Which Way is Up:
Towards Accessible Wayfinding in Transit Stations

by Dalia Leven

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Signature of Author...
Department of Civil and Environmental Engineering
February 28, 2006

Certified by ....
Kenneth E. Kruckemeyer
Research Associate, Department of Civil and Environmental Engineering
Thesis Supervisor

Certified by..
P. Christopher Zegras
Assistant Professor, Department of Urban Studies and Planning
Thesis Reader

Accepted by..
Professor Langley Keyes
Chair, MCP Committee
Department of Urban Studies and Planning

Accepted by ....
Andrew J Whittle
Professor of Civil and Environmental Engineering
Chairman, Departmental Committee for Graduate Students

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ABSTRACT
Passengers' most frequent interaction with a rail transit system is at its stations, which represent the beginning, the end and sometimes the middle of transit trips. The design of these stations can greatly affect a user's travel experience by creating friendly, efficient, attractive environments that are inherently *usable* as transit stations. Many types of devices are necessary in these stations to help people navigate from one point to another within a transit system. Wayfinding devices are the elements, whether architectural or graphic, that provide information not only on how to navigate a station, but also how to use the services provided there. Because they provide such important information, these elements must be accessible to all potential passengers.

This thesis used the structure of Systems Engineering to give a clear focus to the problem of design accessible wayfinding systems in transit stations. In order to create a comprehensive listing of design requirements for these systems, a detailed inventory of all potential user groups was developed. Following directly from this, a framework was developed that allows for easy cataloging of the design requirements for each of these groups. Three technical areas that are developed in this thesis cover all of the issues inherent in wayfinding design include content, deployment and formatting.

Case studies of both the MBTA and the CTA were analyzed for their ability to address the above requirements. In each of the cases several historical design guidelines were introduced and compared with the most recent set of design guidelines. The cases also looked in detail at the existing conditions and how they differ from both the official design guidelines and the accessibility recommendations developed in this thesis.

Three final products came from this work, including the detailed recommendations that were developed for each of the case studies. In addition, specific design requirements were compiled that can be used as a checklist for wayfinding designers at any transit agency. The framework that was used to create these requirements can be used to develop wayfinding design criteria in any type of complex environment.

Thesis Supervisor: Kenneth Kruckemeyer
Research Associate, Department of Civil and Environmental Engineering

Thesis Reader: P. Christopher Zegras
Assistant Professor, Department of Urban Studies and Planning

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List of Abbreviations

ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
ATSS	Active Transit Station Signage
CA	Customer Assistant
CTA	Chicago Transit Authority
DAT	Dementia of the Alzheimer's Type
DOT	Department of Transportation
GPS	Global Positioning System
LED	Light Emitting Diode
MBTA	Massachusetts Bay Transportation Authority
MMIK	Multi-Modal Traveler Information Kiosks
NCES	National Center for Education Statistics
PA	Public Address
RTA	Regional Transportation Authority
RTL	Rapid Transit Lines
TCRP	Transit Cooperative Research Program
WMATA	Washington Metro Area Transit Authority

1. INTRODUCTION

Many types of devices are used throughout the built environment to help people with the process of wayfinding, or "spatial problem solving[1]" that is necessary to navigate from one point to another in complex spaces. Wayfinding devices are the elements, whether architectural or graphic, that provide information not only on how to navigate a space, but also how to use the services provided there. In a transit system, they provide the basic "instructions" on how to use it and are crucial at the primary points of customer interface, the stations. These devices take many forms including maps, directional signs and landmarks and must be designed with a focus on the customer experience in order to foster an environment that is both friendly and efficient.

Together, a series of wayfinding devices should combine to form a coherent wayfinding *system* that easily allows users to navigate through complex buildings. The design of these systems is more than just the design of individual signs, but requires an understanding of architecture and human psychology. The focus of this thesis will be on combining all of the elements that are necessary in order to create high quality wayfinding systems. In order to do this, a new framework will be developed that allows designers to account for the myriad of requirements.

Public transportation systems represent the backbone of the world's largest and most vibrant cities and provide the key to their sustainable development. Unfortunately, these systems have been losing the competition with private automobiles for decades as more and more people choose driving as their preferred means of transportation. In recent years many city, state and regional governments have turned to strategies of "smart growth" and compact development that rely on alternative modes of transportation to accommodate expected population growth.

Public transportation agencies in the United States have gone to considerable lengths to improve the operations of their systems in recent decades. Despite significant improvements in service efficiency and management, transit ridership has continued to

[1] Arthur & Passini, 1992.

fall and agencies have continued to require financial support beyond farebox revenues. In order to attract potential riders to public transportation a new emphasis on the customer experience is necessary.

The quality of a passenger's transit experience is not based only on the operating characteristics of the transit network. One of the main benefits of the private automobile over mass transit has always been the comfort factor, and it is in this area that transit must improve if it hopes to lure riders away from their cars. Increasing comfort level in a mass transit system is a multi-faceted problem that requires significant work in many areas. A user's experience in the built environment is not defined solely by the activities in which they participate while there. There are many ways to improve the passenger experience in a transit system, both at stations and aboard vehicles.

Passengers' most frequent interaction with a rail transit system is at its stations, which represent the beginning, the end and sometimes the middle of transit trips. The design of these stations can greatly affect a user's travel experience by creating friendly, efficient, attractive environments that are inherently *usable* as transit stations. A great example of how environments can be designed along these lines are shopping malls throughout the United States, which are now designed as climate controlled paradises ideally suited for long shopping trips and not as stark utilitarian spaces. Owners of these types of private spaces have realized the benefits of providing a high-quality experience to their customers, and this potential must be transferred to public spaces where possible.

The ease of navigation through a complex environment significantly impacts the usability of that space. The architecture of many transit stations is confusing and unfriendly, because it was designed to accommodate the specific needs of train loadings and fare collection without consideration of the experience of the individual passenger. In reaction to this oversight, a wide range of navigational aides have been developed in order to overcome the often confusing architecture and design of many transit stations. The design of these elements is an important tool that transit agencies can leverage in order to improve the experience of their customers and make public transportation a more desirable travel option.

The creation of wayfinding systems has typically been the domain of graphic designers and the process often results in rather artistic products. More recently behavioral psychologists have begun to analyze human wayfinding performance and the related cognitive functions. Combining these two disciplines has created a more scientifically based solution to the problem of wayfinding design that can account for variations in wayfinding skill and performance. These methods have typically been applied to the design of indoor and outdoor public spaces including parks, roadways, universities and libraries.

Like most architectural elements, traditional wayfinding systems have been designed for users of "average" cognitive and physical abilities and possessing a basic set of wayfinding skills (Wilkoff, 1994). However many users are not able to make full use of the existing designs because they do not fit the profile of an "average" user. Users with visual impairments, limited proficiency in English or mobility impairments have different wayfinding requirements based on their individual skills and abilities. Modern wayfinding design must now account for all potential passengers of a transit system.

1.1 UNIVERSAL ACCESSIBILITY

Public transportation systems are by their very nature open to use by a broad spectrum of the public; therefore they must accommodate a wide variety of users. The original Americans with Disabilities Act (ADA) stated that more than 43 million Americans suffer from some form of disability, although some estimates place the number as high as 80 million. This represents 32% of the US population that live with disabilities that "interfere with their day-to-day functioning" (Null, 1996). Since the adoption of ADA in 1990, transit providers in the United States have been required to make their systems accessible for people with a wide range of physical and mental impairments. The passage of ADA reflects a new belief in American society that many of these impairments are only "disabilities" due to "environmental or attitudinal barriers, not [due to] the person with a physical or mental impairment." (Null, 1996) The removal of these environmental barriers through inclusive design is the primary goal of the design theory of Universal Accessibility.

Universally Accessible design seeks to create spaces that are usable "by all people to the greatest extent possible" (Null, 1996) without segregating them by their abilities or impairments. "The key to understanding universal design is awareness and sensitivity to the needs of *all* potential users; not just those who fit the definition of the "average" person." (Wilkoff, 1994) This requires that environments be designed so that all people, no matter their physical characteristics are able to fully enjoy them. In such a system, all paths are accessible for users confined to wheelchairs instead of designing a separate path for the mobility impaired. In many transit stations this design ideal is not attainable architecturally without significant rebuilding because of necessary level changes; however the theory can be applied to the design of wayfinding devices so as to provide the necessary information to all customers. Denying people accessible wayfinding is essentially denying them the access and mobility that they need in order to live fully functional lives in an urban society.

This mandate for accessible design has had a profound affect on the design and rehabilitation of transit stations. Universally Accessible design avoids the need for elements that are designed for specific user groups with needs that differ from the 'average' user. By incorporating the needs of all passengers into the general design guidelines, designers are able to avoid installing costly specialized elements for these groups. This type of design does not benefit only users with disabilities, but "can improve the functionality of a space for people without physical limitations as well." (Wilkoff, 1994)

Universal Accessibility and the ADA have drastically changed the specifications for wayfinding devices, specifically through ADA's Title II which deals exclusively with transportation facilities. By requiring that all stations be fully usable by people of all mobility levels, wayfinding information in transit systems must now be provided in multiple media, languages and locations. In reality, these requirements has often led to either the proliferation of user-specific wayfinding devices or the associated visual clutter or wayfinding systems that do not address the needs of many users.

1.2 METHODOLOGY

Design of the built environment is based on the physical needs and characteristics of its users. Wilkoff represents the design process as a cycle where user needs, the environment and the designer interact to create the best possible space, as shown in Figure 1-1. In this model, the characteristics of building users determine the design of the environment through the designer. This holds true for wayfinding design as well, as a usable system can only be created by considering the needs of wayfinders. Universal Accessibility also highlights the importance of the user to the design wayfinding system, but does not always yield the optimal solution. By starting with the users, we will be able to create a design framework that will result in a wayfinding system that meets the goals of Universally Accessible Design.

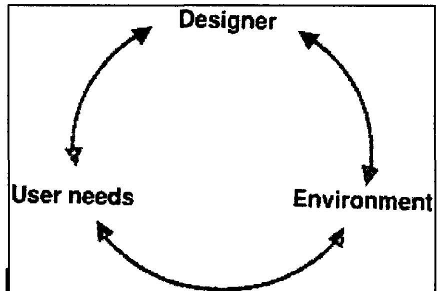

Figure 1-1: The interaction between designers, users and the environment. (Wilkoff)

While the traditional design methods for wayfinding design may still be appropriate on the level of individual devices, these processes do not account for the full range of users in order to create a comprehensive and unified system. Fortunately, universally accessible wayfinding design does not require the development of an entirely new framework, as it can be easily structured as a problem in Systems Engineering. While initially developed for use in computer software applications, the framework can readily be applied to wayfinding design without significant alterations.

> Systems engineering is the process of defining, developing and integrating quality systems. Examples of systems are a car, a stereo, the metro, and [a] University. Whereas other engineering disciplines concentrate on individual aspects of a system (electronics, ergonomics, software, etc.), systems engineers focus on the system as a whole. Systems engineers work with stakeholders to define what the system must do and how well it must do it, analyze cost and performance, and manage the development of the system. (George Mason University, 1997)[2]

Not only can this definition be applied to the design of a wayfinding system, it broadens the projects' scope to formally include a wider range of system design concerns.

[2] http://www.gmu.edu/departments/seor/insert/story2/storyold.htm

Wayfinding design fits into this structure because it can be broken down into a series of subsystems that must be designed, but which cannot be taken out of the context of the whole system. Each individual wayfinding element (a sign, for example) must be designed by a graphic designer, however the design of that element must consider not only the design of all the other signs in the system, but the architecture of the building and the services offered at a given station. Using the framework of Systems Engineering also allows us to work through the design of our wayfinding system as a structured series of steps.

Most texts dealing with systems engineering focus on its applications in software engineering, however all include a framework of inter-related steps that result in a cost-efficient and functional solution. This structure is applicable to the problem of wayfinding system design. The first step in the sequence is to clearly define the problem that must be solved. The second necessary step in Systems Engineering is requirements gathering, which is based on the problem statement. "System requirements describe…the full characteristics of the…system, from initial design to operations and support." (Eisner, 1997) These detailed requirements are used in the third step to design the individual elements that make up a wayfinding system. After design, the fourth step is implementation of the system which requires that the wayfinding system be installed, allows for some performance analysis of the system. Analyzing the success of the system provides an opportunity for feedback that can be used to redesign elements as necessary. The final applicable step in the Systems Engineering framework is to plan for the future life of the system, which can include elements like life-cycle costing, monitoring and maintenance.

Applying these steps to the task of wayfinding design is fairly straightforward and begins with a formulation of the problem statement. Luckily, the problem statement has already been formulated in general form by the theory of Universal Accessible design which sets as a goal the design of wayfinding systems that are accessible by all potential passengers. This design theory was discussed in detail in Section 1.1, and outlines the goal of this thesis which is to create wayfinding systems for transit stations that are usable by all potential passengers. The problem has been further studied in an extensive literature on wayfinding, which will be discussed in Chapter 2.

The second step in the Systems Engineering is requirements gathering, which determines the design criteria that will be used for the rest of the process. It is this step that will be the focus of this thesis. Cataloging a comprehensive set of requirements is a substantial task that requires a detailed analysis of the process of wayfinding. This thesis will analyze wayfinding systems in transit systems and present the system requirements in a form that can be utilized by any transit agency looking to redesign and improve their wayfinding system. This work will not deal in detail with the remaining steps in the Systems Engineering process and leaves them for future researchers.

1.3 THESIS OUTLINE

In order to develop a comprehensive list of the design requirements for a wayfinding system as required by our Systems Engineering framework, a detailed study of wayfinding processes and devices is necessary. The first part of this study will provide the background knowledge that is necessary for readers to understand the wayfinding problem. Chapter 2 will define the physical and cognitive processes involved in wayfinding. It will look at how people understand space and navigate complex environments and which skills are utilized during the process. Also included will be a discussion of the common tools that are available to help passengers solve wayfinding problems in transit stations.

In Chapter 3 we will begin to catalog the wayfinding requirements of transit passengers. Utilizing the wayfinding processes already investigated, a complete set of user requirements will be developed for all potential customer groups as specified by both ADA and social equity. The first step in this process is to define the audience for this type of wayfinding system and the characteristics of these users. Since there is no one set of characteristics that can accurately define all possible users, multiple categories of passengers will be created. A full set of wayfinding requirements will be cataloged for each of these user groups. From this analysis a comprehensive survey of the goals of wayfinding systems designed for transit stations will be compiled.

The next stage of research will compare real world transit systems with these system requirements to determine the success of different transit agencies in accounting for the full spectrum of customers. Case studies of the MBTA and the CTA will be presented in Chapters 4 and 5, respectively. In each of the cases, several historical design guidelines will be introduced and analyzed for their ability to address the Universal Accessibility requirements set out in Chapter 3. The frequency of guideline updates and their contents will help to gauge the level of institutional attention and priority given to wayfinding within a transit agency. This analysis will also look closely at the design standards and guidelines that currently govern wayfinding in each of these systems. Second, the existing wayfinding conditions throughout each of these systems will be analyzed in comparison to both the requirements developed in this thesis and to the design guidelines that were developed by the individual agencies. This will help us to understand the implementation process and the level of resources that a transit authority has been able or willing to devote to wayfinding in their stations.

Chapter 6 of this thesis will utilize the previously completed analysis to develop a set of recommendations that can be used by the CTA, the MBTA and other transit agencies. Generalized recommendations for wayfinding systems in transit systems will be developed based on the accessibility requirements of various user groups and will provide a framework for the implementation of Universal Accessibility principles in these scenarios. Aggregating these individual group requirements will provide a checklist of system design requirements that will allow agencies to serve the full population of transit customers in any urban area. These recommendations will build on the existing design standards and on-the-ground conditions in the case study systems and will attempt to improve both the quality and accessibility of wayfinding in transit systems.

This thesis results in several products which will be usable for transit agencies seeking to improve their wayfinding systems. The first result is a detailed catalog of potential user groups and their defining characteristics. Second, a framework is developed that allows designers to account for the requirements of all of these user groups. This framework divides wayfinding system design into three separate but inter-related technical areas. An application of this framework is illustrated by outlining the design requirements for a wayfinding system in a transit station. This analysis and the lessons learned from the two case studies are combined to provide a specific set of design requirements that can be used by wayfinding designers at any transit agency. While the specific recommendations will be useful only for transit agencies, the framework developed in this thesis can be used to develop wayfinding requirements for any type of indoor environment.

2. WAYFINDING IN THE BUILT ENVIRONMENT

This chapter provides the background information that is necessary for the development of a comprehensive wayfinding system. It will begin by defining wayfinding and its importance in the built environment. A search of the available literature on the subject results in two complementary definitions of wayfinding: as both a cognitive process and as a set of physical elements. The cognitive processes involved in solving wayfinding tasks are discussed in detail in section two using literature from psychology and the social sciences. Section three's detailed study of the physical elements used during the wayfinding process is based primarily on literature from the fields of architecture and graphic design and introduces many of the common solutions to the problem of wayfinding. This comprehensive look at wayfinding in the built environment will serve as the basis for the detailed design criteria and implementation recommendations developed in the following chapters.

