A Methodology for Transit Station Impact Analysis

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ABSTRACT

A methodology is developed for the identification and evaluation of the impact of transit terminals on their environment. A catalog of transit station studies is presented that enables the user to initiate the evaluation process with the identification of critical impacts using a cross- and self-interactive matrix procedure. The impact that the station has on its environment as influenced by local land use patterns is examined by using the cross-interactive matrix. The self-interactive matrix establishes the station design elements and identifies the most sensitive station design components. Where important impacts exist, strategies for preventing problems or managing the issues involved are developed in terms of altering the station design variables or site location or promoting changes in neighboring land use so as to provide an acceptable environment.

The public's acceptance of new urban and intercity transportation systems is greatly influenced by the negative or positive environmental impacts created by terminals. The transit station itself is a major physical force within a community and can serve to enhance a neighborhood by bringing to it vitality and activity or to diminish the quality of life by adding congestion, noise, and blight.

Although the community as a whole usually benefits from a major transportation project, the gains are often not realized at locations surrounding the station because of disruptions of the social and environmental structure. In many cases residents of the neighborhood surrounding the transit station feel that they must bear all the negative impacts whereas the community receives all the benefits. Such conflicts must be resolved and solutions should demonstrate a balance between neighborhood and community values.

The purpose of this paper is to present a methodology for the evaluation of environmental impacts created by transit stations. The methodology recognizes the vast and diverse literature in the realm of transportation impacts and organizes this in a fashion that is useful to the practitioner. A catalog of transit station impact studies that enables the user to learn the nature of specific impacts created by transit terminals is used. The interactions of the various elements of the site plan are described to assist the planner in determining the causes of negative social and environmental impacts that must be dealt with in the design process. A hypothetical example is presented to demonstrate how the process is carried out.

IMPACT ASSESSMENTS

The first step in the impact assessment procedure is to identify the potential impacts of a transit station. These impacts are then incorporated into the alternatives analysis for the terminal design under study. Because an impact assessment must identify specific effects before the alternatives analysis, it is important that a disaggregated range of transit station impacts be used so that a detailed impact classification system is produced.

Impact Classification System

The impact classification system described in this paper is fully documented in a recent report, Catalog of Transit Station Impact Case Studies (1). The catalog is a reference as well as a state-of-the-art review of the impact of public transportation terminals on land use and community development. Published documents are described and a general overview of each is furnished with a capsulized sampling of the findings.

For classification purposes, a list of impact keywords (Table 1) is given. These impact keywords provide the user with an entry point into a reference catalog and a quick check of any descriptor in the catalog's overall classification framework. When a keyword is selected, the user is directed to the correct catalog topic area. If the user's keywords do not appear in the table, the list can be used to suggest similar or related descriptors.

The topic index in Table 2 provides the framework for the indexing in the catalog. Each topic area is a collection of descriptor keywords from Table 1 that are interrelated. Some impact descriptors are specific and are listed as individual topics, whereas others are quite general and are associated with other impacts that can be grouped under a single topic. Each major topic is listed in Table 2 with the descriptors associated with the topic and the number of references provided on the topic area.

Use of the Catalog

The following example illustrates how a typical impact is referenced in the catalog. Consider the case of a user who desires information on the development potential of sites adjacent to a public transportation terminal. The impact descriptor in this case is development potential, the associated keyword from Table 1 is development opportunity (joint development), and the topic index in Table 2 states that there are 17 references in the joint development section.

A sample reference, shown in Figure 1, furnishes the report title and the source for that reference. A listing of the full address of the supplier of the reference is presented in the catalog appendix. The next item in the catalog listing is a general annotation of the entire reference, followed by a description of the methods used to collect or determine the information. Finally, the major findings are described as they apply to this topic.

