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.

Yet the information needs of passengers in transit facilities may be incorrectly perceived by designers because of differences from other environments.

Research has shown that when finding their way through a city, people will define their location in relation to the city's various physical features. Among these may be landmarks such as tall buildings, major intersections where many vehicular and pedestrian routes converge, or neighborhoods having distinctive identifying qualities (1). However, the subway rider is cut off from such surface features and must seek other sources of locational information. In this study it was attempted to determine 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.

ROLE OF ARCHITECTURAL DESIGN

The location, configuration, and architectural design of stations are significant determinants of transit use because they are the access points or front door of the transit system. Clean, comfortable, attractive, and safe station facilities are naturally important, but the movement and orientation of passengers is a key design factor that may not receive adequate consideration.

It is unlikely that riders will be able to enjoy using a transit system and appreciate its architectural features if they cannot easily navigate through it. "A pedestrian who is confused by incoherent space is not receptive to supplementary aesthetic visual inputs. When the main concern is orientation, aesthetic input is relegated to a lower level of receptivity" (2). Further, "poor visual design statements are particularly undesirable in transportation terminal environments, where pedestrians are likely to be anxious to meet train or plane schedules, and thus are more easily confused and disoriented" (2).

Insufficient consideration of way-finding needs not only can make the transit rider uncomfortable, it can even be dangerous (3):

> The transit designer should facilitate the rapid, purposive movement of people through the station. Whenever the user must pause because he is confused, uncertain, or frustrated, he is a potential target for a criminal incident. The passenger needs control and predictability in the transit station. He should know, or be able to find out rapidly, what to do to accomplish each activity. If not, passengers will be confused, frustrated, and angry.

With a single large illuminated sign costing several thousand dollars and the need for a great many of these signs, system signing can be a costly burden to a transit agency. Further, as station architecture fails in its ability to provide directional information, more signage will be needed in order to compensate for that failure. When there is inadequate passenger information, added personnel may become necessary to fill the gap.

A basic function of public transportation is to provide rapid transit. Time spent lost, wandering around, and confused defeats this function.

STUDY OBJECTIVES

Through unobtrusive observation and behavior mapping of novice riders of the subway systems of the Metropolitan Atlanta Rapid Transit Authority (MARTA), the New York City Transit Authority (NYCTA), and the Washington Metropolitan Area Transit Authority (WMATA), definition of the qualities of the subway environment that are beneficial to the passenger's way-finding and orientation tasks was sought. Emphasis was placed on examining the potential of station architecture to inform and direct, as well as on studying the effectiveness of conventional signage and other information devices.

DESIGN ISSUES

During the course of the study, three design issues emerged that had an effect on the way-finding behavior of subway riders. Each of these issues arose out of the actual physical design, features, and layout of a subway station. However, it was often the rider's perception of the physical reality, accurate or not, that influenced way finding. These three issues were as follows:

1. Architectural differentiation: lack of an architectural statement consistently indicating the different and often opposite destinations served by passageways, stairs, platforms, and other choice points;
2. Desirable characteristics of signs:
    a. Directional association: the placement of directional information so that it is easily and obviously associated with the pathway choice that the user must make,
    b. Message content: the need for directional information to be in a form and terms that are easily understood and useful,
    c. Redundancy: the need for the same information to be presented several times along a route; and
3. Perceptual access: the ability of subway station users to see through or out of the station to known landmarks or points on the movement pathway for the purpose of judging their location, direction, and distance from their intended destination.

Architectural Differentiation

Many of the difficulties experienced by subjects in the study could be traced to the lack of an asymmetrical architectural statement distinguishing between directional choices. Symmetry of a building's plan has generally been considered advantageous to way finding by facilitating the cognitive representation of a setting (4). However, having an overall cognitive representation of a station is not enough for successful navigation of a subway system. It is also necessary to be able to distinguish between the directional function of the station's individual parts. The rider's goal is to locate the specific part of the station served by the train that will deliver him to his ultimate destination.

The basic problem caused by the symmetrical mirror-image design of most subway stations is that it fails to acknowledge and alert the rider to the different and usually opposite directional nature of a station's two longitudinal halves. The manner in which this upsets the rider's ability to orient himself may be related to whether those riders are repeat users of the specific station, or system in general, or if they are complete novices.

In the case of the former, the nature of the problem may be easier to define. If a consistent system of asymmetrical or other architectural cues exists in a subway system, it will alert riders to the need for a pathway choice and perhaps provide a basis for making that choice.

The effect that symmetry has on the true novice is less obvious. Because such riders are experiencing a system for the first time, they would have no recollection of system features or cues to draw on. Asymmetry in this case would simply alert riders that there are differences between destinations of different pathways. NYCTA and MARTA riders entering subway stations that are symmetrically laid out appear not to realize that stairways on opposite sides of the stations serve different directions, let alone which directions they serve, until they confront a sign or make an error. Station asymmetry or other forms of architectural differentiation could emphasize the axis dividing stairs and platforms serving different destinations.

### Desirable Characteristics of Signs

When station architecture fails in its ability to convey directional information, greater responsibility is placed on the signage system or other information aids that must compensate for the architectural failure. However, in many instances throughout the study, subjects sought assistance from signage and found no help or, worse, were misdirected due to the sign's location, its message, or the failure to provide further reinforcement through redundancy.

#### Directional Association

In some instances, a sign's effective meaning is a product not only of what its message says but also of where it is located. Several WMATA riders transferred to the wrong train platform by incorrectly assuming that the information on a sign referred to the escalator near which it was located whereas it actually was meant to direct riders to a distant escalator.