2.1 INTRODUCTION TO WAYFINDING

This section provides a basic introduction to the concept of wayfinding. A working vocabulary will be provided for those readers with no background in environmental psychology or graphic design. This will provide the necessary fluency in the problems and issues of wayfinding design in addition to the basic motivation for this research. Two basic definitions of wayfinding will be presented here that will help us to understand the needs of wayfinders and the tools available to designers to meet those needs. We will then look briefly into why wayfinding should be an important concern for designers of the built environment in general, and transit stations in specific.

2.1.1 What is Wayfinding?

Whether in the built or natural environment, wayfinding is a constant part of our spatial experience. It is the process of navigating a route between two points and occurs within, and therefore is directly tied to the physical environment. Our understanding of the wayfinding process is limited to our observations of human interaction with these physical elements and past research has focused heavily on measuring these interactions through quantifiable measures of wayfinding performance. While significant research has been done on the psychological aspects of wayfinding, increasingly the focus is to determine the actual interactions between psychology and architectural design.

Two definitions of wayfinding are essential to cover the full scope of the problem. The first defines the process of wayfinding as a series of tasks performed within the built environment. The second definition deals with the physical elements that provide access to information about the environment. By accounting for the underlying processes used in wayfinding tasks designers can ensure that the physical environment is conducive to efficient navigation.

Wayfinding as a Process

The definition of wayfinding as "a natural skill that people learn as small children and develop as they grow" provides the basis for our understanding of wayfinding as a mental process (Raubal & Engenhofer, 1998). Wayfinding consists of a series of complex cognitive techniques that determine the structure of people's interactions with their environment. Under this framework Arthur and Passini define wayfinding as a method of "spatial problem solving" consisting of three separate but interdependent processes; decision making, decision executing and information processing (1992). These three stages of wayfinding provide a clear structure for the formulation of research questions, although the bulk of recent studies have focused on the last of the three steps. Information processing involves the most interaction between the physical and the psychological, therefore providing insight into how spatial information differs from other types of sensory inputs.

Wayfinding as Physical Elements

Kevin Lynch defined 'way-finding devices' as the elements that people use to find their way. Wayfinding tools, devices and accessories are the physical elements within the environment upon which people base their spatial decisions and can include everything from individual house numbers to complete city maps. In *The Image of the City* (1960) Lynch integrates these devices with his five elements of the city (paths, edges, nodes, landmarks and districts) to explain how people view and make use of the built environment. Lynch's study relied on the use of physical wayfinding clues to define his city elements and to learn how wayfinders mentally structure these clues.

Traditionally the design of wayfinding systems includes a collection of physical elements and a strategy for deployment within the environment. Many types of wayfinding devices have been studied by designers in various fields, including cartography and graphic design; however these disciplines traditionally have focused on design optimization and not the psychological foundations of sign and map usage. Wayfinding systems should be a key element of architectural design, as they directly affect the usability of a building or urban area. The creation a comprehensive wayfinding system includes the design and deployment of not only signs, but all necessary maps, directories and information personnel. In addition, it is necessary to develop a plan for maintenance and upkeep of the system as changes will inevitably become necessary in any urban context.

Current research by urban designers and architects is intent on determining the relationship between form and the human experience with it. Attempts to quantify the physical elements that affect human interaction of space have resulted in a methodology called Space Syntax. This highly controversial theory has implications for wayfinding design as it places special emphasis on the importance of sightlines in circulation and navigation patterns of users of the built environment (SpaceSyntax.com). The resulting studies have provided some limited insight into the effects of architecture and urban form on human behavior and wayfinding processes; however the methods remain controversial with engineers and designers who believe that too much reliance is placed on a quantitative link between specific design elements and human behavior. Further, the emphasis place on sight does not account for those passengers with visual impairments, negating the ideal of accessibility that is the goal of this thesis.

2.1.2 Why is Wayfinding Important?

"Wayfinding design has a major impact on all users of the built environment...[as] it affects their emotional state, including their feelings about the setting and its tenants." (Arthur & Passini, 1992) As an essential aspect of architectural programming, wayfinding design is often given short shrift in the design of public spaces in favor of more conventional or even artistic aspects of design. Neglecting wayfinding as a key aspect of architectural design has left many spaces without a necessary aspect of functionality. Several persuasive arguments have been presented in the literature in order to explain the importance of wayfinding as both a design element and a psychological process. These explanations for the need for wayfinding in public spaces will be introduced below.

Fruin's authoritative research on pedestrian activity in public spaces indicates that the main goal of pedestrians is typically to get to their destination. "If the visual elements that define the space convey purpose and orientation to the pedestrian, then a wider range of receptivity to other visual inputs is possible." (Fruin, 1971) Without clear wayfinding, pedestrians must focus most of the mental capacity on reaching their chosen destination and will be unable to observe any other characteristics about their environment, including any artistic efforts.

Efficiency of daily pedestrian flows through a space can be increased by designing spaces with simple layouts and clearly marked paths and spaces. Studies of the daily activities of institutional staff (at hospitals, universities, etc.) indicate a high percentage of staff time devoted to assisting others with navigation illustrating the relationship between the design and operation of a space. (Peponis et al, 1990) Efficiency and pedestrian interactions are important in the design of a wide range of spaces including hospitals, offices, museums and retail centers in which spatial design has become an increasingly important field.

During emergency situations, wayfinding can have a direct effect on public safety. People are more comfortable using well-marked exit paths with which they are already familiar. (Arthur & Passini, 1992) Familiarity with an emergency path is key, as one study found that only "8% of people fleeing fires reported relying on signage to find their way to exits." (O'Neill, 1991) Clear demarcation of exit paths allows for faster egress during these situations.

Transportation facilities do not resemble any other type of space and present extreme wayfinding challenges to architects and designers. Their design and construction is usually the responsibility of a public transportation authority which must frequently overcome severe budgetary constraints and may not focus on seemingly peripheral design considerations, including wayfinding. A transit station is by its very nature a transitory space, seldom serving any purpose other than the safe, efficient loading and unloading of transit vehicles. It is therefore essential that passengers be able to find their way in, out and through a station as quickly and efficiently as possible. Further, no transit trip can occur without using multiple stations. Because the stations are part of a larger system of transit service, some level of coordination between stations is necessary to create a sense of continuity throughout for passengers.

Stations that serve rapid rail transit systems face an additional challenge that is rarely encountered by designers of other types of public space. Grade separation of these services frequently causes their stations to be either underground or elevated and open to the outdoors. "In the subway, shadows and artificial light, confusing signage, uncertain location of exits, indirect routes, and points that create friction in the flow of people can make navigating the station difficult and prevent passengers from grasping the directions above ground." (Shuffield, 2004) Unpleasant psychological conditions for users are notorious in underground situations making wayfinding an even more important element of station design. Open-air elevated or at grade stations are also difficult to navigate because of the wide range of sensory inputs (sounds, weather, light, etc.) that are cannot be controlled by the wayfinding designer.

2.2 SPATIAL COGNITION

This section will deal with the methods that the human brain has developed to comprehend and effectively utilize spatial information. Essentially, these can be separated into three related but distinguishable processes; perception, storage and application of spatial information (Arthur & Passini, 1992). Spatial perception incorporates all the means of visualizing and learning about the environment. This information must then be stored and recalled in the second process which is typically known as Cognitive Mapping. The final process requires the application of spatial knowledge in order to make wayfinding decisions in actual time. These sequential processes allow for an organized study of the cognitive and physical needs of wayfinders in the built environment. These three processes will be introduced in further detail in the following sections and will be used as the basis for the wayfinding design recommendations that will be presented in later chapters.

2.2.1 Human Perception of Space

Spatial perception is an essential part of the wayfinding process, and is how information about the environment is gathered and collected. Sight is the primary means of observation of spatial information for most wayfinders. Arthur and Passini indicate that the process of spatial perception differs from other visual methods of obtaining information, like reading. They observe a pattern of "scanning and glancing" that allows wayfinders to scan the whole environment and focus only on the information that is important to them. Scanning is a type of "pre-attentive perception" that identifies important objects in the surrounding area. Only these important environmental elements are focused upon for a short time in a 'glance' during which the content is read and stored. (Arthur & Passini, 1992)

It is important to note that there is a limit to what information can be gleaned simply from stationary visual observation. Complex environments "cannot be perceived from a single viewpoint therefore people have to navigate through large-scale spaces to experience them." (Raubal & Winter, 2002) Moving through a space is the most powerful tool available for spatial learning because it includes the use of all of the senses and provides a clear understanding of the structure of complex places. This type of spatial learning is available to all users of a building, including those with visual impairments that may prohibit traditional visual perception.

The importance of visual perception in wayfinding creates special challenges for users with visual impairments. Building users with visual impairments must use their other senses in order to obtain spatial information. Alternatives to sight including sound, touch and smell become the primary sources for spatial learning and are often highly developed in blind users. Wayfinding therefore cannot be thought of as a purely visual process and other types of sensory inputs must also be employed to convey the necessary information.

It is also possible to gain spatial knowledge through the use of graphic devices, such as maps. Maps provide structural information at a larger scale than can be obtained from a first-person perspective by utilizing illustrations and graphic representations that include the overall plans of buildings or urban areas. 'Reading' a map uses different processes than either the reading of text or the scanning and glancing process utilized when experiencing the environment directly. There is no systematic pattern for map reading analogous to reading from left to right and top to bottom. The overall structure of a space and individual items of immediate importance to the individual wayfinder are usually the foci of attention in map reading, and may be perceived in any order. (Arthur & Passini, 1992)

The theory behind tactile maps is very different from traditional graphic representations. In a visual map, the user is able to see the overall structure and then to select the relevant and important information quickly from a dense display of information. Tactile maps present spatial information "in a sequential fashion, where each scalar view is digested from the general to the specific." (Landau, 1999) A series of tactile maps is necessary to convey first the general geographic overview followed by connections between points, services provided at each destination and the names corresponding to them. A visually impaired person can gain an understanding of even complex spatial relationships through careful study of such a system of tactile maps. These devices would be especially useful in transit systems to help blind passengers understand the structure of the network and of complex stations. Some tests have been conducted with these devices; however they have not yet been deployed on a wide scale by any US transit agency.

2.2.2 Cognitive Mapping

Cognitive Mapping was introduced to describe the processes of storing and processing environmental information. (Lynch, 1960) This work was based on a set of unique images of the built environment that were produced in the minds of individual people. These images were based on the experiences and perceptions of individuals as collections of urban elements. Lynch introduces five elements (district, edge, node, path and landmark) that constitute the building blocks of cognitive maps and can be used to collectively represent even complex environments in a tractable format that can be stored, recalled and updated as necessary.

Cognitive maps are created primarily through interaction with the environment; therefore every person will have a different image of the same environment based on their personal experiences. Because of their personalized origin, these maps often will only slightly resemble the actual environment or traditional cartographic maps. Cognitive mapping occurs from a first-person perspective and can therefore result in significant distortions of space. Directions and distances within these images are often warped and inconsistent. Some areas of the map will be more detailed than others while connections between areas may be fuzzy.

A cognitive map represents only how one specific person views an environment and spatial relationships within it. Elements and connections that are not utilized by an individual are often omitted and a hand drawn cognitive map will often bear little resemblance to the actual geography. Different elements are likely to be included as references by different people based on individual experiences; however it is common for some very important elements to be included in all cognitive maps. These important elements are typically used as reference points by people as they navigate a space. Lynch compared the cognitive maps of test subjects in several urban areas and found striking similarities from people who were familiar with the area. Similarity between a map and reality often increases with knowledge, comfort and use of a space.

2.2.3 Methods of Wayfinding

The third process in the sequence of spatial cognition is the application of spatial knowledge to real-world wayfinding tasks. Once information has been gathered and processed it must then be accessed and used in order to locate the desired destination. There are multiple strategies that can be employed by wayfinders performing indoor wayfinding tasks. Lawton introduces the three primary strategies discovered using a series of human tests that investigate the characteristics of wayfinders and their strategies. Representing the full range of wayfinding tools available, the three major strategies are called orientational, informational and layout-reliant. (Lawton, 1996) Each of these strategies has strengths and weaknesses that make them more or less suitable for specific tasks; however, all are commonly used by people during indoor wayfinding in large-scale buildings. Individuals may use elements of multiple strategies based on the situation and their level familiarity with the space. Each of these strategies will be introduced below.

Orientational Wayfinding

Orientational wayfinders use reference points to determine their position within an environment. (Lynch, 1960) These wayfinders make direct use of the elements in their cognitive map to determine their location by utilizing landmarks in two different ways. Many people use major landmarks to determine their location within a space. These wayfinders determine their position (direction and distance) relative to known reference points that allow them to triangulate their position within the environment. The second application of landmark references is the creation of routes within a building from a series of landmarks. The routes will be composed of a series of (often very small) landmarks that represent the path between two specific points. Wayfinders can use their remembered routes to navigate between locations and to determine their position with reference to these paths.

This type of wayfinding strategy can be illustrated by using a common example. The "Infinite Corridor" at MIT is the central spine of the school's circulation system and is used by many students as a landmark. When searching for an unknown building on campus, many students will find how to access their desired destination from their reference point of the Infinite Corridor. Obviously, some familiarity with the environment and knowledge of landmarks are necessary in order to employ this strategy effectively. Therefore it can not be easily used by newcomers to a particular space.

Instead of using physical landmarks, many wayfinders orient themselves according to the four cardinal directions. These wayfinders are able to maintain knowledge of which way is North, and are thereby able to ascertain in which direction they are facing. This strategy can also be used inside a space without knowledge of the cardinal directions, where wayfinders keep track of where they are with respect to their origin. This method allows people to create a cognitive map based on their travels through a space (Passini & Proulx, 1988).

In analyzing the usefulness of this wayfinding strategy we must remember that cognitive maps are often severely distorted, inaccurate representations of reality. Seemingly important elements may be omitted, directions may be skewed and distances may be warped. However, to make effective use of these mental images it is the connections between spaces that need to be accurate, not the individual elements themselves. The density of accurate connections that are represented in a cognitive map will determine how well that map can be used to navigate through an environment.

Information-Reliant Wayfinding

Information-reliant wayfinders rely solely on the information provided within the environment in order to make spatial decisions. Decisions are made on a case-by-case basis, dependent on the information available at each decision point. With no prior knowledge of their environment, wayfinders will use the information provided for them to reach their desired destination. These wayfinders are very sensitive to the design and deployment of wayfinding accessories, as missing or incorrect information can cause them to become lost or disoriented.

A very common example of this wayfinding strategy would be a traveler landing at a new airport and following the signs to the baggage claim area. This strategy is most appropriate for use in situations when the user possesses no prior knowledge of the space. Signage and other wayfinding devices are necessary for these wayfinders, and they may have no cognitive map of their surroundings.

Layout-Reliant Wayfinding

The final common indoor wayfinding strategy relies on architectural clues to aide in wayfinding tasks. This strategy utilizes the layout of a building to determine the location of the desired destination. Architectural clues lead to an understanding of the structure of the environment for wayfinders using this strategy. The activities that are ongoing within specific spaces also are important clues that can be used to convey information about the location of certain types of destinations.

This strategy can be used in familiar or unfamiliar buildings alike, and utilizes previous experiences in the built environment to help understand the wayfinding task at hand. For example, wayfinders in an unfamiliar subway station can use natural light to point them towards the exit. The clustering of similar or related uses can also structure the decision making process in an understandable manner. One 1990 study investigated architectural wayfinding and found that "the presence of other people" was one of the cues followed by subjects in navigation. (Peponis et al, 1990)

2.2.4 Individual Wayfinding Differences

Some research in recent years has been devoted to determining what physical and socio-economic factors effect wayfinding performance. Lawton found some evidence of gender bias in the selection of wayfinding strategies, but not in performance (1996). Specifically, men are more likely to utilize a strategy based on general orientation in both indoor and outdoor scenarios, while women are more inclined to utilize strategies based on route-structures and landmarks. While these gender differences are relatively small, the main gender split occurs over spatial anxiety, with women being significantly more uncomfortable performing wayfinding tasks in unfamiliar environments[3]. This anxiety, when severe, can cause wayfinding performance to drop by inducing a type of situational cognitive impairment (Arthur & Passini, 1992).

In a study of blind wayfinders, Passini et al discovered that age and education have more of an effect on wayfinding performance (as measured by accuracy, not time) than even the ability to see (1990). These characteristics accounted for more than 15% of the variation in wayfinding performance and accuracy. Older people and those with lower levels of education have significantly poorer performance during wayfinding[4]. Gender was found to be completely insignificant in determining the number of errors made by test subjects performing controlled wayfinding tasks.

