity and pattern of lighting, sound
2.2.2.8 People, traffic:	Type, intensity, distribution
2.2.2.9 Views:	Type, length and distribution (reference points, destination, other systems) Focused: urban, natural, etc.
2.2.3 <u>Change Points</u>	
2.2.3.1 Frequency:	
2.2.3.2 Movement:	Continuity, distance, time-of- wait, effort of transfer be- tween systems

2.2.3.3 Space:

Size, types, variation, and distribution of personal, social, and storage spaces as above

2.2.3.4 Signals:

Forewarning, identifying and directional signs, etc.

3.0 OFF-SYSTEM CRITERIA

3.0.1 Local Nuisance, Stress, Pleasure

3.0.1.1 Noise

The system should not produce excessive noise or vibration levels in the adjacent areas. "Excessive" will have to be defined in terms of the audible sound characteristics of each system in relation not only to adjacent activities, but also to the behavioral characteristics and attitudes of the nearby inhabitants.

When ascertained, the performance standards should be expressed in terms of maximum sound intensity, character of sound (sustained, intermittent, abrupt), frequency, adjacent land-use, and time of day.

While sound emission from the system is usually an aggravation, it should be remembered that some sounds associated with transportation systems can be pleasurable and informative, appealing to the romantic associations of some and providing excitement and desirable sensory stimulus to others. Thus, somewhere in the total environment, provision for hearing the noise of rapid movement should be allowed. Certainly the occasional sound of bells, gongs, whistles or horns is a welcome contrast to the continuous "white" sound typically emanating from an expressway.

3.0.1.2 Light

The system should not produce excessive glare and flicker, nor should it deprive surrounding areas of needed light.

In addition to the use of light for guidance, safety, and route information, it could also be used to increase visual diversity and reduce the monotonous and disturbing effects of uniform overall illumination.

3.0.1.3 Fumes, Dust and Micro-Climate

Poisonous or obnoxious products such as fumes, odors, dust, etc. should be reduced, if not eliminated. Stress and discomfort from micro-climate should also be minimized. It is difficult to envisage

positive benefits coming from the emission of odors, smoke, etc., but, from a distance, smoke trails from jets taking off, spray from hovercraft, and the steam from old locomotives, are among the more expressive and dramatic sights of the city; they are, in a sense, symbols of the struggle against the inertia of friction and gravity.

Some micro-climatic effects of systems can be manipulated to positive ends. For example, the motion of a fast vehicle could help create the only breeze during a hot still summer day. Or, an elevated structure might increase shade areas, partially protect playing children from a shower, or shelter an area from cold winds.

The design control of these factors and their impact on the surrounding area is a very sensitive issue, and, from unpleasant past experiences, many communities see transportation channels only as oppressive and degrading influences to be shunned. It will take effort and care to transform this stereotype image.

Populations, Activities, and Environments

Elderly and quieter population groups will be more sensitive to these stresses than the younger more noisy groups. But people with higher incomes are more mobile and thus able to escape the situation if a transportation system is disruptive of their environments. The elderly, however, and the lower class populations are not only less flexible financially, but also are more "place bound" and attached to the neighborhood and its familiar characteristics. Areas in which these kinds of residents live should be regarded as more inviolable nuclei which must not be subjected to the disruptive effects of a transportation system. There will be some variation in performance standards depending on the density and type of activity, for example: outdoor theatres, music and reading facilities, or areas where delicate processes need vibration-free terrain, must have a relatively quiet atmosphere. Gathering places, such as neighborhood and downtown shopping areas, restaurants and entertainment places may be more immune. Open areas where people go especially to enjoy the advantages of nature should not be subjected to distractions. Inherently noisy areas such as industrial and manufacturing are the least sensitive to these effects and could probably withstand lower performance standards.

In considering the disruptive effects of the system on the host community, the average yearly, monthly, weekly, daily, and hourly use, as well as peak use, for each of these periods should be examined.

Differences due to the time of day must be considered, particularly hours of sleep and rest in residential areas, study periods at

educational facilities, and certain repetitive ceremonial activities which require quiet and concentration. Investigation of ambient noise levels and urban inhabitants' tolerance levels, such as those made in the recent London study, are needed.

Many of the most acute stress problems occur during construction. Since this period may span several years, the costs caused by prolonged stress should be taken into account.

System Characteristics

The elevation of the channel is one of the most relevant system variables in this case. Regardless of channel width, an on-grade alignment will usually produce the maximum negative interaction with the surrounding environment, although the noise may be more easily buffered.

In the case of elevated channels, the structure may cast unwanted shadows creating cold dark areas. Noise and light interference may be less, however, especially when the channel is very high. Depressed cuts can reduce noise and fume effects on surrounding areas but not on places directly overhead or immediately adjacent.

Except for possible vibrations through the earth, below-grade covered alignment creates minimum disturbance to members of the surrounding area. In effect, the system does not exist since it is neither seen, heard nor felt. Mechanical requirements for ventilation will still probably mean some degree of surface manifestation of the system in the form of vent stacks and the necessity of making access points visible.

In terms of present technology, the helicopter is the best developed example of airborne alignment. If noise, air blast, and dust problems could be reduced or eliminated, and if capacity and other engineering problems could be solved, an airborne alignment could achieve the most positive interaction with this criterion. At the present time, however, these are serious problems. To achieve a positive relation to the comfort-nuisance off-system criterion, enclosure or shield systems should be considered as integral design elements of the channel. As adjacent conditions of land-use or form vary, the requirements for the enclosure will vary and, hence, appearance and functional specifications will alter.

Distance from the nuisance source is one of the most critical variables. Effects will also differ in situations where the channel is in a valley where noise reverberates and fumes collect, in contrast to a flat site or ridge location which would cause less nuisance.

- Intensity, direction, color, location of source, temporal characteristics, form, and whether the source is mobile or static are some of the factors that determine whether a positive or negative interaction will occur between *illumination* and the comfort-nuisance criterion.