ILLUSTRATIVE EXAMPLE

Descriptive Scenario of Station Site and Terminal

Consider a transportation terminal that serves as a terminal and transfer point for commuter buses with

TABLE 1 Index of Keywords

Accessibility
Accidents (see Safety)
Aesthetics
Air Pollution
Assessments (see Property Values)
Attitudes
(see Citizen Participation)
Capital Cost (see Economic Impacts)
Citizen Participation
Commercial Development
Community Cost (see Social Impacts)
Congestion
Construction Impacts
Crime
Development Opportunity
(see Joint Development)
Disadvantaged Mobility
Displacement Cost
see Construction Impacts)
Drainage (see Erosion)
Dust (see Air Pollution)
Economic Impacts
Educational Institutions
(see Institutional Land Use)
Employment
Energy
Environmental Impacts
Erosion
Fares (see User Costs)
Financial Impacts
Goal Assessment
Housing (see Residential Land Use)
Image (see Citizen Participation)
Infrastructure
Institutional Land Use
Joint Development
Landscaping (see Aesthetics)
Level of Service
Life-style (see Social Impact)
Lighting (see Aesthetics)
Location Theory
(see Terminal Location Data)
Modal Coordination
Neighborhood Character
Noise Pollution
Operating Cost
Open Space
(see Institutional Land Use)
Opinions
(see Citizen Participation)
Orientation (see Aesthetics)
Parking
Parks (see Institutional Land Use)
Passenger Volumes
Pedestrian
Population
Property Values
Psychological Effects
Public Policy (see Infrastructure)
Recreation (see Institutional Land Use)
Relocation (see Construction Impacts)
Residential Land Use
Retail Sales (see Economic Impacts)
Revenues (see Property Values)
Safety
Shopping (see Commercial Development)
Social Impacts
Speculation
Subsidy (see Economic Impacts)
Taxes (see Property Values)
Terminal Location Data
Traffic/Terminal Area (see Congestion)
Travel Impacts
Trip Length (see Travel Impacts)
Trip Reliability/Comfort/Convenience
(see Level of Service)
User Characteristics
User Cost
Value Capture
Vehicle Volumes (see Passenger Volumes)
Water Pollution (see Erosion)
Wildlife and Vegetation Impacts
Zoning

TABLE 2 Topic Index

Accessibility (7)*
Aesthetics (7) landscaping, lighting, visual barriers, orientation, psychological effects.
Air Pollution (7) dust
Citizen Participation (6) attitudes, goals, images, opinions
Commercial Development (11) retail sales, shopping
Congestion (6) traffic around station
Construction Impacts (10) displacement cost, relocation, R-O-W
Crime (3)
Disadvantaged Mobility (3)
Economic Impacts (20) budgets, capital costs, capital programs, financial subsidies
Employment (7) jobs
Energy (8) power demands
Environmental Impacts (16)
Erosion (4) drainage, hydrology, water pollution
Infrastructure (17) public policy
Institutional Land Use (6) education, public service, parks, recreational
Joint Development (17) development opportunity
Level of Service (7) trip reliability and comfort and convenience
Modal Coordination (4)
Neighborhood Character (5) cohesion/stability
Noise Pollution (5)
Operating Cost (8) maintenance, operating costs comparison
Parking (6)
Passenger Volumes (8) user volumes, vehicle volumes
Pedestrian (5)
Population (3)
Property Values (16) assessments, mortgages, rent, revenues, taxes
Residential Land Use (12) housing
Safety (4) accidents
Social Impacts (14) community cost, neighborhood cost, life-style
Speculation (4)
Terminal Location (11) location theory
Travel Time (8) travel length
User Characteristics (7)
User Cost (6) fares, freight
Value Capture (4)
Wildlife/Vegetation Impacts (2) balance of nature
Zoning (4)

* ( ) indicates the number of references included in the topic.

_____, Joint Development: Making the Real Estate Transit Connection, The Urban Land Institute, Washington, D. C., 1979. Available: The Urban Land Institute.

The report presents the joint development concept for transit terminals. It is aimed at local officials, developers, and citizens for a view of how joint development can be translated into practical, successful projects.

Methodology

1. Case studies in five areas are presented showing examples of major joint development projects. The sites are located in Washington, Atlanta, and Baltimore.

Findings

- o Sites with appropriate zoning regulations and minimal institutional interaction are most attractive to private developers.
- o Site locations that minimize construction problems and maximize pedestrian flow and commercial potential are preferred by private developers.
- o The availability of unencumbered sites ready for immediate use by developers is preferable.
- o Station entrances should be available to sites with the greatest developmental potential.
- o The cost of the project is extremely important to the developer.

FIGURE 1 Typical catalog listing.

exclusive bus-lane privileges into the center city. The station is located at the fringe of a large metropolitan area of 500,000 population on a primary arterial adjacent to an Interstate freeway interchange. Because of its location at the fringe of the urbanized area, it does not serve local transit feeder lines and has no defined local service area.