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[3] I was, however, able to find nothing proved or disproved the theory that men never stop and ask for directions. But based on personal experience, I am inclined to believe it.

[4] The study included no wayfinders over the age of 65 to avoid other possible impairments, but still found that age was a determining factor in wayfinding performance.

2.3 WAYFINDING ELEMENTS

The problem of wayfinding was detailed in the previous section; this section will the most common solutions to this problem which take the form of physical elements that are used during the wayfinding processes. The elements can be divided into two categories: architectural elements and wayfinding devices. The first category is composed of various types of traditional architectural design elements that have an effect on wayfinding behavior. "Wayfinding devices" typically refers to accessories in the built environment whose sole purpose is to provide wayfinding information. This includes all of the signs, maps and other graphic devices which are extremely important for navigation through unfamiliar environments.

2.3.1 Architecture

Architecture provides the background in which all indoor wayfinding activities are performed. Basic architectural design can have a profound impact on a building's navigability. The overall structure and programming of a building is often the biggest clue for wayfinding through a complex environment.

Arthur and Passini advise that buildings should ideally be structured hierarchically so that they better match the decision making steps that make up the wayfinding process. By grouping similar uses together, decisions can be made sequentially from the general to the specific. This allows the wayfinder to make decisions hierarchically; as they arrive at each decision point they can use the information available to make successively more detailed choices. This natural decision process does not require that wayfinders retain the whole route in memory, or even to know the detailed location of their destination. When symmetry is implemented as a part of floor plan design, wayfinders can gain information about a building's structure without having to explore the entire thing. Symmetrical layouts and graphics are also easier to commit to memory (Passini et al, 1990).

Another important architectural element that affects wayfinding is the level of visibility within a building. A building with high visibility allows wayfinders to see more of the connections and paths between spaces, allowing for increased directional awareness. In order to efficiently navigate through a building, wayfinders "must become orientated by the visual perception of the next goal or destination through a direct sight line." (Braaksma &Cook, 1980) Simply put, when people are able to see where they are going and where they came from, they are better able to understand the overall structure of the building. The visibility of a space is usually measured by the number of direct sightlines that connect it with other important points. Indirect sightlines, where two points are visually connected through the use of an intermediate sign, can also be incorporated into the measure of visibility. (Dada & Wirasinghe, 1999) The importance of visibility increases in multi-level spaces because level changes are often opaque, making it difficult for wayfinders to relate one floor to the next (Berkeley, 2004).

The wayfinding applications of Space Syntax theory focus on the correlations of architectural and urban design on wayfinding behavior. One such study was conducted in a hospital and investigated architectural configuration as it relates to wayfinding to determine how "variations in the environment itself influence the cue selection and the storage of environmental information." (Peponis et al, 1990) This study suggests that wayfinding requires an abstract understanding of the pattern of a building in order accurately perform navigational and orientational tasks. Further, it is implied that spaces with high visibility attract people because wayfinders are able to gain more useful structural information about a building from these locations. The structure of a space and the floor plan layout can greatly affect wayfinding performance. Walking speed while navigating and the number of navigational errors were both shown to improve based on "the quantity of and complexity of relations between choice points such as hallway intersections in buildings." (O'Neill, 1991)

Small-scale architectural design decisions also affect how people interact with a building. Of major importance for wayfinding purposes is the articulation of entrances and exits which determines their visibility within the building. A well designed exit will be visible from a distance and easily distinguishable from storefronts, restrooms or other elements. (Bednar, 1989) Design characteristics can also help newcomers to a building understand the purpose of specific elements; small, unlabeled doors are more likely to be for "authorized personnel only" than a large, highly articulated door.

There is one additional architectural element that is an essential wayfinding tool in both indoor and outdoor environments: light. Indoors, the appearance of natural light can be an important clue that alerts wayfinders to the physical boundaries and orientation of their environment. Light features have a particularly strong impact in underground situations, where natural light can help to direct people towards the surface or an exit (Berkeley, 2004).

2.3.2 Wayfinding Devices

Wayfinding tools, accessories or devices are physical elements whose sole purpose is to aide in the wayfinding process. Generally, these elements include signs, maps, oral or written directions and any other graphic spatial information. These elements are often employed in situations where destinations are remote and not visually accessible. In these situations, the architecture and other design elements do not provide sufficient explanation of the building's spatial structure to the user. Transit stations typically use many different types of wayfinding accessories in order to make their complex systems transparent for the average user.

In order to grapple with the amount and types of wayfinding devices found in the built environment, it is helpful to create clear categories that facilitate discussion of these elements. This section has divided wayfinding devices into four functional categories that provide the information necessary to make and execute all types of wayfinding decisions. Informational and orientational tools give users information about the building and their location in it in order to make a decision about where to go. Identification and directional tools allow the user to accurately execute those wayfinding choices in real-time. Designers must understand the different functions of these devices in order to create a system that provides all of the necessary information at the necessary junctions. Each of these categories will be introduced below with appropriate real-world examples.

Information

Informational devices provide information about any services that are available at the location. These devices give building users the information needed to accurately select their destination. They also provide behavioral instructions such as safety warnings and emergency evacuation procedures. Some examples include:

- Hours of operation on store window
- Bus schedules
- Applicable safety regulations

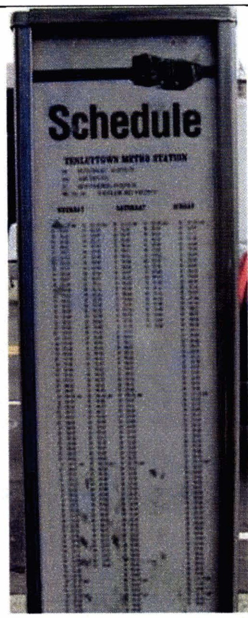

Figure 2-1: WMATA Bus Schedule

Figure 2-2: Business hours, storefront sign

Figure 2-3: Behavioral instructions in an area that does not allow smoking.

Orientational

Orientational accessories provide the spatial information necessary to construct and use a cognitive map. These devices explain the structure and layout of a building. Orientational elements can serve as reference points within the building, providing a structural backbone from which users can base their wayfinding decisions. They can also give cardinal directions, floor numbers or wing names in very large buildings. In addition to providing large-scale structural information, devices in this category will tell wayfinders where in that structure they are located and which direction they are facing.

Orientational reference points can be highly individualized, as discussed in section 2.2.2 on the construction of cognitive maps. They help geographically structure spaces and the paths between activity centers. "Many different things at many different scales could function as landmark references" as long as they are easily distinguishable for the user. (Peponis et al, 1990) Any memorable and distinctive part of the environment can legitimately used as an orientational reference point. Orientational accessories therefore represent a wide range of elements including:

- Compass Rose
- The Washington Monument for tourists in DC
- Shopping Mall map
- Rail system map

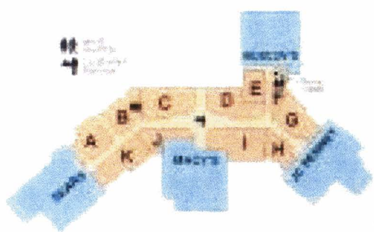

Figure 2-4: Ocean County Mall Map

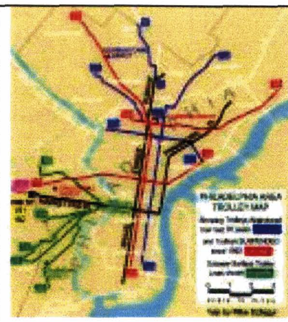

Figure 2-5: SEPTA light rail map

Figure 2-6: The Eiffel Tower can be used as a reference point in Paris

Directional

These are the most common type of wayfinding device, and they provide point to point directions for wayfinders. These devices are essential in order for people execute wayfinding decisions. Directional signage is used to guide wayfinders along a route towards a specific destination. Most often these devices will take the form of signs with directional arrows but can include any device that gives advice on how to reach a particular destination. Examples include:

- Written step-by-step directions
- Airport signs providing directions to baggage claim
- Library signs showing how to find specific call numbers

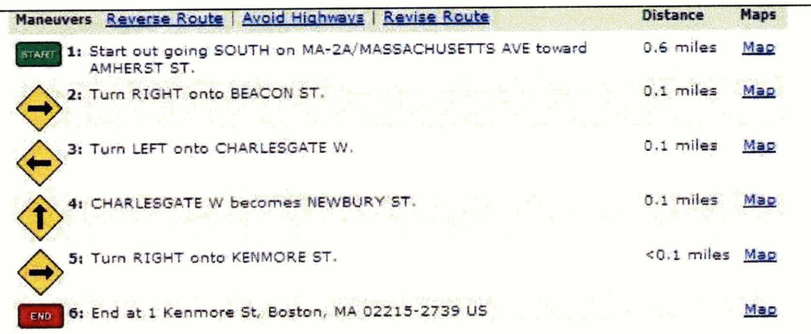

Figure 2-7: Turn-by-turn directions from Mapquest

Figure 2-8: CTA signage

Identification

Identification devices are essential for the final step of the wayfinders' decision making process. They are used to identify locations, so that building users are able to know when they have reached their final destination. Therefore all possible destinations at all scales must be labeled, from entire buildings to smaller destination zones. Some examples are given below:

- The street address on a home
- Transit station name
- Store name

Figure 2-9: route clues at the National Zoo identify the animal destination

Figure 2-10: CTA Station Identifier

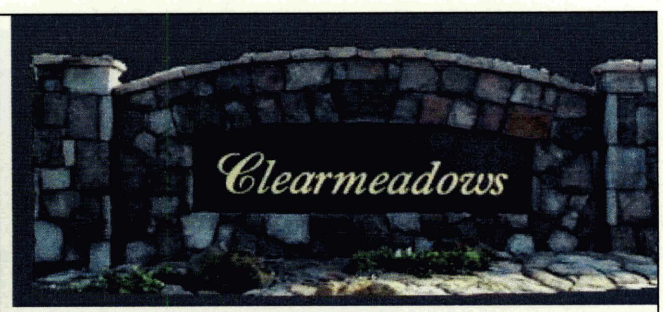

Figure 2-11: Subdivision Neighborhood Identifier

Figure 2-12: CTA platform signage

All of the information necessary to understand the wayfinding process and to design effective wayfinding systems has been presented in this chapter. Wayfinding has been defined wayfinding as both a process and as a set of physical elements. The existing research on the wayfinding performance was presented in order to provide an understanding of how people interact with their environment. The physical elements that are used to perform wayfinding tasks were also introduced. The four functional categories of wayfinding devices contain all of the information necessary in a transit station. This definition of the problem of wayfinding was comprehensively defined through this background information, which is necessary in order to create practical design guidelines for a comprehensive wayfinding system. All of this information will be applied in the next chapter with a detailed set of design recommendations that accommodates the full spectrum of potential passengers.

3. WAYFINDERS: CUSTOMERS AND THEIR NEEDS

The development of complex systems is often done through the process of Systems Engineering. After a problem has been well defined, the net step in this process is the development of a requirements document that catalogs the technical requirements of the system to be designed. The problem of wayfinding design was defined by the literature review in Chapter 2. This chapter gathers the system requirements by focusing on the three major technical areas of wayfinding system design: content, format and deployment. This chapter will look at the full range of potential users of a transit system in order to develop comprehensive requirements in each of these three areas. The first section will analyze the audience of a transit wayfinding system and break the group down into appropriate and workable sub-groups. The second section will analyze the requirements of a "baseline" user in each of the three technical areas. The third section will present a detailed investigation of each of the sub-groups developed in section 3.1 and present any additional requirements specific to that group.

3.1 WAYINDING DIFFERENCES

As illustrated in the previous chapter, wayfinding design is an immensely complex problem that requires knowledge of many different disciplines and an understanding of the built environment. In order to compile a comprehensive list of the wayfinding needs of transit passengers, we must first understand who those passengers are likely to be. A complete list of the mental and physical characteristics of potential transit passengers as one group is impossible; they are too varied. Nearly everyone is a potential transit rider and therefore everyone must be accommodated in the design of transit stations' wayfinding systems. This is especially true in the United States where transit systems under public ownership are subject to laws that require equal access and therefore must accommodate a general public that is quite broadly defined.

Traditional architectural and urban design often consider only one type of user: the average user. This method allowed for a static list of physical characteristics that could be employed as design criteria. Historically, this has also been true of wayfinding design. The more recent push for accessibility in public spaces, spearheaded by the

Americans with Disabilities Act (ADA) of 1990, attempts to create environments that are usable for all members of society. This has meant radical changes in all of the physical design disciplines as designers must now account for the wide variety of characteristics and abilities found throughout the general population. Because the act of wayfinding results from human interaction with the built environment, a wayfinding system must take into account both the physical and cognitive capabilities of its users.

These design goals are consistent with the ideal of Universal Design which attempts to overcome biases in traditional architectural design. Universal Design differs from traditional "accessible" design by creating places that do not separate people based on their needs and skills but instead creates unified environments that are readily accessible to all users. In a transit station designed to meet "Accessible Design" criteria, elevators will be provided as an alternative to stairs or escalators for those with mobility impairments. However, if the same station were designed for "Universal Accessibility" only one path from the entrance to the platform would exist, and in the ideal situation would contain no stairs or other obstacles to movement. Grade separation is necessary for rapid rail transit lines, however long ramps are also not desirable for many users. Most stations will therefore end up with multiple paths, each straightforward and desirable, with redundancy between them. In order to remove various obstacles from the design of transit stations, it is necessary to understand the passengers and their needs.

Both the principles of Universal Design and Systems Engineering indicate that the next step in the wayfinding design process should be a complete listing of potential users and their requirements for effective wayfinding systems. Individual users may be members of several different groups based on their usage patterns, physical characteristics, cognitive abilities and other traits. While studies in the past (both architectural and wayfinding) have focused on the design needs of different user groups, none has defined groups based on their usage patterns. Passengers with different use-characteristics are separated in this thesis because they enter the transit system with different levels of background knowledge about the system and need different types of information in order to plan and execute their trip. "Traditionally, we've approached [wayfinding design] with this assumption that everyone already knows how to find their way around." (Chandler, 2005) In order for this thesis to adequately define the wayfinding content that is required in transit stations, the passengers' knowledge of the system must be accounted for. This is also the only way to account for *all* potential passengers, as all will fall into one of the following use-based groups:

- Habitual riders
- Commuters
- Infrequent riders
- Non-users
- Tourists

In addition to their use characteristics, many passengers have physical characteristics that further define their wayfinding performance. As already noted, wayfinding systems have traditionally been built to accommodate users with "average" physical characteristics. There are many passengers for whom these characteristics are not appropriate and who have significantly different wayfinding requirements. The major groups of physically-dependent passengers include:

- Mobility impaired
- Visually impaired
    - Color Blind
- Hearing impaired

The use of various types of wayfinding devices requires certain skills and cognitive abilities that not all passengers possess. In order to accommodate these passengers, wayfinding systems must be provided that can be used by people with different skill levels. Not all passengers will fall into one of these skill-based groups, which include:

- Mentally impaired
- Illiterate
- Limited Language Proficiency (assumed to be English in this thesis)

The physically dependent and skill-based groups are typically used in the study of Universal design (Wilkoff & Abed, 1994) as users with mobility, visual, hearing, mental or literacy impairments are the main targets of the ADA legislation. In order to develop full and detailed requirements for each of these groups, the definition of each group had to be as specific as possible. Therefore, Arthur & Passini (1992) break users with literacy issues into two groups: those who do not know English at all (situational illiteracy or Limited English Proficiency) and those who can speak but not read English (functional illiteracy). The color blind have also been included as a subset of the visually impaired because they have definably different functional requirements from other users in the group.

These twelve groups and their respective wayfinding needs are the focus of the rest of this chapter, and each group receives some attention in the following sections. Special emphasis is given to the physical and psychological characteristics that differentiate each of the groups from each other and from the "average" passenger. By focusing on the differences between the groups this chapter will be able to determine what additions and alterations are necessary in order to adequately accommodate all of the passenger groups. This framework is based on the needs of various user groups and can be applied to any public space, not only transit stations. These individualized requirements will be aggregated to develop a fully inclusive set of design specifications for wayfinding systems in transit stations.

3.2 BASIC SYSTEM REQUIREMENTS

Later in this chapter specific requirements will be developed for each of the user groups listed in the previous section. However, to avoid excessive repetition of the basic goals of any wayfinding system, we will develop a set of basic set of requirements that will serve as a baseline for each of the specific user groups to follow. This set of requirements should answer two basic questions: "What do transit customers need to know?" and "How will they get the information that they need?" A thorough answer to these questions must deal with three technical areas: content, deployment and format. Content addresses what information must be included in a station's wayfinding system. Deployment deals with where in a station this information must be located and installed. Format refers to the design of individual wayfinding elements and the media used to convey the required content.