To alleviate negative effects of system illumination, an attempt should be made to devise methods of confining such lighting to the channel proper or, if necessary for the safe conduct of the vehicle, to the minimum area immediately adjacent to the route. Experiments are under way in this field. Sheet or planar sources such as road beds, guide rails, or walls can reduce the need for headlight glare.

In the future, a wider range of electronic devices besides light might be applied to transportation, for example: a mix of infrared ray detection beams or radar. Time-controlled illumination as well as some local neighborhood control when lights are not needed could reduce the monotony of continuous illumination.

Typical street and freeway lighting is criticized by many as "cold." Moreover, it is usually constant, and engineering requirements dictate its source placement in ways that intensify its qualities. Variations in color and placement, and the provision of time-control might improve this situation. The design of overall environmental lighting systems would minimize the need for vehicle-based guidance illumination and would contribute in a positive way toward meeting off-system orientation and instruction needs, help structure the environment in visual terms, and contribute to the interest and identity of the local area. The multi-color coded systems of airport lights and the colored route lamps on some subway systems offer examples of what might be done.

Many means could be devised to lessen, if not eliminate, most acoustic nuisance. A number of sound-obliterating procedures are possible: motor silencers, reduced roadbed friction (this, however, may conflict with safety), varied speed, varied volumes, physical barriers, detailed location and alignment, spatial displacement both laterally and vertically, sound insulation and protection at the receiving point (this should be a last resort and raises serious questions of cost and liability), and, of course, manipulation of the activity distribution pattern itself where this is easily accomplished.

In order to produce beneficial micro-climate effects for the environment, various means might be tried for casting shadows, creating wind movements, or emitting warm air. The sunny and leeward sides of channels should be seen as different design problems from the shady and windward faces.

The spacing of entry and exit points will affect the distribution of nuisance in the city. While wide spacing would seem to create the least disturbance because it requires fewer installations, widely dispersed access points frequently produce peaks of intense activity, not only transit but also residential and commercial activity resulting from transit convenience and high human density. Therefore, general increases in noise, circulation, physical bulk, and activity mix could result from widely spaced access points. Insertion of these access points into old environments could create a problem. In new areas, well-designed solutions could meet most of the criteria.

Closer spacing of access points may produce smaller point disruption, but obviously would spread more widely the total impact of the system. The ubiquitous private auto is typical of this, as would also be the contemplated automated individual-collective systems. It may also be easier to control noise and other nuisances within the relatively few channels of widespread access point systems.

Higher densities of vehicles on the system will increase nuisance effects. The basic problem might be solved by scheduling to avoid conflicts with those times when people require quiet and minimal stimuli. However, scheduling is difficult to control. Significant variation in standards and daily behavior in host communities may exist which could have an important bearing on density distribution. Perhaps, for example, a larger number of young people or childless couples in certain areas customarily sustain longer waking hours or tolerate more sensory stimuli of the sort associated with motion, sound and light, than others.

However, the increasing tendency towards 24-hour use of cities suggests a corollary trend towards uniform vehicle density distribution. Finally, just as structures are designed to adapt flexibly to heat and insulation, perhaps they could be built to vary their acoustical transparency from total admission of nature's sounds (birds, water, etc.) to total exclusion of noise over a given level.

3.0.2 Local Fit, Mix, Privacy and Control

3.0.2.1 Local Fit and Mix

The system should not seem dominant, oppressive or authoritarian, especially in areas of small scale, high value, or domestic activity. The system should "fit" within the structure of the environment it traverses. The vast scale of elevated expressways tends to overwhelm local environments by virtue of "endlessness" and height. If the existing small-scale city pattern has curves and follows grades, then

the system should incorporate curves and grades in its design, provided that safety and sound levels are controlled.

Although the system need not be a chameleon, it should respond to local character and uses, to the spaces and structures in or near the right-of-way. However, the effort to "embed" the system in the local environment may not always work. In certain cases good fit may mean a contrasting physical relationship where the channel is clearly separate above or below the surroundings, as in high, elevated tracks and helicopter flight paths.

The system should, where possible, "mix" with other systems. Multiple use of the same channel is easier with typically slow-speed mechanical mini-transit systems, although it is still difficult to mix such systems with pedestrians. Predictability, consistent behavior, interruptibility and a non-threatening appearance are some important criteria for achieving a mix.

3.0.2.2 Local Privacy

The system should not invade local privacy. Passing travelers looking into windows or peering into domestic backyards can restrict the use of local space. High speeds and viewing angles make this situation infrequent on expressways, but it becomes more of a problem on slower moving systems; it could present a serious problem for the use of helicopters and other systems that allow the traveler to look down on his surroundings. Use of the system to increase privacy is a possibility. In some cases, it may be better to overlook a wide transportation channel than a narrow local street where houses flank the opposite side.

3.0.2.3 Local Control

The system should allow a degree of local control. This is a procedural rather than a direct environmental goal, but is appropriate to mention here.

Some local political control over system design should be encouraged. Local communities could develop their own evaluative criteria and alternative designs prior to new construction. Then they could reserve the right to monitor and adjust the effects of the system through time.

A system that was adaptable to changing community requirements would be preferable under these circumstances.

Populations, Activities and Environments

Privacy is a necessary quality for all groups, but there may be variations in the degree to which the various groups want to be

exposed to outside influence, or are able personally to deal with it. In many cases, higher income groups value privacy and are able to insulate their private environment to ensure privacy. The elderly may enjoy having some visual contact with the system, if it does not bring other nuisance factors with it. Also, various ethnic groups have different attitudes toward privacy, and some actually prefer a street orientation which implies a close relationship between their activities and some part of the transportation system. Privacy is obviously most crucial in residential areas, and it would also be very important in places where people gather in intimate groups, such as libraries or small neighborhood parks.

Valued places are the most threatened by bad "fit" of a transportation system. In design of the system, natural, scenic or recreational value of the landscape must be taken into account as well as value in terms of architectural interest or uniqueness in the metropolitan area. Achieving a "fit" in the local environment will be more difficult in areas where the grain of the urban or landscape pattern is a fine one, where slopes are steep, where streets change direction frequently.