The characteristics that provide a general description of the preliminary station design are as follows:

- Predominant mode: bus;
- Station type: surface;
- Transit line status: terminus; off-street siting;
- Station size: 2,000 passengers/day, peak demand;
- Pedestrian accessibility: poor;
- Automobile and bus accessibility: excellent;
- Parking capacity: 500 spaces; and
- Storage and maintenance facilities on site: none.

The neighborhood land uses immediately adjacent to the site are shown in Figure 2. A large plaza-type shopping center is located within 0.25 mile of the transportation terminal site. Garden apartments are within 0.50 mile of the site opposite the interchange. The vacant land to the rear of the terminal is zoned for commercial and light industry and adjoins medium-density garden apartment residential and single-family residential housing developments within a mile of the site. A gravel operation now exists at the eastern periphery of the vacant parcel. Access to the parcel from the arterial highway is available from a strip of land 300 ft wide immediately adjacent to the terminal site.

Terminal and Land Use Interaction Matrix

The matrix showing interactions between the station design characteristics and the existing neighborhood land uses is shown in Figure 3. The specific impact interactions indicated are derived from responses to the following question: Is there a perceived enhancing (positive, +), inhibitive (negative, -), or independent (zero, blank) relationship between the design characteristic and the land use? After this impact matrix table is completed, attention is focused on those cells that exhibit an inhibitive (negative) relationship. The interacting pairs of elements thus identify conflicts or issues that need to be addressed in the impact assessment.

A review of the cells in Figure 3 reveals that the proposed terminal is compatible with existing high-density housing, all existing transportation facilities, and retail facilities and would not preclude development of existing vacant property. However, the terminal location or design may have a negative impact on single-family residential development, educational facilities, and the gravel pit operation.

The next step in the analysis focuses on determining the specific causes for the anticipated problems. This is accomplished by now asking why this pair of elements is negative or what impact descriptors listed in Table 2 create the negative relationship. The key question can be addressed by professional planners, city officials, or citizen groups. For this example, the perceived negative station and land use impacts as identified from the cells in Figure 3 and the impact keywords (Table 1) are collected in Table 3. At this point, the planner can use the Catalog of Transit Station Impact Case Studies (1) to determine the significance of each impact and to determine what, if any, strategies are available for attenuating these undesirable effects.

Table 3 thus shows the keywords for referencing the catalog that are desired for each of the cells in Figure 3. For example, the interaction between single-family residential development and the bus mode produces the following keywords: air pollution, noise, property values, and aesthetics. A review of all the impact descriptors in Table 3 indicates that the overriding negative impact of this terminal is safety in the local neighborhood. The keyword "safety" is listed 21 times. Following safety, accessibility, congestion, noise pollution, and parking are most frequently listed. Accordingly, if the proposed station is to meet with local acceptance, the cited impacts should be resolved.