In order to provide the necessary requirements in each of these three technical areas we must first define both the system and its users. For the purposes of this thesis, the baseline user will fall into none of the listed physically or skill defined groups and has some knowledge of the transit system and its city. This corresponds well with the "average" passenger for which wayfinding systems have traditionally been designed. The baseline passenger will therefore be defined as a member of only the "habitual riders" group. Habitual riders are defined as those passengers who frequently use the system for most of their transportation needs. They will make most of their work, shopping and leisure trips using the transit system, and may or may not have access to their own car. While these passengers tend to have a broad knowledge of the transit system and the services it offers they may lack intimate, detailed knowledge of individual stations and station areas.

The informational requirements of passengers increase as the boundaries of the station area expand. In order to adequately capture the transit station environment without including too much of the surrounding neighborhoods, the area used in this analysis will encompass the entire transit station, including any transfer locations that may be located outside such as bus stops or commuter rail stations. The station area in this thesis includes bus stops only as peripheral elements, as wayfinding for a bus system is beyond the scope of this research.

3.2.1 Content Requirements

Developing the content requirements for transit passengers is a difficult task, as many different activities can occur at a transit station. The most effective method of exploring what transit passengers need to know is to follow a customer through a hypothetical experience at a station and develop a series of questions that the average passenger might need answered. This requires a trio of experiential narratives, one for customers for whom the station represents the origin of their rail trip, a second for customers for whom the station represents the end of their rail trip and a third for whom it is an intermediate point of transfer (rail-to-rail only). Tables 3-1, 3-2 and 3-3 present these narratives for the baseline user who has already been defined as a member only of the "habitual rider" group. Each content requirement is listed in the form of a question along with the wayfinding category in which that information belongs. In total, these three tables represent the basic content requirements of a wayfinding system in a transit station that has been designed for our baseline passenger.

As you can see from Table 3-1, the habitual rider does not require a great deal of information at the onset of their transit experience. Almost no static informational content is required by these users because they are already assumed to know how the system works. They do not possess detailed knowledge of each station and therefore do need directional information to guide them through the station. Also necessary are some identification elements to alert this passenger to the exact location of the station within a neighborhood. Emergency instructions have been placed in this table because the start of a rail trip is when a passenger spends the most time in a station. This question is really applicable in all three situations.

Table 3-1 Questions of baseline Transit User, Rail Station as Origin

Question	Information Category
Is there a station here?	Identification
Which station is this?	Identification
Which line is this?	Identification
Where is the station entrance?	Direction
Which line/direction do I want to take?	Orientation
Where is the platform that I need?	Direction
When will my train arrive?	Information
What do I do in case of emergency?	Information

Again, habitual riders require little direct help from the station's wayfinding system at their destination station. Because it is assumed that they have general knowledge of both the city and the transit system they require no informational content. The general content requirements of this baseline passenger as they exit the transit system are extremely limited, as shown above in Table 3-2. The definition of an exiting passenger has been expanded to include passengers transferring from the rail to the bus network.

Table 3-2 Questions of a baseline Transit User, Rail Station as Destination

Question	Information Category
Which station is this?	Identification
How do I exit the station?	Directional
Where am I within the city?	Orientation
Where am I within the neighborhood?	Orientation
Where is the bus stop for my bus line?	Directional

Table 3-3 shows the content requirements for a transferring passenger. These questions are essentially a combination of those asked for arriving and departing passengers that pertain to areas *inside* the station. Thus the same content that was provided for the first two trip types must be repeated for transferring passengers. It can be seen that most of the content required at a station by habitual users is actually related to the environment around the transit station, not the station itself. This is partially because the baseline passenger has been defined as one with a good working knowledge of the transit system.

Table 3-3 Questions of a baseline Transit User, Rail Station as Transfer Point

Question	Information Category
Which station is this?	Identification
Which line/direction do I want to take?	Orientation
Where is the platform that I need?	Directional
What do I do in case of emergency?	Informational
When will my train arrive?	Informational

Taken together, the content requirements for habitual users are not overwhelming and most are fairly obvious. Stations must be identified for both arriving and departing passengers. Directions must be provided along the primary paths from station entrances to the platforms, and between platforms wherever appropriate. The time until the next train arrival is important information for passengers. The structure of the whole transit system must be provided in order to allow people to travel effectively. Orientation within the city and the individual neighborhoods must be established to help passengers reach their ultimate destinations. Finally, there must be some instructions available in case an emergency situation arises. The relatively short list of requirements that comes from these tables could lead us to the false conclusion that a wayfinding system is simple, however format and deployment must be considered as well in order to create a comprehensive design plan.

3.2.2 Deployment Requirements

The technical area of deployment essentially describes an installation plan for wayfinding elements that provides the necessary content at the locations where it is most needed. This thesis does not delve into the methods used for installation, but deals instead with the ideal locations for certain types of wayfinding elements. Having established that for the defined baseline passenger the wayfinding system will be composed of mostly static visual elements, the criteria for deployment of these elements can now be established.

Table 3-4 transforms each of the questions developed in Tables 3-1, 2 and 3 and transforms them into the actual information that must be displayed. The locations in which each item is necessary are also shown in the table in general terms. For the purpose of this discussion, a station has been broken in several distinct areas which are used to define the deployment locations including the platforms, the paid mezzanine (station house inside of the fare array) and the unpaid mezzanine. Where appropriate, further detail is used. The locations for these items have been determined in order to provide the necessary content at the locations where it will be needed for passengers to make a decision.

This table indicates that all of the content required by the baseline transit passenger (with the exception of the directional content) should be located either outside of the station or in one of the three general station areas just introduced. A significant portion of the content necessary for habitual riders must be provided outside of the station itself and deals with how the station interacts with the environment around it. While this table was developed for the habitual rider whose level of familiarity with the system reduces the need for repetition of information within the station, some content, specifically station identification must be deployed in multiple locations. Station identification elements located outside of the station entrance are for use by passengers arriving at the station from the surrounding neighborhood while those located on platforms are for use by passengers arriving at the station by train. The function of a neighborhood map located on a platform is to allow passengers to select the exit that is closest to the desired destination. Neighborhood maps are only then necessary when the map shows sufficient detail about the station structure to make that type of decision.

Table 3-4 Deployment Requirements for the baseline passenger

Content	Deployment
System Identification	outside of station
Station Identification	outside of station
Line Identification	outside of station
Entrance location	outside of station
Directionality of trains/system map	paid mezzanine
Path from entrance to platforms	en route
Train arrival	on platform
Station Identification	on platform
Path from platform to exit	en route
Path between platforms	en route
City map	unpaid mezzanine
Neighborhood map	unpaid mezzanine, platform
Emergency instructions	All interior

This thesis will not deal with locating each wayfinding devices with precision, as there is no hypothetical station to use. It will however define the criteria that must be used in order to locate the proper content not only in the necessary locations, but in a manner that ensures its visibility and availability for the passengers that need it. A visible wayfinding device is one that will be seen by passengers, in this case by those with the characteristics assumed of the baseline passenger. Each wayfinding device must be placed in the line of sight of the passengers who need it, which can be determined from the circulation patterns of each individual station. In many situations this means that the user will be in motion (either walking towards their destination or arriving by train) and they should not have to stop and search for the devices that they need. Wayfinding devices must be oriented so that they are in line with the direction of motion of the passengers who will use them. For example, devices directing towards the station exit should be oriented to be visible by passengers leaving the platform area.

When utilizing sightlines to determine proper signage placement, we must account for human factors (height, walking speed, etc.) that may affect where the best location is. Arthur & Passini recommend that two areas be used to display wayfinding areas in consistent locations throughout a station. The first area is a 16 inch-wide band that begins 47 inches from the ground and is ideal for locating wayfinding information because "this level fits more or less comfortably within the cone of vision of pedestrians, both adults and children, and of people in wheelchairs." This easily accommodates our baseline user and allows passengers to examine wayfinding devices up close, if necessary. Because of the often crowded environment found in most transit stations wayfinding elements deployed at this height may become obscured by pedestrian traffic. Therefore backup wayfinding elements should be deployed at a height of 87 inches from the ground (roughly at the top of a door). These elements should contain larger devices that can be read from a distance. Together, these two areas will allow for all necessary wayfinding information to be displayed in highly visible and accessible locations.

In order to ensure that wayfinding elements are actually visible for passengers, the design of the devices must be considered in the context of their eventual locations after deployment. The 'Target Value' of a wayfinding device is a measure of the contrast between the element and its background in either color or tone. An element with a higher target value increases "its value to the viewer as a target to be perceived from a distance" and therefore increases its visibility to station users. (Arthur & Passini, 1992) Therefore, in order to be truly visible wayfinding devices must be deployed in locations that provide high target values.

The criteria developed for wayfinding deployment holds for all types of wayfinding elements; however directional devices must adhere to additional rules for installation. Directional devices provide directions along a path between two locations and essentially provide a graphical link between two visually inaccessible locations. In order to provide this type of link these devices must be located at all decision points along the path which includes all points where traffic splits, merges or turns (Arthur & Passini, 1992). While this deployment plan may be sufficient for passengers who are familiar with the transit system and its stations, other passengers may require additional reinforcement. In order to create a full visual link between two discontiguous locations, Braaksma & Cook advocate that a directional element to each destination must be visible from all possible origins. This requires the addition of supplementary directional devices as reinforcement along long paths without decision points.

In contradiction to directional devices, informational, orientational and some identification elements should be deployed out of the direct flow of pedestrian traffic. Any element that may take some time to read and understand, especially maps, must be placed in a location where people can study it without blocking the flow of traffic.

3.2.3 Format Requirements

The main goal of the final technical area is to ensure that passengers are able to understand the information that is presented to them. This requires that all wayfinding elements are designed in a format that is legible to all possible passengers. The media used to convey wayfinding information in addition to the design of the specific elements help to determine their legibility. The format requirements for even the "average" user are complex and are based on the assumed physical and cognitive characteristics of that user.

The medium used to convey the necessary information is typically some form of visual element. Text and graphics combine to create signs and maps, the most common forms of wayfinding devices, which are easily usable by passengers with "average" physical abilities. Static elements are typically used for most types of content, and all of the content requirements found in section 3.2.1 can be satisfied using these types of elements. (Train arrival information *can* be provided using a static schedule, although even in exceptionally well-run transit systems this would only provide an estimate and not accurate arrival times.) Design considerations for these typical wayfinding elements include font selection, font size, color selection, message design and layout. Maps present a special set of challenges in each of these areas. A broad array of choices exists in each of these items, and this section will not present all of them, however the basic requirements for each will be presented along with some common or recommended solutions.

The first consideration in the design of any wayfinding element is the message itself. The design of a message is based on the content requirements discussed in the previous section; however it results in the actual text that will be used to convey the required information. Word choice is the primary concern for most devices; however images also play an important role. For both, clarity of meaning is essential in order to convey the required content. It is recommended that common, understandable words be used in wayfinding elements to maximize the number of customers who can understand them. "Average" users, as defined in this chapter, read and understand English, but simpler words allow for faster and easier comprehension (Arthur & Passini, 1992). Image selection can be as essential word choice to provide clarity about the meaning of a given wayfinding device. Pictograms have been developed to replace wordy signs with well-known and easily recognizable images. Figure 3-1 shows some message design alternatives for the same content requirement that utilize different text and graphical elements. While portions of the process for map design also falls into this category, they will not be discussed in detail here.

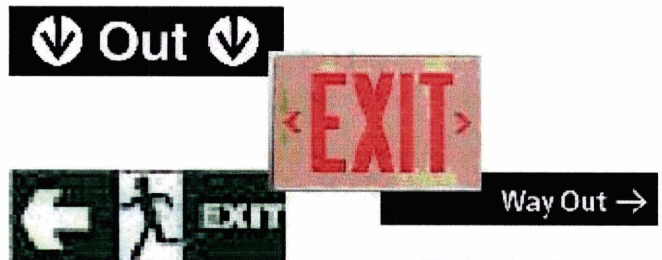

Figure 3-1: Different message design options for directional exit signage. Clockwise from top 1) CTA Design Standard from Signage Manual, 2) Traditional Illuminated Exit Sign, 3) Frankle-Monigle exit sign at Clark/Lake station, CTA and 4) Exit signage used in UK transit systems

One special and extremely important subset of pictograms is the arrow. Arrows play an extremely important role in wayfinding systems, but are often very confusing when anything beyond a simple left or right hand turn is required. The most common problem is the confusion and inconsistency of designating up, down and straight ahead as illustrated in Figure 3-2. In directional devices, graphic signs (using arrows) have been found to be faster to read

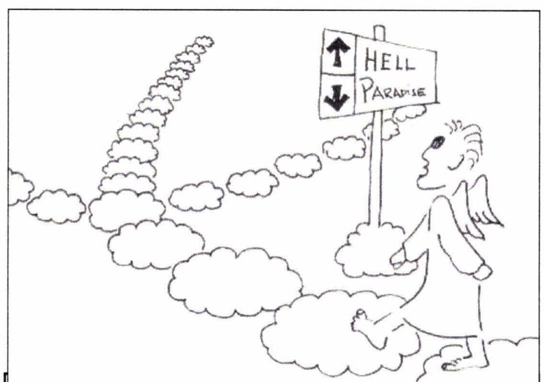

Figure 3-2: Choose carefully! Arrows can cause confusion. (From Arthur & Passini)

than text only signs but also result in more navigational errors (O'Neill, 1991).

Font selection plays an important role in the legibility of wayfinding devices. The increased use of computers in graphic design has made the font choices more standardized, with many generic fonts available in different software applications (such as the 'Times New Roman' standard used in Microsoft Office). Many organizations have conducted independent studies in order to determine the 'best' or 'most efficient' font with the result that many similar fonts are used as standards in different agencies. The US Department of Transportation has long held to its standard typeface on highway signs, however after significant research a new font has been approved for use as shown in Figure 3-2 (Coles, 2004). Overall, sans serif fonts are preferred for wayfinding devices because they are easier to read quickly.

Figure 3-3: Two US DOT standard fonts: Clearview-Bold (left) vs FHWA Standard Alphabets Series E-modified (right)

Letter size is typically determined based on the distance from which a sign must be read. The most common specification for wayfinders with average visual abilities requires letters to be one inch high for every 50 feet of distance (Arthur & Passini, 1992). The use of both capital and lower-case letters is encouraged because it allows words to have their own somewhat unique silhouette (Landa, 1997). The optimal spacing between letters, words and graphic elements has also been determined and the interested reader should see Arthur and Passini for a very detailed explanation of these criteria. For wayfinders of average visual abilities, it is sufficient to say that letters, words and pictures should be separated enough to be distinguished from one another.

Color is often used to portray important information, especially on maps where color-coding is a popular and powerful tool. The practical limit of the number of color coded groupings that can be used in a single graphical element is seven. "Average" passengers can easily distinguish between seven different colors, although fewer groupings provide more clarity. In addition, certain colors are often reserved for specific types of elements in a wayfinding system, such as red which is often used on cautionary warning devices. The preconceptions that passengers may have about the use of color in wayfinding systems must be addressed when designing color coded devices and may be different in each country. Contrast between the text and background color is necessary and can be measured by calculating the "brightness differential[5]" of any color combination (Arthur & Passini, 1992) A value over seventy ensures legibility as defined by ADA and shown in Figure 3-4.

	beige	white	grey	black	brown	pink	purple	green	orange	blue	yellow	red
red	78	84	32	38	7	57	28	24	62	13	82	0
yellow	14	16	73	89	80	58	75	76	52	79	0	
blue	75	82	21	47	7	50	17	12	56	0		
orange	44	60	44	76	59	12	47	50	0			
green	72	80	11	53	18	43	6	0				
purple	70	79	5	56	22	40	0					
pink	51	65	37	73	53	0						
brown	77	84	26	43	0							
black	89	91	58	0								
grey	69	78	0									
white	28	0										
beige	0											

Hues	LR(%)
red	13
yellow	71
blue	15
orange	34
green	17
purple	18
pink	30
brown	14
black	8
grey	19
white	85
beige	61

do not use

acceptable

Figure 3-4: Color contrasts. Shaded boxes represent a combination that can be used. (Arthur & Passini, 1992)

The design of wayfinding devices ends by combining all of the above elements into a cohesive unit. The layout of each element must incorporate the message design, text design, images and colors in a format that allows for full comprehension of the necessary content. Habitual riders will be moving at speed through a station and must be able to 'read' wayfinding devices quickly. Each kernel of information must be separable and legible within the context of each device, while still making a coherent whole when seen together.