System Characteristics

Vehicle design will affect mix and privacy. At the fine scale of mix, system vehicles may need foolproof radar avoidance systems especially if they were expected to mix with pedestrians. Vehicular speed and window size will affect local privacy.

Channel variations are crucial for "fit." Fitting the environment may imply local cross-sectional coordination where the channel is depressed or embedded into hillsides. It may also imply fitting the flow of the land or the grain of the streets, without creating wasted spaces, jagged left-over forms, and other signs of carelessness and destruction. Smooth connections can be made through contouring, retaining walls, planting, lighting, choice of compatible materials and so on.

Standard channel cross sections are inadequate to the variation in environments. In designing the system, special attention must be given to the type of structural isolation, elevation, enclosure of the channel, separation between channels, necessary width and height of the right-of-way, massiveness of the channel structure, permeability of the channel to cross-traffic, and the types of shared uses of the right-of-way.

On-grade *alignment* conditions may create a serious threat to fit and privacy because of the possibility of close proximity between the channel and adjacent activities and also because of the possi-

ble need for topographical changes to accommodate the right-of-way. Various types of enclosures, screens or even excess right-of-way may alleviate the privacy problem.

Elevation of the pathway will help both the topographic fit and privacy problems as long as sight lines from vehicles are such that riders may not see into adjacent private areas. However, domination of the surroundings is more likely. Thin structural supports may allow surface continuity under the elevated path, but acquisition for right-of-way may not be significantly better than in the case of on-grade locations.

Below-grade alignment would appear to offer the most positive interaction effects with the fit-privacy criterion, although conditions during construction (cut-and-cover, which can be more disruptive than tunnelling) may create such damage that new fit and privacy conditions would have to be established at social costs difficult to measure. The most important variables for fit are width of channel and radii of alignment curvatures. Systems that can reduce these will have significant advantages. Distance from the channel to the receiver is again a relevant characteristic.

The impact of access-point spacing on this criterion is similar to that of comfort and nuisance. Spacing can affect design problems of bulk and area requirements around stations and for right-of-way needs. Because of higher area requirements, widespread access systems are probably more difficult to fit locally. While the access points are closer together and, therefore, probably smaller in scale, their cumulative effect may be no greater than a street corner bus stop. Privacy may be more endangered by dispersed systems which require frequent access points, yet fewer people would be involved and those might be neighbors.

Of the various types of service, freight unloading and distribution may entail area requirements which aggravate fit as would feeder vehicle storage at access points. Freight systems do not innately create stresses on privacy, but psychological issues may be raised by proximity to or sight of a freight line near one's residence.

The necessity for stations with their circulation and bulk requirements will raise fit problems. Where the route itself is underground and only the stations protrude, somewhat less "fitting" may be required. If the sharpness of change is to be minimized, proper fit would entail changes in development controls, physical form, activity, and density in the immediate area, particularly in highly vulnerable, low- to medium-density residential areas. Problems of domination are often exaggerated by above-

ground parking facilities or air-space development if it is permitted over the station or its parking areas.

Privacy may seem to or actually be violated by the increased number of persons in the area of access points including, for example, a number who may make innocent contact with nearby inhabitants to seek directions.

Since motorway access and interchange points generally require so much area, privacy will not be threatened *after* construction. However, fit, particularly in built-up urban areas, is extremely critical due to the vast areas required for vehicular maneuvers. Improved guidance systems may shorten radii, and, as a result, required area may be minimized.

3.0.3 Valued Activities and Environments

The system should not destroy or damage valued activities or areas. Valued places may be those that are intensely used by large numbers of the population or by special groups; they may house activities unique to the vicinity. They may be historically or culturally meaningful buildings and places, buildings of high architectural quality, areas of strong physical character and identity, fine natural areas, or of particular geological or ecological interest.

The system can help to create newly valued environments. Air rights over or under the channel, or newly created space within the right-of way, could provide location for badly needed recreation activities, housing, offices or any other kind of use. They could also create attractive new environments. Some of the new plazas created over parking garages show what can be done.

Populations, Activities, and Environments

Identification and ranking of these elements and areas should be undertaken in such a way that community or group agreement can be reached. A number of surveys of this type have already been carried out at city scale. Generally, however, such surveys determine values held by surveyors only, rather than those of local neighborhood groups. Sample interviews would be required to determine significant elements for which there was community consensus, or to identify elements about which consensus did not exist, but which were significant in the minds of certain groups: a geographic community, or people with common occupational interests, for example.

Value might be determined not only in terms of economics but also in terms of intensity of use--use as it occurs over a period of time--monthly, weekly, and daily as well as at particular periods--

peak-hour, day or night. Use value can also be considered in terms of import to particular groups: the public in general; cultural, social, and special interest groups, and income groups. Value can also be measured in terms of natural, scenic and recreation value of the landscape and in terms of architectural interest or singularity in the metropolitan area.

Analysis of value in the natural landscape has become the focus of attention for landscape architects concerned with protecting ecological systems and determining the "carrying capacity" of particular landscapes. Once these elements and areas are identified, a route location should be chosen which avoids taking or dividing them, or damaging them by its close presence. A route which passes along the interstices of a mosaic of such areas is to be preferred. Where some significant element must be taken or damaged, it should be replaced or reconstituted as far as technically possible: a new park, a redirected stream, a relocated church or an area of fine housing. This will usually prove to be an expensive and difficult undertaking, which is, indeed, a measure of the damage caused; it should be accounted as part of the cost of highway location.

System Characteristics

Similar to the criterion of comfort, the greater the isolation of the *channel*, the less the value of the environment is disturbed. The necessary width and height of the right-of-way, radii, massiveness of the channel structure, and the permeability of the channel to cross-traffic are crucial characteristics which generally would determine whether the system would destroy valued activities in the environs.