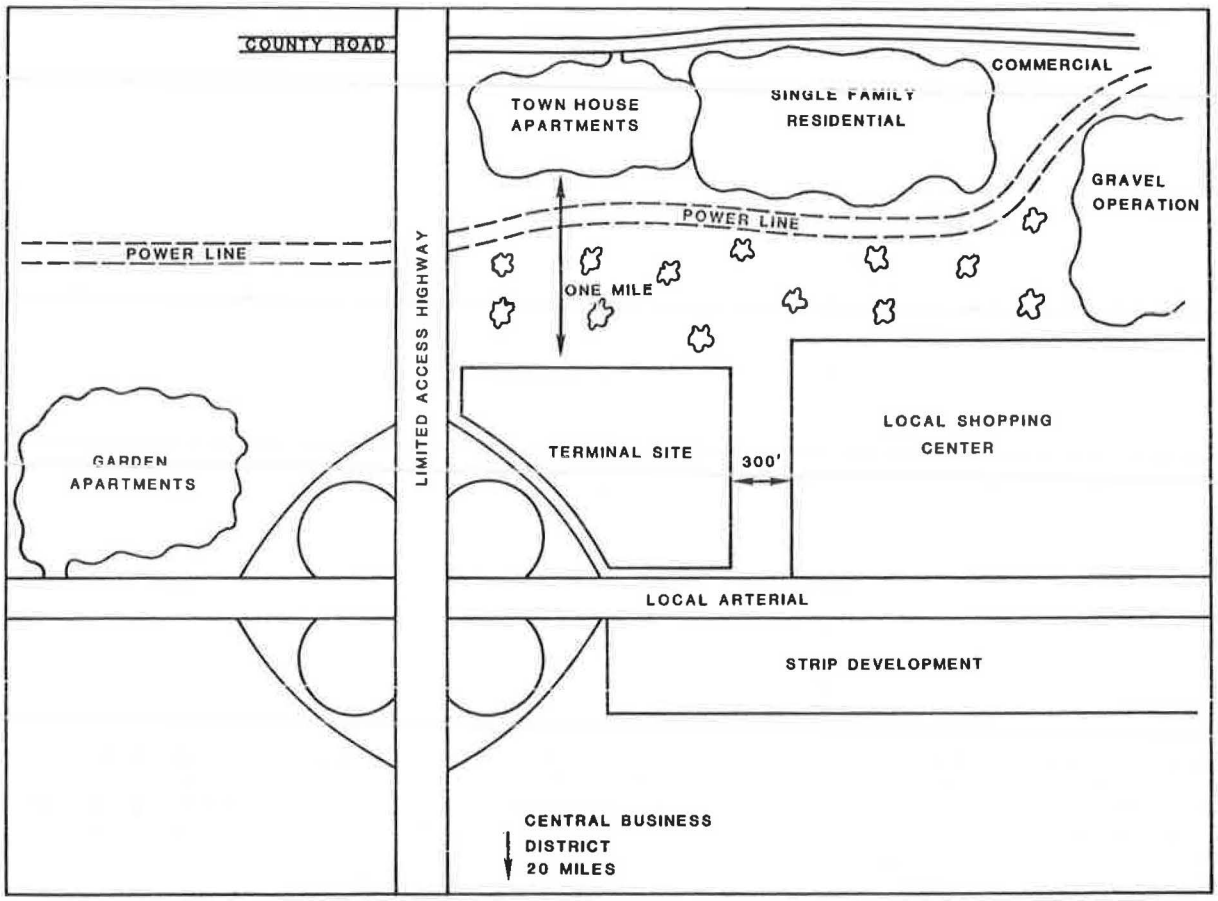

FIGURE 2 Transit station site example.

EXISTING NEIGHBORHOOD LAND USES

STATION DESIGN CHARACTERISTICS	1 Residential							4 Transportation and Utilities						5 Trade								6 Services								7 Cultural		8 Resource Production	9 Undeveloped Area
	111 Single Family	112 Garden Apts./Townhouses	113 High Rise	42 Motor Vehicle	45 Highway/Street ROW	46 Automobile Parking	48 Utilities	52 Retail-Building Material	53 Retail - General Merchandise	54 Retail - Food	56 Retail - Apparel	57 Retail - Furniture, Home Furnishings, Equipment	58 Retail - Eating & Drinking	61 Services - Finances, Insurance	62 Personal Services	63 Business Services	64 Repair Services	65 Professional Services	68 Educational Services (Elementary School)	73 Amusement (Movies, Game Room)	85 Mining (Gravel Extration)	91 Undeveloped Land	92 Noncommercial Forest										
Predominant Mode: Bus	—			+	+	+	+			—			+	+	+	+			—	+	—	+	—									
Station Type: Surface	—			+	—	+	+						+							+	—	+	—									
Transit Line: Terminus/Off Site	—	+	+	+	+	+	+						+							+	—	+	—									
Station Size: 2,000 Passengers/Day	—					—			+				+		+	+			—	+												
Predestrian Accessibility: Poor		—	—		—				—	—	—		—	—	—	—			—	—												
Automobile Access: Excellent	+			+	+	+	+		+	+			+	+				+	—	+		+										
Parking Capacity: 500 Spaces	+	+	+	+	+	+	+				+		+		+	+		+	—	+		+										
Storage & Maintenance: None	+	+	+	+																												
Joint Development Potential	—	—	+	+	+	+	+		+		+		—	—	+	+		+	—	+	—	+	—									

INSTRUCTIONS: The matrix is completed by addressing the following question: "Is there a perceived enhancing (+), inhibitive (—), or independent (blank) impact relationship between the station design characteristics and the neighboring land uses?"

FIGURE 3 Terminal and land use interaction matrix.