Maps are among the most complicated of wayfinding devices and require the most care in design to be in accordance with the format requirements laid out in this section. In addition to these formatting requirements, maps should provide information about the user's location within the environment. The you-are-here type of map provides personalized orientation information in addition to the necessary large-scale structural information. Three important rules should be adhered to in the design and implementation of these types of devices. First is the Orientation Principle which states that the map should be aligned in the same direction as the environment around it. Second, that forward motion should be equated to the up-direction on a map. And third that the map should be located "near an asymmetrical part of the environment" so that

[5] The Brightness Differential is calculated based on the light reflectancy of each color, a detail that paint suppliers should have on record. For more details and the actual formulations, see Arthur & Passini, 1992.

users can orient themselves to it. (Devlin, 2001) While the second rule is commonly followed, the first and third principles are often ignored due to installation complications. Orienting a map in the same direction as the real environment is vital in order for users to be able to use it easily and comfortably (O'Neill, 1991). When this is not possible, the standard is to equate north with up on a map.

In the case of an emergency situation the static, visual devices described in this section may not be sufficient to convey detailed instructions to our baseline passenger. While evacuation procedures, regulations and safety warnings can all be displayed using these devices, in a true emergency it may be necessary to provide more detailed, up-to-the-minute information and instructions. There are several possible formats for this content, including variable message signs and public address systems. Because the latter is more commonly found in transit stations, PA systems will be used to fulfill the format requirement for this type of content for our baseline user. A good PA system should be audible and understandable from anywhere in the station.

This section has discussed the three technical areas of wayfinding system design that are necessary to create a requirements document for such a system: content, deployment and format. In addition to providing explanations of each of these areas, the requirements of the baseline user (a habitual rider) were developed using this framework. These requirements will be used as a baseline in the following sections as the bare minimum that a wayfinding system must accomplish in order to serve *any* of its customers. In the next section, this same framework will be applied to each user group in order to develop a full catalog of wayfinding requirements that can be used by all transit agencies.

3.3 REQUIREMENTS BY USER GROUP

The previous section used a baseline user group (the habitual riders) to define a baseline of requirements in each of the three technical areas of wayfinding design. The requirements of the other eleven user groups will be explored in the following sections accounting for the content, deployment and formatting of wayfinding materials. In

Chapter 6 of this thesis all of these various requirements will be aggregated in order to help transit agencies create wayfinding systems that are accessible to all potential passengers. The definitions provided in the following sections are neither exact nor all-inclusive, but provide approximate characteristics that can be used in the wayfinding design process. These groups are not mutually exclusive as any individual transit user can (and probably will) fall into multiple groups. Together with the habitual rider detailed in the previous section, this represents the full range of transit users and will provide a complete set of wayfinding requirements.

3.3.1 Commuters

As a use-based group, commuters may be members of many different user groups. There are no physical or cognitive differences between this group and the baseline user. There are behavioral differences that separate commuters from the habitual riders group. Commuting passengers use the transit system usually for only two trips each day, to and from work. Due to repetition and experience, commuters typically know their route very well, which often includes an intimate knowledge of two stations and any transfer points along the way between their daily origin and destination. Often, there is no familiarity of the system outside of this route because commuters rarely (if ever) deviate from their standard path. Therefore, when a commuter has departed from his/her traditional route they often require nearly as much assistance and wayfinding aid as any novice traveler.

This represents an interesting challenge for transit agencies seeking to increase ridership and decrease dependence on private automobiles in their cities. Commuters, many of whom own and use cars for travel other than work-based trips, have already acknowledged the benefits of public transportations and their willingness to use the system when it is beneficial to them. The opportunity exists to convince these riders to take advantage of the full transit system by educating them on the benefits and the services available and making their travel experience easier. This section will focus on wayfinding design for commuters on their daily routes, not for those using the rest of the system. In that situation, the wayfinding requirements more closely resemble those of the infrequent riders as presented in section 3.3.2.

Commuters as defined in this section use the same stations everyday, and know their route very well. Because of the high level of familiarity, there are very few content requirements for this user group. In fact, most of the content requirements that were listed as part of the baseline requirements will most likely not be used by commuters. However, they are often in a hurry and place a high value on their personal time. Service delays and interruptions are onerous to these users, despite their inevitability. Commuters require reliable information about their service, and information about these types of service issues should be provided in as close to real time as possible. This will decrease passenger friction and increase satisfaction with the system which is extremely important in the quest to retain choice riders and increase the frequency of their transit travel.

There are several locations in which information about service delays will be helpful to commuters. Passengers waiting on the platform should have some way of knowing that their train has been delayed. Service delays should also be available before passengers pay their fare in case they want to take an alternate route. Finally, when delays are significant, the information should be available for passengers from their homes so that they can make alternative transportation plans if they want. For example, it could be made available via the internet, cell phone or other mobile technology.

Information about service delays cannot be provided by traditional, static visual devices. There are several potential formats for this type of information ranging from high-tech solutions like variable message signs and audio announcements to low-tech solutions like a chalkboard updated by the station attendant. Any of these solutions can be acceptable so long as they are updated frequently and displayed in a consistent location.

3.3.2 Infrequent Riders

Infrequent riders will use the transit system rarely, and then only for special events and may not know their way around their station of origin, their destination or the system itself. They have very high information requirements as they have very limited knowledge of a transit system. Ensuring that the wayfinding requirements of these passengers are met will improve their perception of the system by providing them with positive experiences. This may encourage infrequent riders to become frequent riders.

There are significant content requirements that must be fulfilled for infrequent riders. The best way to catalog all of the content requirements is to formulate a series of questions that these passengers might ask as they make use of a transit station. Again, this will result in a trio of experiential narratives that follows an infrequent rider through all possible activities at a station. The tables below illustrate these narratives by presenting the questions, the information type and the deployment recommendations. In total, these three tables should represent the basic content and deployment requirements of a wayfinding system that is usable for infrequent transit riders.

Table 3-5 Questions of an Infrequent Rider, Station as Origin

Questions	Content	Deployment
*Is there a station here?	System identification	outside of station
*Which station is this?	Station identification	outside of station, paid
*Which line is this?	Line identification	outside of station, unpaid
*Where is the station entrance?	Entrance location	outside of station
How much will the train cost?	Fare information	unpaid mezzanine
How do I pay for the trip	Fare information	unpaid mezzanine
Which station is near my destination?	City/system maps	unpaid, paid, platform
How much does a transfer cost?	Fare information	unpaid mezzanine
How do I get where I want to go?	System map	unpaid, paid, platform
*Which line/direction do I want to take?	Directionality	unpaid, paid mezzanines
*Where is the platform that I need?	Path from entrance to platforms	en route
*When will my train arrive?	Train arrival estimate	on platform

*Also applies to the baseline user

Table 3-5 shows the questions that would be asked by an infrequent rider as they begin their transit trip. The majority of the questions (those which are marked by an asterisk) were also asked by the baseline group; however these riders require the information in multiple locations. As can be seen from the table below, these users require significant additional content, but the most drastic addition is in the deployment requirements. Repetition of content is more necessary for these users because they do not have the same level of familiarity with the system as the habitual riders. Among the additional content is information about fare policies, a system map and a map that links the rail network to the city's geography.

Table 3-6 presents the same information for an infrequent rider who has just arrived at their destination station. There are again some content additions to help these passengers find their final destinations within the neighborhood and understand any connecting bus services. Also necessary are operational hours for the system and for the specific station to help passengers plan their return trip. Most of the additional wayfinding devices required by these users are repetitive ones that now must appear in multiple locations within a station. Most of them should be located in the unpaid area of the station, as this represents the final decision point along their trip that is inside of the station. Therefore, as much information as possible about the surrounding neighborhood should be provided at this location.

Table 3-6 Questions of an Infrequent Rider, Station as Destination

Questions	Content	Deployment
*Which station is this?	Station identification	on platform
*How do I exit the station?	Path from platform to fare array	en route
*Where am I within the city?	City/system maps	on platform, unpaid
*Where am I within the neighborhood?	Neighborhood map	paid, unpaid mezzanines
Where is my final destination?	Neighborhood map	paid, unpaid mezzanines
Which exit do I want to use?	Neighborhood map, exit ID	unpaid mezzanine
How do I get to that exit?	Path from fare array to exit(s)	en route
What bus lines serve this station?	Route maps	unpaid mezzanine
*Where is the bus stop for my bus line?	Path from fare array to bus stops	unpaid mezzanine
What time does this station close?	Last train/hours of operation	unpaid mezzanine

*Also applies to the baseline user

There is only one new content requirement has been added for transferring passengers from the baseline group: detailed information about transfers and system structure. It was assumed the habitual riders would not need this information, but it must be available to those who do need it. All of the deployment requirements in Table 3-7 place wayfinding devices on platforms or along the route between two platforms because it is assumed that transferring passengers will not be entering the rest of the station house.

Table 3-7 Questions of an Infrequent Rider, Station as Transfer Point

Questions	Content	Deployment
*Which station is this?	Station Identification	on platform
Can I transfer here?	Transfer Information, System Map	on platform, on train
*Which line/direction do I want to take?	System Map	on platform
*Where is the platform that I need?	Path between platforms	en route
*When will my train arrive?	Train arrival estimate	on platform

*Also applies to the baseline user

Infrequent riders do not have any different formatting requirements from the baseline passenger because this is a use-based group and is determined only by behavioral characteristics and not physical abilities.

3.3.3 Non-riders

Among all of the use-based groups introduced in this chapter, non-riders are defined by the fact that they are *not* a user group; members of this group do not use public transportation at all. This group represents untapped potential in the urban market that should be taken advantage of. Two types of content are required in order to capture some of this market: traditional wayfinding and advertising. In the realm of wayfinding, all of the content listed for the infrequent rider group must be supplemented by detailed information about where the system goes and where stations can be found. This includes some method for knowing where the nearest station is located. Advertising content should include the convenience, speed, cost savings and extent of the transit system in an attempt to convince these non-riders to become customers.

In this case, the deployment criteria help to define the formatting requirements. While the basic format requirements for visible and legible wayfinding elements have not changed, there are significant alterations that must be made because all of the necessary content must be made available outside of the transit stations and outside of the transit system. The creation of a strong system identity that can be displayed on vehicles and outside of all stations will help to increase recognition and visibility of the system. A unique logo, distinct colors and lights at night can all help to increase the visibility of individual stations and the whole transit system even to those who have chosen (so far) not to ride. The other possible formats for transit advertising will not be discussed in depth in this thesis; it is sufficient to say that they are numerous and varied.

Formatting and deployment options for the other wayfinding content are limited to low cost methods that can reach a majority of city residents. One of the most obvious methods for achieving this goal is to utilize the internet, although this media may not be accessible to potential riders who are elderly or have low incomes. Simply posting the necessary information on the internet does not improve its visibility unless adequate advertising ensures that people know where to find the information. Mass-mailings of system maps and information is another option for reaching this audience. Many other ideas exist for converting non-riders to riders through the use of various marketing techniques, but that will not be a major focus of this thesis.

3.3.4 Tourists

Tourists must be represented as a separate use-based category because their content requirements vary greatly from those of the other user groups. All of the previously mentioned groups maintain some level of familiarity with their city; even the non-transit user knows something about the urban area through which it runs. This is in stark contrast to a tourist or visitor who will not only have no background about the transit system but may also know nothing about the city itself. In some cases, the user may have no knowledge about transit systems in general (fares, etiquette, safety, etc.) Tourists may be from anywhere: across the world, across the country or even from elsewhere within the same metropolitan region. They are also frequently looking for different types of destinations than local riders.

Most of the content requirements for the tourist user group were already covered by the infrequent and non-rider categories. Orientation on a metropolitan scale is especially necessary for these passengers and must be provided in conjunction with detailed system maps. Popular tourist destinations and hotels should be highlighted on these maps or on separate devices that indicate what destinations are accessible via which transit stations. While it is impractical to enumerate all possible destinations in any station area, popular tourist attractions have already been catalogued by countless guidebooks. It is possible to provide directional signage for this abridged list of attractions without overwhelming travelers. Customer service staff throughout the system should be trained so that they have the ability to direct passengers to most of a city's tourist attractions.

Deployment requirements for tourists are a combination of those for infrequent riders and non-riders. For those tourists who wish to plan their travels before they depart for their vacation, all the necessary information must be made available from outside of the system. The internet-based system introduced briefly in the previous section could meet this requirement for many tourists. Once in the system, information about popular tourist devices should be available at most stations, especially those in downtown areas. Directional devices to nearby attractions should be deployed along the path from the platforms to the appropriate station exit. Neighborhood maps located near exits should also display the locations of these attractions. The anxiety caused by traveling in a strange city can cause disorientation for tourist passengers. In order to make these passengers comfortable it is essential to deploy redundant devices at all decision points and in waiting areas. The need for repetition and redundancy may be so great for this group that handheld wayfinding tools may be the most effective strategy, such as the special tourist maps given out by the CTA at the two airport stations.

The definition of tourist in this section assumes that the user does not fall into any of the other possible user groups including the Limited English Proficiency group. Therefore these tourists all speak and read English and do not have any additional format requirements beyond those previously introduced. Additional requirements for customers without proficiency in English will be discussed in section 3.3.10.

3.3.5 Mobility Impaired

This user group is defined solely by the physical characteristics of passengers. All members of this group will also be a member of one of the use-based groups that has already been discussed, in addition to possibly belonging in any additional groups that will be introduced below. However, for the analysis in this section, it is assumed that the members of this group belong only in this group and the baseline "habitual riders" group. These passengers have some physical limitation that makes some types of physical exertions (often using stairs) difficult or impossible. As physical capabilities decrease with age, many elderly passengers will require the facilities provided for this user group. Many transit users will fall into this group at some point in their lives as it includes those with injuries, pushing strollers, bicycles, shopping carts or luggage. These users with "temporary" mobility impairments may be more reliant on wayfinding devices than the permanent members of this group who may be more adept at traveling with their disabilities.

In any situation where the path between two points is accessible to all users, there are no new content requirements for this user group. The additional content and deployment requirements that are necessary for this user group are shown in Table 3-8. (All three narratives have been combined into one table.) There are two main categories of content that must be added to the station wayfinding system. Accessible station elements must be clearly labeled including station entrances, vertical circulation elements and whole stations. This includes the need to classify all stations as accessible are inaccessible so that passengers know which stations they will be able to use. The second category is directional devices that direct passengers in this group to their destinations along and accessible route. Paths should be marked not only by their accessibility levels, but by their destinations. One final element must be included in some systems where it is not possible for a mobility impaired person to board the train without additional help. The CTA, for example, uses "gap-fillers" that require placement by a staff member to allow for smooth boarding for these passengers. In these situations, it must be made apparent who the passenger should see in order to receive this help.

The deployment requirements for mobility impaired passengers have been highlighted in Table 3-8. Directional devices must be provided along the appropriate paths at the appropriate decision points as discussed in section 3.2.3. This requires that necessary content should be deployed so that passengers with mobility impairments do not have to backtrack to reach their destination. For example, the location of the elevator should be provided before the user reaches the staircase and is forced to turn around. Especially important in multilevel stations is the continuity along the whole route, requiring directional wayfinding elements to also be provided inside of all elevators.

Table 3-8 Questions of Mobility Impaired Passengers

Questions	Content	Deployment
Is this entrance accessible to me?	Station accessibility labels	outside of station
Where is the nearest accessible entrance?	Path from non-accessible to an accessible entrance	outside of station
Is my destination/transfer station accessible to me?	System accessibility	at home, unpaid mezzanine
Are the elevators at my destination/ transfer station working today?	Elevator updates	at home, unpaid mezzanine
How do I get to my platform via the elevator?	Path from fare array to platform (via elevator)	en route
How do I get help boarding the train?	Emergency call button	On platform
How do I get to the exit from the platform via the elevator?	Path from platform to exit (via elevator)	en route
Where is the nearest accessible exit?	Path from fare array to exit	en route

Some of this accessibility information must be made available to passengers before they start their trip. Many stations in older transit systems are not accessible, and users with mobility impairments must be able to determine the accessibility of both the origin and destination stations (and transfer points as well) *before* they begin their trip. Providing up to date information about transit station accessibility can be especially tricky in systems that rely heavily on elevators and escalators that may often be out of service. At stations with multiple entrances, inaccessible entrances should be labeled with directions to the nearest accessible entrance.

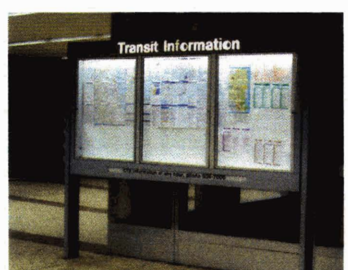

Figure 3-5: This CTA information kiosk may prevent customers confined to wheelchairs from seeing the fine print on some devices.

All of the information that transit passengers require must be easily visible to those with mobility impairments. First, this means that any information provided along a non-accessible path must be repeated along the accessible path. In addition, content must be provided at a height that is visible to passengers confined to wheelchairs. The areas set aside for wayfinding information in section 3.2.3 are also appropriate for these users. Devices deployed in special cases as shown in Figure 3-5 are often too high to be visible by passengers confined to wheelchairs.