If high vehicle densities produce increased vibrations, this could create a disturbance for historically valued land. The continuous presence of visible vehicles could seriously alter the perception of an activity area, and even produce incongruities. For example, uniformly high-density distribution of vehicles on a freeway or rail line, however quiet the facility, may cause economic or social blight because of psychological incompatibility with the surrounding activities and structures. Shared use of the right-of-way for activities would create new value since it would utilize a channel to be built for other purposes. Shared rights-of-way could be used for scenic parks, bicycling, horseback riding, walking, for athletic fields and playgrounds, utilities, viewing platforms or other transit facilities. Platforms or walls could be built over the channel to support housing, community facilities, commercial activities or industry. In this case, the channel would be generating new activities within an area, thus adding new value

where none existed before and perhaps spreading value from the channel into the neighborhoods.

The choice between few or many access points depends on specific situations. Few-and-far-between access points offer a smaller number of threats to landmarks and other specific urban elements of value; but the system of many and small access points can be more easily sited among existing structures and activities.

In certain cases, the valued activity area or landmark structure will be a major destination and, hence, spacing will be less significant than the specific design of the access point and local area circulation. In such cases, some physical changes are essential just to maintain much of the very character which makes the area a desirable destination point.

A dilemma exists in station location in weak yet useful retail areas. If the station is located in such an area, the disruption and actual demolition may destroy the enterprises. If located nearby, new, stronger ventures may arise to gain the benefit of access point traffic. Policies allowing the involvement of local merchants and property owners in developmental benefits might reduce the severity of this type of impact and tend to assure preservation of valued local activities.

3.0.4 Local Structure, Permeability

The transportation system should not disrupt existing structural connections in the city. Beyond direct damage to specific elements, a major channel may disrupt important physical, visual and symbolic connections: destroy a fine view, or prevent psychological access between one section and another by visually disrupting a customary line of approach or a continuous linkage of activity. The permeability of the system to cross-movements and views is, therefore, the key attribute.

The system should help to reinforce and emphasize the structural coherence of the surrounding city. Many parts of the city are weak in character, and already poorly connected. The system itself is a major connecting mechanism. Linkage to isolated neighborhoods, increased access to unknown but valuable areas, and interconnection across existing barriers can all increase the number of interactions between parts of the city. This is closely related to the criterion of social interaction.

Populations, Activities, and Environments

Orientation in the environment is an important element particularly in residential, commercial, institutional, and recreation

areas. It is crucial in built-up places when the transportation system has to be superimposed on the existing structure. Within each one of these areas all the actual and desirable functional interrelationships between activities as well as three-dimensional relationships have to be identified.

In the same way as in "fit" the texture, grain and pattern of the city are of crucial importance when considering orientation in the urban environment. To insure that the system does not disrupt connections, many factors must be considered: the shape of the land, vegetation cover, building height and bulk, openness of buildings, and the grain of streets are a few examples.

With respect to pattern, the development could occur along or parallel to ridges, rivers, and shorelines; along or parallel to man-made channels, edges and berms; across valleys and hills; across urban districts; through or around urban foci. All development would depend on the connections desired.

System Characteristics

To satisfy this criterion, the channel should be so constructed that it allows views to and through it; this would imply a channel above-grade or with floating connections. The channel should not be totally enclosed but open, even transparent, at various points. This criterion would allow the channel to be massive in certain areas where this would fit with desirable city structure although at other points a less massive quality might be preferred to preserve and create views. The channel should have some permeability to cross-traffic (such as in elevated or depressed channels) if it is to maintain the urban web of structural connections. Vertical transitions involving descent or rise to and from underground and aerial alignments may be more serious than continuous elevated routes so long as the latter do not require frequent access (the ramp problem on freeways).

Where channels must cross such links, various devices may be used to minimize the damage: manipulating the elevation or reconnecting structures, locating activities and pathways over or under the channel.

To create new connections, the right-of-way and the land taken along its margins could be used to generate new development which has values and purposes beyond the transport of vehicles. One can go much farther and imagine large structures which combine traffic and other functions in a complex whole; or linear redevelopment projects in which the road is only one interlinked portion.

Since a major transportation channel is a continuous facility, its right-of-way is usable for other continuous activities: transit,

utility lines, and, particularly, for mobile recreation: walking, bicycling, skating, and horseback riding. On special occasions the structure, or parts of it, might be reserved for holiday uses: parades, races, dances.

The presence of access points as stations, or transfer, interchange or collection points creates natural opportunities to provide orientation for the off-system areas. These points can become important landmarks visible over long distances--major orientation elements in the districts they serve.

3.0.5 Information, Invitation, Expression

The system should inform abutting inhabitants of its nature, express its purpose clearly, and invite them to explore it. The entrances or station stops should not be remote, confusing or difficult to find. Many people are fearful of new systems, others are ignorant of their nature or sometimes even of their existence. They need reassurance. Examination and exploration of the system should be made possible to permit the unsure to achieve a sense of mastery over it. Hence, it should be designed to permit such investigation with reasonable safety. According to one report from Watts, California, buses that were marked "Airport" were not used because people thought that an airline ticket was required for boarding. Additionally, no intermediate service points were indicated. Generally, information is too powerfully stated by noise, loud speakers, or dominant structures, or too weakly presented. Abutters of the system usually know too much, since they are overexposed to the system while users do not know enough about it.

Populations, Activities, and Environments

Information and instruction are important for all segments of the population, but particularly for those groups neither trained nor capable of finding their way in the urban environment: lower income groups, children, new arrivals, and the elderly, for example.

Information about the system might best be tied to intensely used public spaces. Since these areas are often frequented and are gathering places, they become natural places for communication.

System Characteristics

Information is conveyed through explicit signs, but also through the form and character of the system. If its form stands out its presence is known, if it is discreet and hidden it may be forgotten or never noticed at all. This goal clearly conflicts with some of the more conservationist goals specified previously. Information can best be focused on the *access points* to the system. These should be distinct and visible from a distance, accessible

from major activity points, clearly signed, and have an open welcoming character.

Signs should be clear and informative providing several kinds of information in different ways, i.e., graphic, verbal, names and descriptions, photos, maps, etc. in order to ensure communication.