#### Message Content

Another obvious deficiency of signage is that its message may not be understood or be useful. Much of the signage encountered during the course of this study did not take into account the user's occasional tendency to not use all of the information presented in multiple-message signs (5).

The WMATA escalator sign also exemplified the importance of anticipating this transit user trait. The sign displayed route information followed by directional instructions in the same type face and letter size. The riders noted only the route information and disregarded the directional information, and so they proceeded up the wrong escalator.

#### Redundancy

It has been noted that because of the limitations of short-term memory and the ease with which recently acquired information can be forgotten, a certain amount of redundancy of information is necessary. This is especially true in anxiety-producing transportation environments (6). This need for redundancy was evident in all three systems because riders sought information to reassure themselves almost continuously during their trips.

The desire for such redundancy may be due to the sheer number of choice points compacted into even an average subway station. The simple trip from concourse to platform may involve knowing which stair to use, which platform side to wait by, which train to board on that side, and so on. The dynamic and crowded nature of the station along with the need to save time only make the situation more complicated.

### Perceptual Access

The value of perceptual access is that it allows users to orient themselves within a structure in relation to the outside environment and its known landmarks. A useful quality for buildings in general, perceptual access can be especially important for the user of a subway system. With both the stations and line segments effectively hidden from surface view, visual access to the outside from within may well be the only way to get an idea of how the system relates to the city above. However, use of perceptual access for the purpose of subway system navigation must be tempered with care that the relationship between the rider's current station location and the observed landmark are functionally accurate in terms of the train network.

MARTA riders entering a newly opened station through which they could see the downtown Atlanta skyline directly ahead had no trouble in choosing the correct train platform. Riders entering from a direction not providing a view of the skyline were far less successful in making their platform choice correctly.

## RECOMMENDED TRANSIT STATION DESIGN FEATURES

Based on the study results, the following is a list of design recommendations for subway stations that would facilitate passenger way finding.

### Station Architecture

1. Stations should be designed to architecturally differentiate and distinguish the areas of a station serving different directions. Although actual structural features may be difficult to work into the functional design, much can be done through the use of architectural finishes, most obviously the color coding of inbound and outbound platforms. Whatever the method of differentiation, it should be consistently applied along a line or entire system in order to offer riders a recognizable, consistent, and dependable cue.
2. Where possible, train platforms and trackways should be visible from the concourse level in order to alert riders to the station's multiroute and multidestination nature as well as to provide an understanding of total station organization.
3. Stations should be structurally opened up wherever possible in order to provide perceptual access to outside landmarks. If intended as a navigation aid, the view to the landmark should relate functionally to the direction of trains from the station to the landmark.

### Signage

1. Signs should be placed where they are clearly associated with their displayed destination information.
2. Signage information should be designed to discourage partial reading and resultant misinterpretation. This may involve a hierarchy of typefaces or letter sizes or both and an ordering of verbal information that will make the sign's message obviously incomplete unless the whole message is read.
3. Route and path information should be reinforced and restated both architecturally and by signs at every choice point along that route or path.

4. In systems serving cities with many known landmarks, verbal directional information can be reinforced and complemented by images of those landmarks, providing a link to the city above.

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# Assessment of a High-Reliability Ticket Vendor Developed by PATCO

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ABSTRACT

A description and evaluation are given of a high-reliability ticket vendor (HRTV) developed by the Port Authority Transit Corporation (PATCO) of Pennsylvania and New Jersey. The ticket vendors are part of the automatic fare collection system used by PATCO in its rail operations. The HRTV evaluation has shown it to be superior in reliability and comparable in maintainability compared with other ticket vendors.

The objective of this paper is to describe and evaluate a ticket vendor recently developed by the Port Authority Transit Corporation (PATCO) of Pennsylvania and New Jersey to enable managers of transportation properties to assess the applicability of PATCO's vendor to their fare collection needs.

PATCO is a relatively small transit system that provides rail service between downtown Philadelphia and suburban Lindenwold, New Jersey, a distance of 14 miles with a total of 13 stations from end to end, for about 40,000 passengers per weekday and about 11 million passengers per year. The system, which began operation in 1969, is characterized by automatic train operation in which each train has a crew of one person and by automatic fare collection (AFC) in which the stations are unattended for long periods during each day. Ticket sales are made directly to the patrons by vending machines monitored by closed-circuit television (CCTV) cameras; the turnstiles, which subtract rides from the tendered magnetically encoded tickets and capture exhausted tickets, are also monitored by CCTV. PATCO's experience has demonstrated that AFC is workable, but it was found that the station equipment had high failure rates, which resulted in patron inconvenience and high maintenance costs. Following acquisition of new turnstile gates and some modifications, the gates now provide excellent service. Over the years there have been several programs to upgrade reliability of ticket vendors, but these programs have not achieved their design goals.

In 1977 a decision was made to initiate an in-house design of a high-reliability ticket vendor (HRTV). This effort was supported by an UMTA research and development grant financed by Section 6 funds. A prototype HRTV was developed and installed at the Lindenwold station on May 9, 1982. A first look at the operation and performance of this new vendor is provided in this paper.

## HRTV DESCRIPTION

PATCO's HRTV, shown in Figure 1, is an exact-value ticket-dispensing vending machine (no change given) that can issue as many as three tickets of different values. It has been designed to accept large fares for issue of a single ticket and can accommodate any