Format requirements for this passenger group are very similar to those for the baseline user. The standard wheelchair icon is commonly used to label accessible elements and is typically paired with the color blue, as shown in Figure 3-6. However, this symbol is not standard symbol for an elevator, which is also shown in Figure 3-6. Consistency in this symbology is essential, and should be coordinated on as large a scale as possible to ensure full utilization.

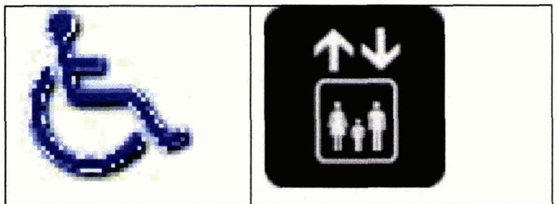

Figure 3-6: These two pictograms are commonly used to indicate an elevator. Left: Universal symbol of accessibility. Right: symbol for an elevator.

3.3.6 Visually Impaired

There are over 15 million blind and visually impaired people in the United States today[6] many of whom are potential transit users. This group includes customers who are fully or partially blind, have various levels of sight in addition to many elderly members of the population with failing eyesight who may have difficulty seeing small text or elements at a significant distance. These users will also belong to one of the use-based groups and may have other physical or mental impairments. The varied nature of visually impaired customers complicates the already difficult task of designing wayfinding devices that are usable to all customers in this user group. Providing accurate, helpful wayfinding for the visually impaired is one of the most difficult challenges for the wayfinding designer, as most of the traditional media for wayfinding are visually based.

Much research has been devoted to the study of how people with visual impairments perceive and navigate through the built environment. The visually impaired do have different methods of spatial perception than fully sighted users. They rely primarily on sound and touch in order to perceive the environment around them, and as such must travel through an environment in order to learn about it. Transit

[6] The Braille Institute

stations can be especially troublesome for these users who rely so heavily on sound because of the high level of background noise that is frequently encountered. Rushing air, another frequent condition at station entrances and on platforms can also disorient these passengers (Passini et al, 1990).

The processes of storing and processing spatial information were once thought to be missing or substantially deficient in blind wayfinders. Of specific concern was whether or not completely blind can construct a cognitive map of a complex structure and understand the spatial relationships between spaces. A comprehensive study conducted with blind wayfinders determined that these users are able to perform all the same wayfinding tasks as fully sighted users. (Passini et al, 1990) The difference is only that the visually impaired frequently do not have access to the information that they need to perform these tasks. The provision of this information is the goal of wayfinding designers seeking universal accessibility.

The execution of a trip by a visually impaired passenger is more complex in two ways. First, a visually impaired user encounters more decision points than a sighted user and must therefore make more decisions. In expectation of this, visually impaired passengers will often plan for their trip in more detail to ensure that they actually reach their desired destination. Because of this high level of planning that occurs, it is necessary to ensure that visually impaired passengers have access to all of the information that they need before they begin their trip. These additional complexities contrast sharply with the level of information that is accessible to these passengers.

The first challenge in this design problem is the heavy requirement for additional content. Many of the content requirements are the same as for the use-based groups that have already been discussed; however there are some additions because many of the architectural clues about the structure and layout of the station are not available to passengers with visually impairments. Three specific situations present extra wayfinding challenges to those with visual impairments over users without. The first is the use of vertical circulation elements, the second is while crossing an open space and the third is when searching for a specific architectural element (Passini & Proulx, 1988). Vertical circulation elements and architectural features like doors must be identified, and directional devices must be provided across open areas and between important points. Many of these content requirements have already been addressed in the previous sections, and so they will not be discussed here. Table 3-9 presents the new content and deployment requirements, most of which provide this type of architectural information.

Table 3-9 Questions of a Visually Impaired Passenger

Question	Content	Deployment
Do I have to go up (or down) stairs?	Stair labels	Before staircase
Where do I buy my ticket?	Booth/Machine labels	Booth/machine
Where do I get on the train?	Platform edge warning	Platform edge

Deployment of tactile devices requires a standard location that allows them to be found by the people who need them. The sightline analysis used to determine the locations of wayfinding devices previously in this thesis is not appropriate for this user group. While it is easy to conduct a visual sweep of an area to find a wayfinding element, a tactile sweep is much more difficult, time consuming and dangerous. A sighted wayfinder does not need to know that there will be an important sign in the path ahead in order to see it; a tactile wayfinder needs to know where to look for clues in order to find them at the opportune moment. For this reason it is recommended that any tactile information be placed at a specific and consistent location with respect to the physical elements to which they refer (ADA Accessibility Guidelines).

The most significant difference in wayfinding design for visually impaired passengers is the new formatting requirements. The strategy that has been employed for all of the other user groups, visual signs, simply does not work for the visually impaired. Two other senses are the primary source of spatial information for these passengers: sound and touch, though smell is used in some situations. Visually impaired passengers using the white cane are making use of both of these primary senses. Designers often rely on Braille to convey textual content to blind users; however only a very small percentage of blind people actually read Braille fluently. Tactile reading of raised letters is more common, although by no means universal in the blind population. Both of these are especially difficult for the elderly to learn because they require a delicate sense of touch.

Several formatting strategies have been proposed to solve the problem of directional wayfinding for the blind, including audio and tactile devices. Audio devices include a continuous audio loop ("Caution: the moving walkway is ending."), devices that are triggered by a button push and devices that are triggered only by passengers with special transmitters (Landau, 1999). These devices let visually impaired passengers follow a trail of sounds to their desired destination.

Tactile solutions for directional wayfinding can be as simple as Braille/tactile versions of standard directional devices (tactile reader can understand arrows); however it may be difficult for the users to locate the devices. Another solution creates a continuous tactile link between decision points along a path. This method ensures that a visually impaired user does not lose the trail along the way. The Raynes Rail, for example uses Braille text along the backside of a handrail to provide directions and information, and periodic audio information is triggered by sensors when a hand passes over them, as shown in Figure 3-7. (Raynes, 2005) Tactile trails that function as shorelines can also be located on the ground to guide visually impaired passengers through large, open spaces (Passini & Proulx, 1988).

Figure 3-7: The Raynes Rail uses both audio and tactile formats.

Identification of many types of spaces is necessary for passengers with visual impairments, including architectural features, vertical circulation elements and rooms. Most of these elements can and should be identified using either tactile or audio formats similar to those already discussed for directional devices. Architectural articulation of some types of elements can help to identify them for these passengers, especially doors and fare control devices which can be designed so as to feel distinctly like doors and fare control devices.

Vertical circulation elements, however, cannot be identified in this way as visually impaired passengers must be prepared to use a staircase or an escalator. One recommended solution is to use a textured floor material at the top and foot of each staircase that will alert blind (and other) passengers that they are approaching this type of element.

Complex spatial relationships including the linear nature of rail lines, the connections between lines and the system's relation to the city above (or below) it are typically conveyed using maps and other graphic devices. None of the conventions used in traditional maps are easily transferable to tactile devices. A simple transfer of the lines on a printed map into a tactile image would be indiscernible by visually impaired wayfinders due to the loss of dimensions like color, font and line weight. To some extent, line weight can be transferred to tactile maps by using different heights for the raised elements; however a limited number (no more than 3) of heights can be discerned in this way (Arthur & Passini, 1992). All of the information presented in complex system and city maps is important and necessary to transit users, especially the visually impaired who are severely limited in their ability to observe urban form. Tactile maps have recently been developed by several companies that provide spatial information as a series of layers that are legible to blind wayfinders. Tactile maps in very complex systems may not be helpful as stationary devices and may be necessary as portable devices that users who need them can carry along their route. (Landau, 1999)

Color Blindness

One of the more common visual impairments that can limit wayfinding abilities is color blindness. A color blind transit user will not read Braille and will rely primarily on the standard visual clues available within the system. The color blind "have trouble seeing the difference between certain colors[7]." Color blindness is more common in men, with approximately one in twelve American males having some color perception problems. While many color blind people simply have difficulty distinguishing shades, it is also common to be unable to distinguish between very different colors, the most common example being red and green.

There are no changes that must be implemented in either the content or deployment technical areas from the baseline requirements that have already been outlined. Format requirements change slightly only when color is used as an identifying device, which a color blind user is not be able to see. Where color is used in this way, as is frequently done to distinguish between rail lines, text descriptions of the colors should

[7] Kid's Health at http://kidshealth.org/kid/talk/qa/color_blind.html

be included. For example, signs should read "Blue Line to Airport" instead of "To Airport" written in blue text. For this reason, the only colors that can be used in a color coding scheme are those colors "to which a generally agreed-upon name can be put – like red or yellow or blue." (Arthur & Passini, 1992)

3.3.7 Hearing Impaired

This is a large group that includes completely deaf users in addition to users with partial impairments and degenerative hearing problems. Approximately one percent of the US population falls into this group, and requires the use of a hearing aid (Arthur & Passini, 1992) This group also contains a relatively high proportion of older users. Transit users with hearing impairments have no additional content or deployment requirements. There are only limited changes that must be made to the format requirements because this passenger group is able to use the visual wayfinding devices that are typically implemented. Difficulties can arise when the primary source of a type of content is audio, as has so far been assumed for emergency instructions and service delays.

Whenever PA systems are used to convey important, time-sensitive information it is essential that a real-time visual backup is provided for those users with hearing impairments. One example of this type of message can be found in the Washington Metro system where the call for the last train of the night is made over the PA system without any visual backup. The WMATA stations all have the capability to provide this information visually as they are equipped variable message signs that are used to announce train arrivals (See Figure 3-8). Providing the capability for station personnel to reprogram these devices in emergency situations will help make this important content available to users with hearing impairments. The same is also true on vehicles themselves where station announcements are now required to supplement the visual devices used on platforms.

Figure 3-8: An example of the variable message signage already installed in Metro stations in Washington, DC.

Emergencies present another challenge for hearing impaired passengers, because instructions are frequently conveyed using PA systems during these situations. Instructions and information must be made available in real time to passengers with hearing impairments who may be in a station. Variable message signs can be used to convey this type of information, however it requires that the technology be easy to program in real time. Control over these devices may also need to be centralized so that they can be programmed in real time to display the necessary information while the station attendants are attending to the emergency on-site. There must also be a method to attract the attention of the hearing impaired passengers to the devices during these situations, and the use of a strobe or flashing light is a common solution. Flashing lights are used in the design of many types of alarms for the hearing impaired including telephones and doorbells.

The final problem that will confront transit users with significant hearing impairments is the inability to ask for help or directions from station attendants or customer assistants. These staff members are important wayfinding resources for transit users and should not be overlooked as potential sources of information. However, requiring station staff to be able to communicate with the deaf is not a realistic goal or expectation. However, training these attendants to be kind and understanding and providing paper and pens for communication purposes could go a long way for a deaf rider who has lost their way.

3.3.8 Mentally Impaired

There are many types of mental impairments that can affect wayfinding performance. Some users in this group may have severe mental impairments that affect their daily lives, while others may be fully-functional in most of their faculties but have some cognitive difficulty in comprehending the built environment. Many users in this group are elderly and also fall into other groups that have already been discussed in the chapter. Transit users with minor cognitive impairments typically learn to cope with their environment through reliance on directional wayfinding tools, verbal instructions or the "trial and error" method.

One of the most common forms of mental impairment that affects wayfinding performance is dementia. Specifically, dementia of the Alzheimer type (DAT) is a growing affliction as the population continues to age. DAT is a disorder of the central nervous system that affects between 5 and 10% of the American population over 65 years of age, many of whom can live with the disease for a long time (Passini et al, 1998). The increasing prevalence of this type of disease makes it important to design spaces that are understandable to users with diminished cognitive capacities.

Memory impairment and spatial disorientation are among the first signs of DAT and continue to degenerate as the disease progresses. Spatial disorientation due to DAT results from both memory problems and cognitive mapping difficulties, which often results in wandering through environments instead of more efficient goal-oriented navigation. This wandering behavior was evident in a study conducted by Passini with DAT patients who required significant help in order to reach their destination during a complex wayfinding task.

Wayfinders suffering from early and medium stage DAT retain the cognitive abilities to make wayfinding decisions based on explicit environmental information (such as directional devices) and routine behavior. However, they are far more likely to rely on decisions based on exploration. Additionally, because of the impairments in memory and cognitive mapping, DAT wayfinders have difficulties in making return journeys because they cannot easily reverse their original path. DAT patients have difficulty formulating and executing full navigational plans but can usually follow explicit instructions well.

These characteristics do not require any changes in the content of wayfinding devices, but rely heavily on redundancy in deployment in order to ensure the constant availability of information. Many passengers in this group have difficulty distinguishing between relevant and irrelevant information and may therefore read anything that they encounter. It is therefore necessary to separate essential directional and identification elements from other information of secondary importance during deployment.

Formatting requirements for this user group are largely the same as those that have been presented for other groups. However, this group requires careful attention to architectural wayfinding clues such as entrance and exit details that allows mentally impaired passengers to make decisions based on familiar types of information. Unrelated content should also be separated when designing the format of wayfinding devices to decrease confusion of mentally impaired passengers.

3.3.9 Illiterate

Establishing ubiquitous literacy remains a challenge in modern society despite improvements in education. The National Center for Education Statistics reports that almost one-quarter (21 to 23%) of adults in the United States demonstrate literacy skills at only the lowest level of proficiency[8]. This definition includes reading skills in several areas (including some quantitative literacy) and attempts to measure the skills necessary for accomplishing daily tasks, including wayfinding. A factor that was cited by the NCES as motivating this unexpectedly high proportion of illiteracy was age, with one third of those in this category being over the age of 65. However, the largest category of the functionally illiterate in the US is comprised of users who cannot read English. This group with be dealt with in depth in the next section. This section will focus on users who speak English but have difficulty reading it, although some of the requirements may be the same for both groups.

Many of these people make most of their wayfinding decisions from memory and past experience, not relying on wayfinding devices at all. Content and deployment requirements for this group will be defined by which use-based group they belong to and are not different because the passengers cannot read.

There are however many format design solutions that have been developed in order to accommodate these users. One typical solution deals with the message design and encourages the use of pictograms and symbols instead of words. Pictograms can be easily exchanged between languages and are typically easy for people to understand and remember. Pictograms can be used to

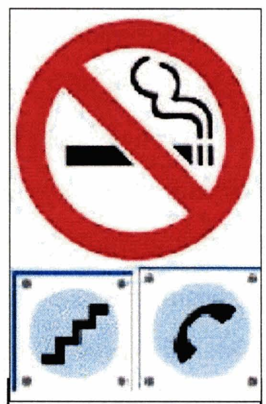

Figure 3-9: Icons are easily read when they clearly represent physical elements

[8] National Center for Educational Statistics at http://nces.ed.gov/naal/resources/execsumm.asp

represent any easily recognized physical element; however some concepts are too abstract to be adequately translated from text to pictures. (See easily recognizable pictograms in Figure 3-9). While many transit systems have developed graphics for these types of concepts, they often require a legend or written explanation because they are not readily understandable and are not standardized outside of the transit system. An example of pictograms that may provide little or no benefit to illiterate users is shown in Figure 3-10. The standardization of pictograms can improve the legibility of wayfinding devices for passengers in this user group throughout the built environment, not just in transit stations.

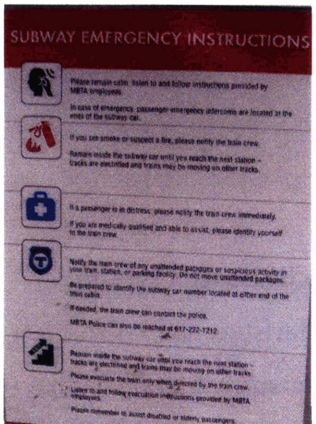

Figure 3-10: Emergency instructions on MBTA trains. (2005)

Pictograms can still be used as identifying devices even if they do not clearly translate into a physical element. Employing unique pictograms can identify a station or rail line as clearly as a written name, however there is a practical limit to how many pictograms a person can remember and identify (Devlin, 2001). Text names themselves can be used as memory triggers in the same way if they have unique shapes. The combination of upper and lower-case letters in names creates more unique shapes than capital letters alone (Arthur & Passini, 1992). Illiterate users can know what the name of their station looks like (though perhaps not how to say it) and will be able to alight at the correct location.

One major problem with pictograms is their variability; every agency, designer and architect may use different icons to represent the same element. This is especially true as people move between countries. The icon definitions must be able to transfer between spaces on as large a scale as possible (certainly within the transit system, hopefully throughout the country) in order to function well for passengers with literacy problems who are also members of a wide range of use-based groups. Despite a worldwide effort, global pictograms standards have not yet been agreed upon by the design community. A study of transit wayfinding by the Transit Cooperative Research Program (1996) looked at the pictograms used in transit systems in North America and made recommendations for standards in those countries; however they are not mandatory and no incentives have been provided for agencies to actually implement them.