Exposure of system flows is a direct way of informing inhabitants of its nature. Streams of traffic, airplanes taking off, ferry boats landing, are interesting and informative spectacles at an appropriate distance. These become even more fascinating at night when they stand out against the static city. If insulation for abutters were achieved, then systems could well be exposed to view.

Frequent small access points may offer more opportunities for the system to disperse information, but they intensify the need for clarity and coherence which are more easily achieved by a system of main channels and few access points. There should be a minimum set or package of journey information at each access point regardless of size of station. Since the small-scale access point may be located in areas of particular group characteristics, there might be special information relating to destinations, needs, and interests of those groups.

3.0.6 Choice and Local Identity

3.0.6.1 Choice

The system should increase the choice, richness and interest of urban life. We take this to include social and functional diversity as well as general physical and environmental diversity. Intrinsic diversity may depend more on wide differences among urban elements than on a great many minor variations. Diversity, to be meaningful must be actually experienced; therefore, physical accessibility and that which is perceived or experienced indirectly through communications media is an essential characteristic of diverse environments.

Populations, Activities, and Environments

The groups that demand choice have already been described in On-System Criteria.

System Characteristics

With respect to functional diversity, the emergence of large semi-intensive "islands" of mixed activity around airports, campuses, recreation complexes, regional shopping centers, and the old downtown districts, etc., indicates a potential for variation in intensity that should be reinforced. Main transportation systems should

connect but not disrupt these islands and be coordinated with mini-systems which could bring together intra-island pedestrian clusters. Access points on the metropolitan system should be clustered to encourage development of these islands.

In new development, the spacing of channels and access points on the system should be deliberately controlled and varied to encourage the formation of different types and character of centers. Landscape analysis surveys in new development situations can determine unique locations.

Physical diversity, in the external character, can be achieved in many of the ways already suggested. Support structures frequently act as dynamic and exciting additions to the scene. Elevated expressways, light trails at night from streams of vehicles or intermittent trains, vehicle sounds, signs, air-space development and stations, can all be organized into a differentiated and interesting system. These phenomena should be exposed at selected vantage points so long as their fit and contrast with the existing natural and man-made environment is balanced.

Spacing of access points will have an effect on diversity at both a macro- and micro-scale. Depending on topography and viewing potentials, widely spaced access points will tend to produce larger physical agglomerations at these points in response to the convenience of proximity to the station and the efficiencies of concentration. The effectiveness of feeder systems will modify this clustering effect to a degree and, of course, not everyone will want to be near the station. However, if access to the system is limited to widely spaced stations, the probable physical consequence is growth of development peaks at those points.

Closely spaced access points are likely to produce the contrary physical form, i.e., lower peaks, tending towards linearity as access levels approach the infinite level. If, in addition to the spacing and distribution of access points, the service is modified, for example, express versus local stops, the heights of the peaks may be further modified. The detailed location of the system can accentuate or detract from existing environmental diversity. Filling in valleys, leveling ridges, blurring shorelines, are destructive operations. Depressed channels in canyons, elevated roads on ridges, split lanes on hillsides can improve the quality of places. Sometimes, in uninteresting areas, flatlands, industrial wastelands and so on, the system can, by its structural form, bring new definition to a shapeless area, for example, the New Jersey Turnpike crossing the Flats.

3.0.7 Social Interaction

Sociologists and others have expressed concern about the increasing social homogeneity of large areas of the city. The transportation system should help to maintain interaction between different social groups or, at least, offer the choice of interaction. On-system interaction has already been discussed. The concern here is with how the system can be organized in relation to the general urban pattern to encourage use by diverse groups.

Populations, Activities, and Environments

Probably few social groups would consciously desire interaction with other groups. More relevant is the question of which groups actually might resist interaction. In the past, resistance against such interaction has occurred in middle- and upper-income groups.

System Characteristics

Access points which always generate activity and have the potential to increase intensity could be chosen at locations midway *between* dissimilar social areas where they may be separated, or in the centers of mixed neighborhoods.

Transfer points can also be potential mixing areas, although the possibility of increased inconvenience might offset the potential social gain in exposing riders to diversity. There is also the possibility that separation on the outward bound journey would tend to heighten the sense of economic and social differences if, in fact, the residential areas served by one line were not open to the riders on another line.

The development of air space over stations and commuter parking areas could be undertaken in accordance with development programs which contain diverse physical, social, and economic elements. As a result there may be a mix of public and private facilities, housing for different incomes, high- and low-rise structures, open space and built-up areas, and a mix of land-uses in general. Programs for the development of air rights could be further diversified along the route so that each station area would have a different dominant character.

In addition to connecting centers of activity and density, a system could be designed especially to connect widely dissimilar sectors of the city in order to induce the potential for interaction between these sectors and the groups riding on the system. In

other words, a deliberate "crossing" of existing patterns could be achieved.

While such mixing would tend to offset the effects of undue homogeneity and monotony, care should be taken in the design of the system to provide for basically different group attitudes towards privacy, protection, and general behavior.

3.1 CHARACTERISTICS OF POPULATIONS, ACTIVITIES, AND ENVIRONMENTS AFFECTED BY TRANSPORTATION SYSTEMS

3.1.1 Population Groups

3.1.1.1 Income Distribution

3.1.1.2 Class Distribution

3.1.1.3 Age Distribution

3.1.1.4 Length of Residence Distribution

3.1.2 Activity Types

3.1.2.1 Residential

- High-density residential (≥ 18 DU/net acre)
- Medium-density residential (9-18 DU/net acre)
- Low-density residential (≤ 9 DU/net acre)

3.1.2.2 Commercial

Retail commercial:

- Local shopping, i.e., supermarkets and convenience-goods commodities and services
- Regional or community-wide shopping centers
- "Frame" shopping, i.e., cars, building, office, and specialized supplies and services
- Downtown shopping, i.e., furniture, apparel, gifts, and luxury items
- Restaurants and entertainment

Office complexes:

- Professional services
- Administration

3.1.2.3 Industrial, Manufacturing, and Agriculture

- Extractive industry
- Heavy industry, manufacturing, and assembly
- Light industry, manufacturing, and assembly
- Research and development
- Agriculture

3.1.2.4 Institutional

- Schools
- Theaters, auditoriums, arenas, and stadiums
- Libraries, hospitals, and government administration

3.1.2.5 Recreation

- Neighborhood recreation, i.e., primarily childrens' play areas
- City recreation, i.e., primarily teenage recreation: football, basketball, baseball, tennis, volleyball, swimming

3.1.3 Social Value

3.1.3.1 Intensity of Use Value

Yearly Use:

- Average yearly use
- Peak yearly use

Monthly Use:

- Average monthly use
- Peak monthly use

Weekly Use:

- Average weekly use
- Peak weekly use

Daily Use, Daytime, i.e., 8:00 A.M. - 6:00 P.M.