TABLE 3 Summary of Potential Station and Land Use Issues

Station Design Characteristics	Existing Land Use	Impact Keyword
Predominant Mode:		
Bus	**Single-Family Residential**	Air pollution; noise; property values; aesthetics
	Educational Services (Elementary)	Noise; safety
	Mining (Gravel Ext.)	Air pollution; noise; aesthetics
	Noncommercial Forest	Wildlife/vegetation; zoning
Station Type:		
Surface	Single-Family Residential	Aesthetics; property values; noise
	Mining (Gravel Ext.)	Air pollution; aesthetics
	Noncommercial Forest	Aesthetics
Transit Line Status		
	Single-Family Residential	Aesthetics; air pollution; citizen participation; crime; noise; property values; safety; zoning
	Mining (Gravel Ext.)	Air pollution; aesthetics; noise
	Noncommercial Forest	Wildlife/vegetation; zoning
Station Size:		
2000 Passengers/Day	Single-Family Residential	Congestion; noise; neighborhood character; crime; safety
	Automobile Parking	Accessibility; congestion; neighborhood character
	Educational Services (Elementary School)	Safety
Pedestrian Access:		
Poor	Garden Apts./Townhouses	Accessibility; congestion; modal coordination; parking; safety; travel time
	High-Rise Apartments	Accessibility; congestion; modal coordination; safety; disadvantaged mobility
	Motor Vehicle	Accessibility; parking; congestion; safety; modal coordination
	Highway/Street ROW	Accessibility; safety; congestion; joint development; pedestrian needs
	Retail - General Merchandise	Accessibility; commercial development; parking; safety
	Retail - Food	Accessibility; parking; safety
	Retail - Apparel	Accessibility; parking; commercial development; safety
	Retail - Eating & Drinking	Accessibility; parking; safety; user characteristics; commercial development
	Services - Finances	Accessibility; safety; parking; commercial development
	Personal Services	Accessibility; parking; safety; commercial development
	Business Services	Accessibility; parking; safety; commercial development
	Educational Services (Elementary School)	Accessibility; safety
Auto Accessibility: Excellent	Educational Services (Elementary School)	Safety
Parking Capacity: 500 Vehicles	Educational Services (Elementary School	Safety
Joint Development Potential:	Single-Family Residential	Commercial development, congestion; crime; parking; property values; safety; zoning
	Garden Apts./Townhouses	Commercial development; crime; parking; noise; air pollution; safety
	Educational Services (Elementary School)	Safety; congestion; noise
	Mining (Gravel Ext.)	Air pollution; noise; aesthetics
	Noncommercial Forest	Wildlife/vegetation; neighborhood character

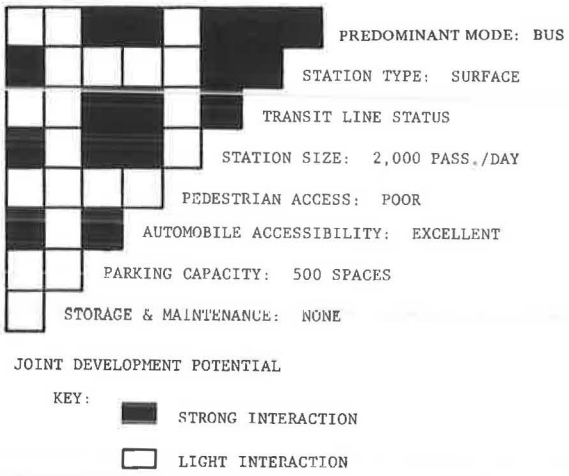

FIGURE 4 Terminal design interaction matrix.

Terminal Design Interaction Matrix

After the specific impacts have been established and remedies suggested via the catalog, it is necessary to determine where changes directed at lessening a single impact may in fact induce other impacts. This problem is addressed by developing a terminal design interaction matrix as shown in Figure 4. This matrix identifies interactions among the design elements and must be prepared using thorough professional analysis techniques. For example, the matrix shown in Figure 4 indicates that if the design element is a line-haul bus mode, the noteworthy interactions include considerations in station type, transit line status, station size, automobile accessibility, and parking capacity.

The summary of station design characteristics in Figure 5 uses those design elements with strong interactions identified in Figure 4 and explores why there is a strong interaction using the keyword impact descriptors. For example, in Figure 4 a strong interaction is indicated between the bus mode and the design of a ground-level terminal. The keyword list in the catalog indicates that this results from a community's concern about aesthetics, air pollution, congestion, noise pollution, and safety. As Figure 5 indicates by the predominance of strong interaction, the major impact to be considered when this terminal is being designed is forecasting the passenger volumes. Secondary impacts shown by Figure 5 are accessibility, parking, and congestion.