The other major format for wayfinding information for illiterate passengers is audio devices. All of the audio formats discussed in section 3.3.6 can be used to communicate with passengers in this user group. PA systems in stations and on-board trains can convey the necessary content about service delays, station names and emergency instructions to passengers who cannot read.

3.3.10 Limited English Proficiency

High levels of immigration combined with a nationwide trend away from cultural assimilation have resulted in a truly multi-lingual society in many parts of the United States. In areas in the south and west of the country and in most of our largest urban areas it is quite common for a large group of the population to have limited proficiency with reading, writing or comprehending English. In some of these areas daily life can be conducted almost entirely in another language, while in others knowledge of English is essential. Imagine yourself looking for a train in Tokyo, not knowing any Japanese, and you can understand how difficult using a transit system in the United States can be to someone without the requisite skills in English. This is illustrated in Figure 3-11, and even with the heavy reliance on graphics in these wayfinding elements it is impossible to know the complete message that they contain.

Figure 3-11: Signage and wayfinding devices from the Tokyo subway system. Courtesy of Jeffrey Sriver.

As with the illiterate user group introduced in section 3.3.9, the content and deployment requirements are not different from those that have been previously introduced. The format requirements presented in that section highlighted the importance of utilizing pictograms and audio messages to aid those who cannot read traditional wayfinding devices. Pictograms remain a viable method of communication with non-English speakers so long as the meanings are clear or fully explained in multiple languages (See an example in Figure 3-12). Audio messages, however, may be just as unhelpful as written ones for those who cannot understand English. (For example, an audio message in Japanese would mean nothing to most Americans in Tokyo.)

Figure 3-12: Multilingual wayfinding legend in Tokyo's subway. Photo courtesy of Jeffrey Sriver.

In many large urban areas there are one or two predominant secondary languages that are heavily utilized. (For example: Chinese and Spanish in Los Angeles or Arabic in Jerusalem.) Providing information in multiple languages can place a very heavy burden on a transit authority unless these secondary languages and their populations can be readily identified and targeted for marketing, such as Spanish in the Pilsen area of Chicago or Chinese in New York City's Chinatown. When these secondary languages are necessary in one particular area, it means that they are also required throughout the system as the goal is to make passengers with Limited English Proficiency comfortable at all stations throughout the network.

Figure 3-13: Street signs in Jerusalem are written in the three common languages of the city: Hebrew, Arabic and English.

Several other coping mechanisms that may be utilized by wayfinders with literacy problems may be unavailable for passengers in this group. The opportunity to ask questions of ticket takers, customer attendants or station managers does not exist if there is no common language. These users must rely entirely on their own knowledge and understanding of the environment. Route memorization is a popular option that is often employed by Chinese immigrants in west coast cities like Los Angeles, where a series of landmarks are learned, often with the help of an experienced traveler in order to make commuting easier. (Kruckemeyer) This strategy is really only possible for a repetitive commuter-style route, not for first time trips typical to tourists in a foreign country.

3.4 CONCLUSION

The focus of this chapter has been to gather a comprehensive set of design requirements that can be used to design wayfinding systems in transit stations that meet the goals of Universal Accessibility. As one of the major steps in the systems engineering process, this first necessitated a comprehensive analysis of who potential transit passengers are, and what characteristics define their wayfinding behaviors. Three types of user groups were developed: use-based groups, physically-dependent groups and skill based groups. In total, twelve user groups were enumerated that encompass the whole range of potential passengers, with many passengers falling into multiple groups, and all passengers falling into at least one.

Wayfinding design is a complicated process, and in order to create a comprehensive requirements document, a framework was developed that would address all of the necessary issues. The design problem was broken down into three related but separate technical areas including content, deployment and format. The content requirements define what information is required by passengers. Deployment requirements dictate where the information should be located while formatting requirements define how it should be presented so as to legible and understandable by all potential passengers. This framework was first applied to the "habitual riders" group which was used as a baseline. Once the basic wayfinding criteria were established, additional requirements were added based on the needs of each user group. Taken together, these requirements represent the design criteria necessary in order to design a universally accessible wayfinding system.

The requirements document that has been developed in the Chapter will next be checked against two large, American transit systems and the wayfinding systems that they have implemented. Chapter 4 will focus on the Massachusetts Bay Transportation Authority's design standards (which date back to 1966) and compare them to the devices that are used in the actual stations. This case study presents one of the best opportunities available to see how wayfinding design guidelines have evolved through four decades of change. Chapter 5 will do the same for the Chicago Transit Authority, and will also focus on some of the supplementary programs that have been implemented by that agency and how they have affected wayfinding. The CTA system is the second largest in the United States, and illustrates one of the most complex situations for transit wayfinding available. Chapter 6 will take the lessons learned from these case studies and combine them with the design criteria that have been developed in this chapter and aggregate them into one set of design requirements. Again, the three technical areas of content, deployment and formatting will be used in order to create a document that can be readily used as a guideline by transit agencies and wayfinding designers. Additional requirements for system maintenance, management and operation will also be provided.

4. CASE STUDY: MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

This chapter will analyze the development of wayfinding design in the Massachusetts Bay Transportation Authority (MBTA) rapid transit system. It will begin with an analysis of the formal written design standards that have been developed for use in MBTA stations and continue to compare these standards with existing conditions in these stations. Both the standards and the current conditions will be analyzed according to the informational and design requirements that were developed in detail in Chapter 3 to determine their continued applicability in today's political and social environment.

The first set of wayfinding standards that will be analyzed is the "Manual of Guidelines and Standards" developed for the MBTA in 1966 prior to the system's expansion and modernization. This document has been used by the MBTA as a baseline for continual system improvements by incorporating this manual into the periodic design updates that have occurred since. The first major update occurred in 1978 for use on the Southwest Corridor Project. The most recent design update occurred in 1990 and is called the "Guidelines and Standards." An update was appended to the Guidelines in 1995 in order to address the new requirements imposed by the implementation of the Americans with Disabilities Act (ADA) in 1990. Together, the 1990 design update and the 1995 accessibility update continue to control the design of wayfinding devices in MBTA stations to the current day. The changes and innovations introduced in each successive set of guidelines will be discussed and illustrated with examples from the system as it exists today.

The wayfinding system currently in use in MBTA stations will be compared to the MBTA's formal standards in order to see what types of informal changes have been implemented in the past 15 years. It is expected that few, if any, stations will have completely implemented the standards as published due to budgetary and site constraints. This comparison will be used in order to formulate a set of recommendations specific to the MBTA for updating the existing wayfinding guidelines and improving conditions in the stations. These, combined with the recommendations developed for the Chicago Transit Authority in chapter 5 will be used to formulate generalized guidelines for wayfinding systems in transit stations in chapter 6.

4.1 The Original Design Manual

A complete set of design guidelines was developed by the MBTA prior to the modernization and expansion of the system that began in the late 1960's. The architectural and engineering consultants who created these guidelines sought to standardize the design of stations throughout the MBTA system in order to make them more attractive, efficient and easier to use. The analysis by Cambridge Seven Associates began with a field study of the stations existing in 1962, which included two topics that are important to this thesis. The survey studied the signage systems that were used at the time under the category of "Graphics" in addition to cataloging "Identity Factors" at each station. The latter is described as "those things by which one remembers, recognizes and identifies a particular station, or that which sets it apart from other stations" (Cambridge Seven Associates, 1966). The results of this survey show that a wide range of signage styles were commonly used throughout the system. Black text on either a yellow or a white background were catalogued most frequently, although the standard design for new sign installations at the time was black text on a yellow background. Many different types of "identity factors" that allowed passengers to identify stations from within an arriving train were noted in the survey, including important architectural elements, key accent colors, highly visible wayfinding elements, lighting levels and even the state of disrepair of certain stations.

The comprehensive guidelines that were introduced at this time established some new principles for wayfinding designers at the MBTA and codified other rules that had long been in use throughout the system. The Manual included a clearly defined set of goals and objectives for station design that emphasized (perhaps for the first time) the importance of wayfinding in the passenger experience. The designers sought to create an environment where the passenger was not only "physically comfortable, he must also know in the fullest sense where he is and where he is going." This new focus on orientation and information shaped the design guidelines in the 1966 Design Manual and created a very powerful wayfinding system that gives wayfinding "high priority in the early design phases of each project."

This Design Manual also represents an attempt by the MBTA to standardize the design of all aspects of their transit system including stations, vehicles and printed material in line with the expansion and modernization projects that began around this time. Wayfinding was only one element among many that could benefit from the standardization that was recommended by this document; however it is one of the few areas in which standardization can be achieved without massive station rebuilding. Standardization is important in the design of wayfinding in transit systems because stations are physically disconnected and must be linked visually through the use of graphic devices in order to create a strong identity for the transit network.

The cohesion that is provided by the original Design Manual is perhaps its greatest contribution to the wayfinding legacy at the MBTA. This consistency allows for easy use of multiple stations and requires passengers to learn to recognize and read only one type of wayfinding device. It allows passengers to travel with confidence knowing that they will be able to find their way at all stations within the system. It also consolidates signage within individual stations to reduce visual clutter and eliminate redundant information.

Specific design guidelines were introduced in the Design Manual for most wayfinding elements. They include details as minute as installation and material specifications and broader subjects such as system and station-wide guidelines for map design and deployment. Many of these details have been implemented fully throughout the MBTA system and provide the backbone of a standardized wayfinding system. The design of advertising elements is not specifically addressed except to say that revenue signage elements should take second priority to wayfinding devices.

The rest of this section will discuss some of the more important innovations introduced in this manual and their affect on the passenger wayfinding experience as a part of the overall design of MBTA stations. All of the standards that will be introduced in this section come directly from the Design Manual, while the analysis is my own except where otherwise indicated. Specifically addressed will be the color-coding system, the inbound/outbound orientation convention, methods of station identification, maps, directional devices and the treatment of accessibility in the 1966 Design Manual.

4.1.1 Color Coding

Before the MBTA implemented their plan for system modernization in the late 1960's, many aspects of station design were implemented on a station by station basis. The architectural design of each station was determined by site conditions and the discretion of MBTA architects. Wayfinding faced a similar situation, with signage requirements for each station determined on an as-needed basis. Especially absent was an effective system of color-coding that reached beyond printed material into the actual transit system. For example, Harvard Station on the red line was identifiable by its maroon (perhaps crimson?) color while Kendall, also on the red line, was primarily green (MBTA, 1966). While these individualized colors may have helped to differentiate stations from one another, there was no unifying scheme that facilitated the creation of line and system identities. The Design Manual contends that the creation of a strong MBTA identity would help to improve its image within the community. Further, it would improve passenger's orientation within the system by helping them to understand its underlying structure. Both the system identity and the line identities were accomplished largely through color coding. Each rapid transit line was assigned a color, with brown reserved for the addition of a future line. This would allow each station on the blue line to be recognized at first glance as being a part of the Blue Line. Standard colors were implemented for the MBTA bus fleet and printed media (including advertising) that would increase awareness and recognition of the services provided by the MBTA.

Color coding is a powerful tool that is also implemented in other parts of the MBTA system to help promote unity and identity. The Design Manual standardizes the use of color within stations including two shades of grey for station and vehicle painting and yellow for "signal and warning purposes." Yellow was used for all warning devices (except emergency exits signs) including the warning stripe on the edge of platforms. Yellow was also used extensively as accent and warning on the bus fleet and was the color eventually developed into an identifying feature of the bus system.

4.1.2 Inbound/Outbound Orientation

The MBTA rapid transit system is a radial system centered in downtown Boston. As such, rail travel has typically been designated as "inbound" for trains traveling towards Boston and "outbound" when traveling away from downtown. This results in a train changing from "inbound" to "outbound" without turning around. This system relies heavily on passengers' knowledge of how the rail system is structured geographically within the context of the Boston region. With a little explanation, this system is easily comprehensible at any station outside of downtown. All stations have an inbound and an outbound platform. Unfortunately, this directionality convention breaks down at a few centrally located stations.

The Design Manual codifies the directional convention of "inbound" and "outbound" trains and platforms despite the confusing elements already noted. At the innermost stations all directions are theoretically outbound. In order to implement this convention at the central stations, the Manual dictates the center of the system to be an imaginary point located inbound of all four downtown transfer stations as shown in Figure 4-1. However, this center is not explicitly marked on any MBTA wayfinding materials, leaving passengers to decipher the convention for themselves. This standard requires explicit written explanations of train directionality, especially at the busiest and most complex stations. At these stations, clusters of stopped customers (reading signs or studying maps) can create traffic bottlenecks and severely reduce the efficiency of the station.

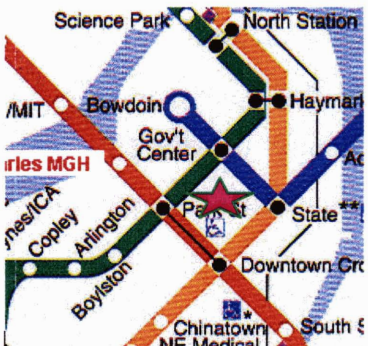

Figure 4-1: The theoretical center of the MBTA rapid transit system.

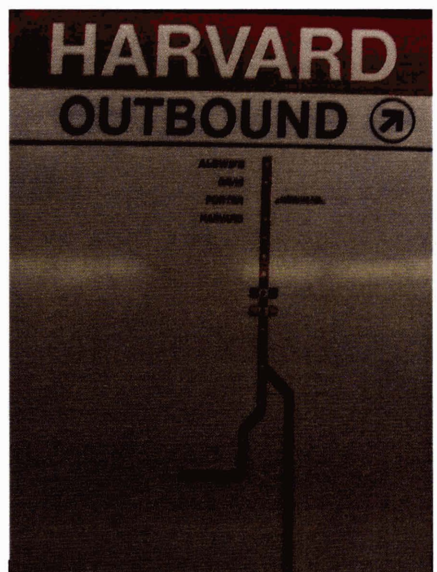

Figure 4-2: This Station List shows which stations are accessible from the outbound platform. It also shows the direction of transfer points, without detailed geographic context. (2005)

The Design Manual introduces a map

element to clarify the directionality convention by listing the stations served by a given platform. (See Section 4.1.4 for further details on MBTA maps.) Station Lists are ordered lists of stations on a line that are divided according to their directionality, inbound and outbound. These elements are used at decision points as directional devices in order to direct passengers to the correct platform, as shown in Figure 4-2. They can also be used to identify the directionality of a platform. These elements must be customized for each station and are to be located near to maps of the full transit systems at all times for context.

In addition to the written signage elements, the Design Manual introduces a standard for color-coding platform endwalls[9] that distinguishes the "inbound" and "outbound" directions. Endwalls on the innermost end of each platform (from the system's center) were to be painted in alternating stripes of red and orange while those on the outer end were to be striped blue and green. Green and blue were colors thought to connote the outdoors, and were therefore located on the "country" end of each platform. These colors were to be the same throughout the system regardless of the line and in most cases would not match the line-based color-coding scheme that was also recommended for platforms by the Design Manual.

4.1.3 Station Identification

Two types of station identification devices are necessary in transit stations: street-side devices and on-platform devices. Street-side identification devices are located on the surface within a neighborhood and are used by passengers entering the system. These elements announce the presence of a station and identify it by name. Identification devices that are located on the platform are used by passengers who will be transferring or exiting at the station and therefore enter the station by train. Both types of devices are discussed at length in the Design Manual, which produces standards for many types of station configurations.

The first element used for station identification incorporates the well-known 'T' symbol in a backlit street sign as shown in Figure 4-3. The standard calls for a black 'T' on a white background with no alterations permitted. The purpose of this sign is to add

[9] Endwalls are the walls at the end of the platforms that are perpendicular to the tracks.

visibility to station entrances and highlight the location of a station within a neighborhood. It is not designed to convey any other information about the station or the services available there. The uniformity of its design helps potential passengers to locate it easily as they scan the urban landscape because they know exactly what to look for. The backlighting of this device increases its visibility in the dark.

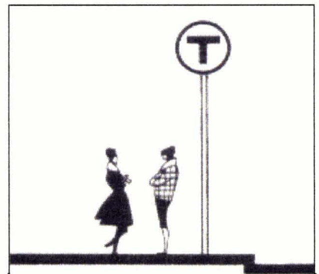

Figure 4-3: Standard for a 'T' Symbol street-side station identification device.

Identification devices at each station entrance are required to provide more information than the 'T' symbol alone, as discussed in Chapter 3. The standard 'station entrance signs', shown in Figure 4-4 include three essential pieces of information: the line color, the station name and the hours of operations for that entrance. These signs utilize the color coding system to indicate the transit line and can be customized to use two background colors at transfer points. The Design Manual requires placement of these elements above all stairwell station entrances, in such a way that they interfere minimally with other signage in the area. Its visibility is therefore somewhat limited.