- Average hourly daytime use
- Peak hour daytime use

Daily Use, Nighttime, i.e., 6:00 P.M. - 8:00 A.M.

- Average hourly nighttime use
- Peak hour nighttime use

- 3.1.3.2 Intensity of Public Use, e.g., libraries, city halls, etc.
- 3.1.3.3 Intensity of Special Group Use, e.g., ethnic groups, professionals' and workers' organizations, civil rights groups, etc.
- 3.1.3.4 Historical and Cultural Significance, i.e., the importance of a particular site, in recent or past history, to the whole population or to a special group

3.1.4 Economic Value

- 3.1.4.1 Value to the owner, i.e., value of the investment, or value in terms of income returned
- 3.1.4.2 Value to the community, i.e., assessed value of the land plus capital improvements for purposes of taxation
- 3.1.4.3 Value to the community, i.e., number and type of jobs provided
- 3.1.4.4 Value to special groups, e.g., low-cost housing for the poorer segments of the population

3.1.5 Urban or Landscape Value

- 3.1.5.1 Natural, scenic and/or recreational value of the landscape
- 3.1.5.2 Value in terms of architectural interest or singularity in the metropolitan area

3.1.6 Urban and Landscape Types

3.1.6.1 Texture and Grain

- Slope of land, i.e., flat, gentle, steep slopes
- Vegetation cover, i.e., woody, sand, bare
- Building height, i.e., high, low
- Openness of buildings, i.e., open or closed windows
- Grain of streets, i.e., fine, coarse

3.1.6.2 Pattern

- Along or parallel to ridge, rivers, shorelines
- Along or parallel to man-made channels, edges, barriers
- Across valleys and hills
- Across urban districts, e.g., low- or high-density
- Through urban foci
- Around urban foci

3.2 SYSTEM CHARACTERISTICS

3.2.1 Characteristics of the Vehicle

3.2.1.1 Aerodynamic properties of the vehicle--primarily the amount of air turbulence generated by the moving vehicle

- High air turbulence
- Medium air turbulence
- Low air turbulence

3.2.1.2 Optimum radius of turn or curvature for the moving vehicle (a function optimum velocity factor)

- Large radius of curvature
- Medium radius of curvature
- Small radius of curvature

3.2.1.3 Noise generated by the moving vehicle at ground zero

- >40 db?
- 10 - 40 db?
- <10 db?

3.2.1.4 Light on the vehicle

Light on the channel:

- High-intensity focused beam
- "Dimmed lights"
- No lights required

"Running lights" for safety and visual identification:

- Intensity
- Variety of color

3.2.1.5 Gradient capability of the vehicle

- High-gradient capability
- Medium- or normal-gradient capability
- Low-gradient capability

3.2.1.6 Amount of toxicity or repugnance of exhaust generated by the moving vehicle

- Very toxic or repugnant
- Moderately toxic or repugnant
- Not toxic or repugnant

3.2.2 Characteristics of the Channel or Path of the Vehicle

3.2.2.1 Structural isolation of the channel

- None (or below grade)
- Some (above grade on trestles, etc.)
- A lot (floating connections or cable car suspension, etc.)
- Total (air craft)

3.2.2.2 Elevation of the channel

- Covered trench or tunnel
- Depressed trench
- At grade
- Above grade
- In air

3.2.2.3 Enclosure of the channel

- Total encapsulation
- Three sides enclosed (stacked freeway)
- Two sides enclosed (stacked freeway)
- One side enclosed
- Totally open (air craft, suspension cable cars, etc.)

3.2.2.4 Uninterrupted straight-line distance between the channel and the nearest user of the abutting land; view of the channel from a distance

3.2.2.5 Lighting of the channel

- Intensity
- Color variety
- Dynamic variety

3.2.2.6 Ventilation of the channel

- Open air
- Forced air:
 - Exhaust carried away similar to the way sewage is disposed
 - Exhaust disposed continuously along the channel
 - Exhaust disposed intermittently at points along the channel

3.2.2.7 Separation between parallel channels

- No separations
- Horizontal separation

- Vertical separation
- Horizontal and vertical separation
- 3.2.2.8 Necessary width of the right-of-way
- 3.2.2.9 Necessary height of the right-of-way (if channels are stacked)
- 3.2.2.10 Massiveness of the channel structure
 - Very massive (earth cut and fill)
 - Moderately massive (concrete and steel structures for elevated channels)
 - Not massive (tunnels, air craft)
- 3.2.2.11 Permeability of the channel to cross-traffic
 - Total permeability (tunnels, air craft)
 - Limited permeability (elevated and depressed channels)
 - Very limited (at-grade, high-speed, limited-access channels)
- 3.2.2.12 Shared uses of the right-of-way
 - Planting and scenic parks
 - Bicycling, horseback riding, walking, etc.
 - Utilities (water, power, common)
 - Recreation (athletic fields and playgrounds)
 - Viewing platforms, turnouts, etc.
 - Other transit
- 3.2.2.13 Ground cover of lands adjacent to and on the right-of-way
 - Primarily paved
 - Primarily planting materials
 - Primarily dirt, etc.