Station Design Development

The synthesis of the results shown in the terminal and land use interaction matrix and the terminal

IMPACT DESCRIPTORS	PREDOMINANT MODE: BUS					STATION TYPE: SURFACE			OFF-SITE TERMINAL			STATION SIZE		AUTOMOBILE ACCESSIBILITY
	Surface	Station Size	Off-Site Terminal	Automobile Accessibility	Parking Capacity	Off-Site Terminal	Station Size	Joint Development	Station Size	Automobile Accessibility	Parking Capacity	Automobile Accessibility	Parking Capacity	Joint Development	Parking Capacity	Joint Development
Accessibility		●	●			●			●		●			●		
Aesthetics	●	●				●	●	●				●				
Air Pollution	●			●	●					●						
Citizen Participation																
Commercial Development																●
Congestion	●				●	●							●			●
Construction															●	
Crime		●			●			●								
Disadvantaged Mobility																
Economic Impacts								●						●		
Employment														●		
Energy																
Environmental Impacts																
Erosion					●		●									
Industrial Land Use																
Infrastructure																●
Institutional Land Use																
Joint Development							●									
Level of Service																
Modal Coordination						●										
Neighborhood Character																
Noise Pollution	●			●						●						
Operating Costs																
Parking			●	●				●	●	●						●
Passenger Volumes		●			●		●	●	●	●	●	●	●	●	●	●
Pedestrian Needs								●				●				
Population																
Property Value														●		
Residential Land Use																
Safety	●		●	●						●	●					
Social Impacts																
Speculation								●								●
Terminal Location								●						●		●
Travel Time										●						
User Characteristics															●	●
Value Capture																
Wildlife/Vegetation Impacts																
Zoning								●								

FIGURE 5 Summary of critical station design characteristics.

design interaction matrix provides a listing of the critical environmental and design factors. Once these factors have been identified, the catalog can be used to provide a starting point for tailoring the design to meet the local contingencies. In the previous example, results of the terminal and land use interaction matrix (Table 2) indicated that the sensitive environmental problems are safety, accessibility, congestion, noise pollution, and parking. These issues can be incorporated into the alternative design evaluation process and should be carefully considered during the selection of alternatives.

The terminal design interaction matrix (Figure 4) has identified via Figure 5 the most critical design factor, the volume of passengers using the facility, followed by parking accessibility and congestion. This information should alert the design team that a careful review of all the procedures used to estimate demand is warranted, as well as a review of all those station design elements that affect accessibility, parking, and reduction of congestion.

The final station design should show an attempt to provide a safe environment, possibly using grade separation for automobiles, pedestrians, and buses. Various types of designs to reduce noise pollution should be considered, and the final design should provide ample parking and maximum access and egress.

CONCLUSIONS

The focus of this paper is on increasing the professional's understanding of the complex terminal and land use interface issues. The problem components identified and defined are structured in a manner that can be expanded and adapted to varying circumstances, and the research strategy enables the generation of alternatives from which a suitable plan of action can be developed.

By use of the two matrices, relationships among the station design and location variables and neighborhood land use types are identified in terms of impact descriptors. Where important impacts exist, strategies for preventing or managing the issues involved can be developed in terms of either altering the station design variables and site location or promoting changes in neighboring land use so as to provide an acceptable environment.

The uniqueness of this methodology lies in its ability to provide a flexible technique that is responsive to particular location needs, alternatives, and constraints. This method is believed to be a substantial improvement over the use of predictive models for assessing the impact of transit stations on neighboring land uses.

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Abridgment

Designing for Passenger Information Needs in Subway Systems

ROBERT BECK

ABSTRACT

What methods subway riders use to maintain their bearings in relation to the city above, how successful those methods are, and what qualities of the subway environment assist or confound the rider's way-finding endeavors were investigated in this study. Three design issues emerged that had an effect on the rider's ability to find his way: architectural differentiation of subway stations; signage location, message content, and redundancy; and perceptual access, or the ability of subway riders to see through or out of a station to known landmarks for the purpose of orientation.

Information that facilitates efficient movement through transit facilities, whether provided by station architecture or by signs, is a crucial design factor affecting such issues as passenger security, convenience, and the desire to use transit. The information aspect of station design can also have a major impact on capital and operating costs.