3.2.3 Characteristics of the Network or System as a Whole

- 3.2.3.1 Optimum spacing of on-off points for the vehicle or passenger (a function of optimum velocity for the vehicle)
 - Distant spacing
 - Medium spacing
 - Small spacing
- 3.2.3.2 Density distribution of vehicles on a channel or path as a function of time of day or week

- Uniform distribution
- High density at rush hours, otherwise moderate to low density
- High density on weekends, otherwise moderate to low density
- High density in the evening, otherwise moderate to low density
- High density in the morning, otherwise moderate to low density

3.2.3.3 Type of service provided

- Passenger only
- Freight only
- Passenger and freight
- Combination of passenger and freight

3.2.3.4 Stations, collection and/or change points required

- Yes
- No

3.2.3.5 Stations required (Case I)

- Primarily stations requiring large parking facilities
- Primarily stations requiring small parking facilities
- Stations requiring some large parking in suburbs and little "downtowns"
- Stations requiring no parking facilities

3.2.3.6 No stations required (Case II)

- Large amount of parking; downtowns
- Relatively large amounts of parking everywhere
- No parking required

3.2.3.7 Ratio of passenger-carrying capacity to land required for rights-of-way, stations, etc.

- High
- Medium
- Low

4.0 CONCLUSIONS

4.0.1 We have established the parameters of a problem from which reasonable conclusions might be drawn. The next phase in developing an evaluative model will be to run through interaction matrices of "Criteria versus User Groups" and "Criteria versus System Characteristics." Outlines of these matrices are shown in the Appendix. Preliminary runs were made but they

were not sufficiently developed to justify our completing them at this point. They have, therefore, been left open for subsequent development.

4.0.2 The importance of recognizing sub-cultural groups in the design of transportation systems is worth emphasizing. Designing systems for a pluralistic client population may at first suggest unmanageable complexities, but there is a compensation in that problems and criteria can be much more precisely defined than when systems are being designed for the "average" traveler or bystander. This acknowledgement of population differences can lead to the provision of some services that would not seem feasible for the general traveler, e.g., provision for physical exercise, ultimate privacy, or certain types of information. Also, if policy desires to extend any single system to a wider population, the target groups could be identified at two ends of the user spectrum, the deprived who cannot afford to or do not know how to use present systems, and those with other choices who have to be attracted to the system. To take an example, current mass transit systems could be made more accessible and easy to use for lower-income groups, and, at the same time, more accessible and private for the middle-income groups. This should help to make transportation systems more personal in their design.

4.0.3 Some of the described criteria are not usually considered in transportation design, although they seriously affect user choices. The need for maintaining personal self-esteem through devices such as privacy, control, and service is one such criterion. The question of information is another. These needs which may be called latent deserve more attention.

4.0.4 Other criteria such as choice, interest, or conservation of valued environments are frequently mentioned as planning goals but these are never measured very precisely. We have suggested some indicators which could be used.

4.0.5 Still other criteria such as safety and accessibility are also the subject of many criteria lists, but perceived safety and perceived accessibility (we have called it structure) are usually ignored. Again we have noted some of the variables that affect the psychological feeling of safety and structure.

4.0.6 The development and definition of off-system criteria as well as system criteria emphasize the current concerns of the general public about transportation system designs. By setting the contexts in which these systems will operate and by defining these contexts in terms of different types of activity and environment, we can show that systems vary in quality according to their surroundings. Many system comparisons ignore these side effects.

4.0.7 From this range of criteria we see that the potential function of a transportation system is infinitely more complex than the carrying of people

and goods. By importing usually static land-uses and activities onto the system and by mixing and integrating systems with local environments, transportation systems may become 'part of the city.'

4.0.8 If the general goal of transportation systems is environmental improvement, concentration on *upgrading existing systems* may be more fruitful than concentrating on adding more new systems. Yet the currently proposed Scenic Roads Program allocates over 70 percent of its budget to building *new* rural roads, when the improvement of existing rural roads is much more important. If the quality of all existing streets could be made more attractive, our cities would be transformed. The criteria of continuity and preservation, therefore, should caution decision-makers to consider some seemingly more modest goals.

4.0.9 Finally, there seems to be no perfect system on the horizon, and probably no system which would maximize all these criteria will ever exist. Rather, optimal systems will be designed for varying particular situations.

4.1 RESEARCH AND DEVELOPMENT

We propose three kinds of research:

4.1.1 Further development is needed of the evaluative model leading to more precise definitions of performance criteria, more measurable "rules," and more careful estimates of user group needs, as well as weightings and system characteristics, and the testing of interactions on the matrices. These could be followed by evaluations of case studies, e.g., of alternative proposed systems and some "best" existing systems. Since we have not scanned the literature of current research and incorporated it into some of the issues raised in this paper, it would be useful to have previews and weightings of these criteria by experts in various relevant fields (e.g., sociologists, psychologists, transportation engineers, planners, designers).

4.1.2 Psycho-social research will be necessary to test many of these hypotheses, especially those concerning the relevance of these criteria to various user groups and desirable performance standards. Until now, research has concentrated on characteristics affecting safety. Only very limited research has been made into privacy and social interaction in transportation systems, personal control, choice needs and structuring methods, information needs and devices, stress other than noise, evaluations of environmental significance and value, to mention some of the major issues.

There may be certain target user groups or critical situations that demand priority, e.g., reactions in residential areas to different types of channels (we are learning fast on this one), or reactions to travel on various systems by those who normally travel by car.

In this kind of research three types of information are needed:

4.1.2.1 Attitudinal research into the reasons underlying user attitudes toward transportation systems

4.1.2.2 Investigation of main user variations

4.1.2.3 Assessment of system characteristics relevant to the identified attitudes.

This kind of research would have to be carried out from direct experience with real or simulated user experience of different systems, e.g., only one vehicle type for each system with movies played on window screens might create a reasonable simulation.

4.1.3 Experiment with certain critical system characteristics to improve their functioning.

4.1.3.1 Vehicular design is an obvious area of research, since previous research has concentrated mostly on questions of comfort and color. Few of the new systems allow personal control of the vehicle when desired, give all-round vision, a choice of activities, sufficient privacy or flexibility for social interaction.

4.1.3.2 Channel and station design have paid little attention to the sequential experience of the user, to decision and fatigue points, information sequencing, orientation levels, choice levels and so on.

4.1.3.3 Of the criteria, the most worth developing in experimental examples might be investigation into improving the informational content of transportation systems, not only by use of signs and lighting, but through direct viewing, identification of social and functional patterns through the physical form of the environment, and the programming of indirect information through maps, diagrams, brochures, billboards, tapes, etc.

4.2 IMPLICATIONS FOR THE SYSTEM DESIGN PROCESS

The basic flaw in present transportation system design is the failure to include a broad enough range of off- and on-system "non-engineering" criteria and requirements. Thus, while adequate standards of a narrow functional nature may be met, such as capacity, speed, illumination, space, etc., a host of other criteria and standards are simply not considered in the typical design process. To properly deal with this class of requirements, several ideas should be investigated.

4.2.1 First, there is the need to adequately represent this kind of requirement in the process. This can partially be achieved by the "team approach"

in which planners, urban designers, behavioral scientists, and architects are *equal* members of a team as well as the engineers, industrial designers, and construction experts who have traditionally been in charge. While the basic objective of the system may be "to move people and goods," new team members would express respect for a larger and more significant objective.

Similarly, economists who also should be included in this interdisciplinary approach should be concerned not only with the feasibility of the system but also with community-wide cost-benefit considerations, including items which may be difficult or impossible to quantify.

If methods to measure and evaluate these environmental and esthetic criteria can be devised, the eventual need for an interdisciplinary team approach might be minimized. Within the team, conflicts may arise which would point to the need for community involvement in terms of policy guidance and expression of preference. The former point requires an informed and concerned leadership and citizenry.

4.2.2 The participation of these latter two groups indicates a second basic area needing improvement. Simulation of the trip characteristics (on-system) and the impact on external systems (physical, economic, social) must be as accurate as possible if the best judgments are to be rendered regarding the proposal's acceptability. Traditional techniques employed by architects, planners, and engineers do not adequately render the sensations of motion (on-system) or physical and social changes (off-system) which various alternatives could produce.

4.2.3 A third improvement needed in the process of system design relates to the identification and measurement of the needs of patron sub-groups. Better, and earlier, surveys and descriptions of these special group needs would produce not only better investigative methods but also better portrayal to these groups of the alternatives and choices they face. This improvement in the design process implies a need for fundamental inquiry into human behavior under various transport modal conditions--another difficult simulation task.

4.2.4 A fourth process improvement is implied in the foregoing statements, i.e., user-bystander participation in the process of designing the system. It may not be enough to place the design of the transport system in the community's planning and redevelopment process, with its inherent checks and balances, public hearings, etc. Affected areas may almost want veto power over the system's design when it is close to home. Where the system design is part of a broader planning and development process and problems are seen and resolved in a broad context, the task may be simpler. In short, where transit system planning and design is actually only a special part of a general development and planning process, and where specific action programs are conducted concurrently, relocation-resettlement problems, for instance, will be easier to handle.

4.2.5 A possible fifth process improvement concerns the specific programmed provision for local-scale environmental "management." This is an extension into the action of the previous factor--participation. Perhaps a finished transit system with all its elements should not be sought. Rather, leeway should be permitted for local management and determination of design while, at the same time, recognizing overall system needs. This local control is similar to the "advocate planning" concept and goes further than feedback and review by local groups, design teams, or "official planner"-generated proposals. The conflicts which may arise stem inevitably from the fact that the system is an organic whole, subject to some critical engineering requirements if it is to function.

4.2.6 A sixth process improvement to be considered is implicit in the foregoing, namely the design, planning, and construction of the system within a physical and administrative framework which enables design decisions, impact problems (such as fit, relocation, disruption, etc.), to be resolved on an area-wide basis. In short, the design problem would be defined or conceived as that for an environment segment in which part of a transportation system happens to exist as a major program element.

4.2.7 A final process improvement which should occur at the outset of the process, is an explicit policy statement regarding the "non-quantifiable" elements in the community and their relative value to the community in comparison to the limited goals of the transit system. Thus, perhaps, even without a full design team approach, if esthetic and social objectives are strongly and clearly articulated and the relative weight and priority attributed to them by the community is made clear, these factors will be given some attention during the design process.

In summary, there is a basic need to redesign the process of transport system design in order to fully respond to the broader needs and requirements of riders and non-riders alike. On a short-term basis, improvements may be attained by a., a more explicit goal statement by the host community, b., "design team" methods with all interests represented, c., better simulation so those affected will be able to pre-test and pre-evaluate and d., development of quantification techniques for so-called human factors to simplify their inclusion in cost-benefit analyses.

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APPENDIX C

Populations, Activities, and Environments	Off-System Criteria													
	Noise	Light	Fumes	Micro-climate	Fit	Mix	Privacy	Control	Value	Structure	Information	Choice	Identity	Interaction
Population Groups:														
Income														
Class														
Age														
Length of residence														
Activity Types:														
Residential														
Commercial														
Industrial														
Institutional														
Recreational														
Social Value:														
Intensity of use														
Intensity of public use														
Intensity of special group use														
Historical and cultural significance														
Economic Value:														
Value to owner														
Value to community														
Value to special groups														
Urban or Landscape Value:														
Natural, scenic														
Architectural interest														
Urban and Landscape Types:														
Texture and grain														
Pattern														

APPENDIX D

System Characteristics	Off-System Criteria													
	Noise	Light	Fumes	Micro-climate	Fit	Mix	Privacy	Control	Value	Structure	Information	Choice	Identity	Interaction
Vehicle:														
Aerodynamic														
Radius														
Noise														
Light														
Gradient														
Exhaust														
Channel:														
Isolation														
Elevation														
Enclosure														
Distance														
Lighting														
Ventilation														
Channel Separation:														
Right-of-way width														
Right-of-way height														
Massiveness														
Permeability														
Shared uses														
Ground cover														
System:														
On-off point spacing														
Vehicle density														
Service type														
Stations														
Station types														
No station														
Passenger capacity ratio														