Figure 4-4: The three possible designs for Station Entrance Signs above station entry stairwells.

Station identification elements are also necessary on each platform for use by passengers arriving to the station by train. The Design Manual introduces a set of bands that provide both identification and some directional information. This device is similar in design to the station entrance signage and is colored according to the rail line color coding

Figure 4-5: Name and Information Band standards at Davis Square. (2005)

system. The colored portion of these bands is called the 'Name Band' a pair of them run the length of the platform, with station names spaced evenly across it. These bands are located at heights of 16 inches and 5 feet so as to be visible by both sitting and standing train passengers. The upper Name Band is paired with an Information Band as shown in Figure 4-5 which provides dedicated space for additional directions or information. The station name is centered in each structural bay of a station which allow it to be viewed from somewhere within every train car. However, this information is not easily visible from all locations and positions within a car.

The implementation of the Name Bands at all stations standardizes the view from a train at *all* stations, with the only difference being the station name itself. This may make it difficult to distinguish between stations for those passengers without direct visual access to the text. In order to help relieve this type of monotonous progression along the line, the Design Manual introduced the concept of station specific photomurals "to establish or to reinforce the special identity of each station." Well known images from the neighborhood surrounding a station are used to create large scale murals on platform walls that are visible from inside train cars. If these murals are to function effectively as station identifiers, they must be substantially different at each station and also must be visible from the interior of each train car.

4.1.4 Maps

Some of the most important types of wayfinding devices in a transit system are the maps that provide structural and orientational information that is essential to planning and executing a transit trip. The MBTA Design Manual introduces several different types of maps to meet the range of wayfinding needs in MBTA stations. These maps exist on several scales to help passengers navigate the MBTA system area.

The first type of map device is not actually located inside of a station at most times. Strip maps are located within rail cars and list stations sequentially along a single line for basic orientation purposes. They rely on the on-platform station identification devices that were introduced in the previous section to provide orientation along the strip. This standardized element functions well and only one design is required for each line. The branching of the Green Line and the sheer number of stations it serves are difficult to accurately depict of this type of map.

System maps are large-scale maps of the Boston metropolitan region that show some basic geographic features along with the rapid transit system and commuter rail services. The bus system and other non-MBTA transportation services are not shown on these maps. System Maps provide a general orientation within the overall Boston region but do not provide any detail about the MBTA services. The information in another map at a more detailed scale must be combined with the System Map in order to plan a trip.

The Rapid Transit Line (RTL) maps show the basic structure of the rapid transit system in a stylized form that roughly approximates the actual system geometry (See Figure 4-6). These maps provide little information beyond the structure of the rapid transit system and transfer points. Still, no bus or commuter rail information is available. These maps are standardized throughout the system and must be updated as needed in order to be truly effective.

Figure 4-6: 1966 version of the RTL map.

In order to accurately understand the inbound/outbound directional convention, the RTL maps must be combined with the Station Lists discussed previously and shown in Figure 4-2. Station Lists are one of the only places where any explanation of the inbound/outbound directional convention can be found, and are therefore essential for the success of this important convention. These map devices must be customized for each station.

The final type of map required by the Design Manual is the Neighborhood map that is customized for each station shows the area surrounding a station in detail. These maps are supposed to include the street names and addresses of the surrounding area to help passengers orient themselves when they emerge from a station. The "you-are-here" icon that is to be included on the Neighborhood map provides an additional method for orientating and locating oneself within the environment. Local bus routes are to be included on these maps and are one of the only places that detailed locations of bus stops can be found. Major landmarks are also to be included. Orienting passengers in detail to the urban environment is an important role filled by the Neighborhood Maps.

This set of maps addresses most of the major informational and orientation needs within a transit system. The only area that is not included in this mapping system is that of the station itself; there is no provision to provide maps of the interior of very large or complex stations. However, none of the maps can convey all of the necessary information without additional information from other devices. System maps are only useful when combined with an RTL map and Station Lists. These interrelations require a great deal of space in order to display all of the necessary information. The strategic deployment of these maps is therefore an important challenge that must be overcome by station designers.

The layout strategy for this map system is also prescribed in the Design Manual and is based on the direction of passenger traffic. The layouts are designed primarily to provide the specific information required by two groups of passengers: those entering and exiting stations. Passengers entering the system are expected to require information about the system in order to plan their trip. System maps, RTL maps and Station Lists should be located at all decision points leading to the platforms, including the unpaid area of the station. Exiting passengers primarily require the Neighborhood map. The Design Manual recommends that these maps be located on the platforms and near all station exits. In order to accommodate the needs of transferring passengers, System and RTL maps are also necessary on the platforms and along the paths between platforms.

Compiling the mapping needs of all passengers results in all four of the station-based maps being located in the unpaid area, on all platforms and in the paid area of the mezzanine. In addition, some maps may be required at other decision points throughout the station. The maps are to be located together in bays of between three and six maps, depending on spatial constraints. They are to be arranged linearly so that passengers encounter the information that they need first, as shown in Figure 4-7. Entering passengers should first see the Station List, followed by the RTL and System

Maps, as this is the information that is most pertinent to them. For passengers who know their destination station, the Station List may be the only necessary map.

Based on the specified dimensions for each of these maps (typically four feet square), wall space limits the number of maps that can be installed in many stations. In stations where some maps must be excluded, the Station Lists have the lowest priority and can be consolidated onto a single map panel if necessary. The Neighborhood and RTL maps have the highest priorities and should be included whenever possible. Platforms are to include several repetitions of both the RTL map and the appropriate Station List. Also prominent on platform map displays were the System and Neighborhood maps.

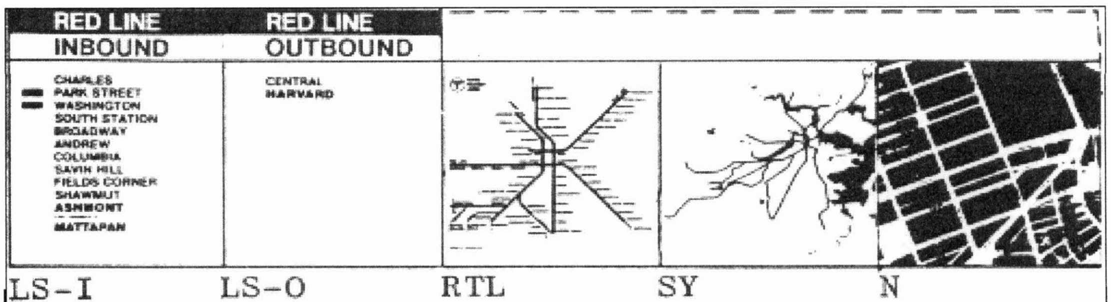

Figure 4-7: An example of a standard map bank where the flow of entering passengers moves left to right encountering first the Station Lists followed by the RTL and System Maps. Exiting passengers flow from the right and encounter the Neighborhood Map first. (MBTA, 1966)

4.1.5 Directional Devices

Directional signage elements play a crucial role in all wayfinding systems by providing detailed instructions on how to reach specific destinations. The Design Manual dictates that directional devices should be installed at all decision points wherever multiple paths intersect or traffic flows divide. In long paths and corridors without decision points, directional devices confirming the destination chosen should be installed at frequent intervals (approximately 50 feet) as reassurance. Both of these guidelines are in line with current recommendations on wayfinding theory and design. (Arthur & Passini, 1992)

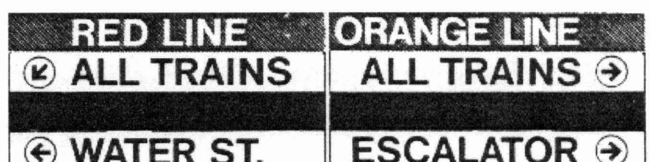

Figure 4-8: Directional devices should be divided by the direction of traffic flow in order to avoid confusion. (MBTA, 1966)

The Design Manual requires that elements at points of branching circulation be separated by the directions of traffic, so that all of the destinations requiring a right turn are grouped together separately from those requiring a left turn (See Figure 4-8).

The design of the standard directional device is simple, and uses text to describe possible destinations and arrows to denote necessary motions. Text and arrows are always black print on a white background, with color only utilized in a limited fashion when one of the four rail lines is the destination. As such, they resemble both the station entrance signs and platform identification elements that have previously been discussed. Elements are to be stacked to make the most use of limited wall space. Where additional reference information may be necessary in order to make a decision, these elements should be located somewhere away from the decision point so that the directional devices are not obscured by stationary passengers. Directional information is also provided in the "Information Bands" (introduced in section 4.1.3) on platforms. Black text and arrows on a white background are the standard here as well, with no colors permitted even for line transfers. Figure 4-9 shows how the lack of color in the Information Band makes transferring more difficult.

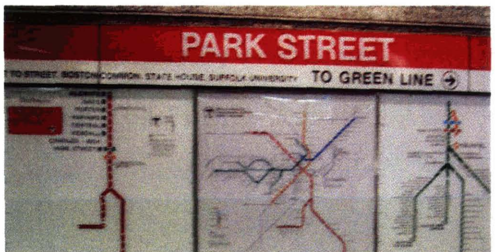

Figure 4-9: Directions to transfers are hard to see in Information Bands

4.1.6 Accessibility

This Design Manual makes absolutely no direct mention of accessibility anywhere in its four volumes. Even in the non-wayfinding sections, accessibility for people with mobility impairments is not a concern of any weight. There is no standard for marking accessible routes nor is there any mention the importance of signage for elevators. There are no provisions for Braille/tactile wayfinding devices. Every wayfinding device presented in the Manual is a visual clue with no audio or tactile counterparts. This may be expected from a document that was prepared in the mid-1960's, however this glaring omission makes it highly unusable for use in stations currently without major updates and additions.

That being said, textual design is an important issue in the Design Manual that attempts to increase the overall usability of the wayfinding system in a manner similar to the criteria for accessible design. This thesis will not delve deeply into the standards for textual design that were established in 1966, and those requiring more detail should read the Manual. Textual design was approached from a desire to make wayfinding elements more legible and visible for MBTA passengers. Helvetica Medium is designated as the standard font for all MBTA printed matter (except for the bus fleet) because it is easily legible and highly visible. Black text on a light (preferably white) background is recommended for the same reason, though details for white text on black backgrounds are also introduced. No text is *ever* to be written in color. Several other important text design issues are standardized including letter and word spacing, letter heights and widths and the allowable sizes of commonly used pictograms. While not truly using accessibility as their main criteria, the designers of these standards did create a wayfinding system that was legible for a large portion of wayfinding passengers.

Overall, the 1966 Design Manual presents a comprehensive look at wayfinding in MBTA rail stations. The three technical areas of content, deployment and formatting are all addressed by these standards. The designs that it proposes are intended primarily to increase orientation within the system while simultaneously improving the aesthetic appeal of some previously derelict stations. The Manual attempts to create a bond between the rail system and the city that it serves through the use of maps, photomurals and a strengthened identity at station entrances. The identity of each line is enhanced through a strict color-coding system and the use of various types of rail system maps. Ultimately, the designers attempted to create a unique "sense of place" at each station. In addition, the Manual seeks to eliminate old or redundant information by consolidating wayfinding devices and standardizing their design. This makes it possible to use the wayfinding system throughout the MBTA rail system by experiencing and learning the conventions at a single station.

There are some oversights and shortcomings in the Design Manuals' standards, which were expounded in the sections above. Many of the design guidelines and conventions were designed to fit the needs of the central transfer stations, which are the most complex in the system. These four stations have the most complex structures and require special attention and flexibility in the design standards in order to accommodate heavy traffic flows between multiple platforms. The addition of detailed wayfinding plans for these stations would make the Design Manual inherently more usable for the MBTA. Again, the most glaring omission from this Manual is the lack of any type of accessible design for the wayfinding system. We hope to see awareness of this issue growing as the design guidelines continue to develop.

In the next section, we will look at a compilation of a series of updates to the 1966 Design Manual that address many of its failures and incorporate many of its successes. Most of these changes have been implemented in order to simplify maintenance or to conform to new standards for accessibility. The standards and guidelines presented in the Design Manual represent an attempt to create an idealized wayfinding system for the MBTA and it is recognized that flexibility will be necessary during the implementation of this system in order to accommodate site specific conditions. At the end of this chapter we will look at the actual wayfinding system currently utilized in MBTA stations. We do not expect to see these standards implemented exactly as written throughout the system, but instead used as a baseline for wayfinding at each station.

4.2 UPDATES IN THE 1990'S

After publication of the 1966 Design Manual, the MBTA went through a period of substantial system expansion and modernization. The decade after its publication added several new stations to the system while improving operation and design at many others in accordance with the Design Manual. Deficiencies in the guidelines were found, while changing circumstances created the need for newly designed wayfinding devices. Over a period spanning almost 25 years many changes and additions were regularly incorporated into the Design Manual regularly. In 1978 a separate although complementary document was compiled for use on the Southwest Corridor Project which built new stations as part of the construction of the new Orange Line. The most recent edition was compiled in 1990 and retains most of the text and diagrams used in the original version. It has been condensed significantly from the original and contains many of the needed alterations and additions. Most significant in 1990 is the continued dearth of information about the design of accessible stations and wayfinding systems.

The introduction of the Americans with Disabilities Act (ADA) also occurred in 1990 and had a significant impact on many aspects of the design of transit stations, including wayfinding. Unfortunately, the 1990 Design Manual did not address many of the new requirements imposed on the MBTA wayfinding system. An update in 1995 catalogued which of the new regulations affected wayfinding design. This update created detailed design guidelines that dealt with the many requirements enacted by the new legislation by implementing mostly incremental changes. Together, the 1990 Design Manual and the 1995 Accessibility Update govern wayfinding design in the MBTA to this day. The following sections will address any changes of substance that were introduced in these documents to the important areas that were highlighted in the previous section.

4.2.1 Color Coding

The color coding scheme proposed in the 1966 Design Manual remains essentially unchanged in the updated version. Each of the four rail lines uses a distinct color in order to establish its own identity. The scheme was expanded by dedicating the color purple to the commuter rail system. Although different shades of purple are frequently found on maps than on the commuter rail cars, this may be due to weather exposure. Another major addition to the color coding scheme was the reservation of the color "aqua" for use on handicapped accessible paths and elements.

4.2.2 Inbound and Outbound Orientation

The convention of designating trains as Inbound or Outbound is maintained without any significant changes in the new updates of the Design Manual. However, the directionally based color-coding of platform endwalls in striped patterns is no longer recommended because it is incomprehensible without additional explanatory information. It would require many trips patronizing a variety of stations and an extraordinarily observant traveler to decipher the meaning of these colors without wayfinding aides. This recommendation survived until the 1978 Southwest Corridor Project Design Manual. (Kruckemeyer).

4.2.3 Station Identification

The basic design of the station identification devices introduced in the original Design Manual has remained the same. There are two street-side devices that are used to indicate the presence of a transit station; the backlit 'T' symbol and the overhead station entrance signs. Instead of only one 'T' symbol, these backlit signs are now required near each station entrance in order to enhance their visibility. These elements are still designed as only a black symbol on a white background. Backlighting in general is discouraged in the updated Manual due to maintenance and budgetary concerns. The standard overhead station entrance sign was shown in Figure 4-4 and has not been altered significantly. However, additional information is permitted on these elements beyond the hours of operation, and the new standard establishes the directionality of the platforms accessible from each entrance as shown in Figure 4-10. Allowing this and other pieces of information to be included on these devices as dictated by individual circumstances is an important addition these elements.

Figure 4-10: The updated Station Entrance Sign standard includes the directionality of the trains accessible through each entrance, instead of the station hours. (MBTA, 1990)

The on-platform Name Bands are still the standard for use in all stations, with a few small changes required by the onset of ADA regulations. The spacing of station names is now mandated by the length of a train car, and a name plate must be visible from each. (The distance varies by line, but ranges from 50 to 74 ft.) In addition, ADA requires that the station name be visible from train passengers seated on both sides of a train. Therefore, the Name Band must be repeated on the non-platform side of the tracks. Also championed in the earlier version of the Design Manual were station-specific photomurals that were used to identify stations for passengers arriving by train.

In the 1990 update these photomurals were relegated to an optional design element dependent on the overall MBTA public art program and budget[10].

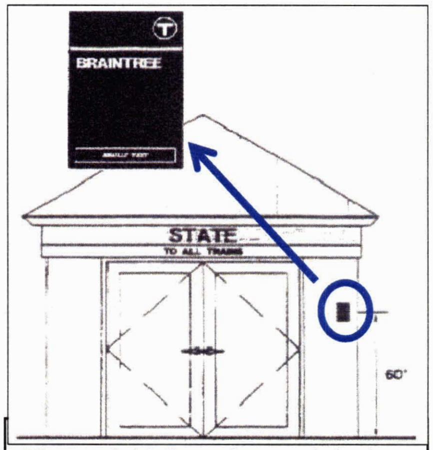

Figure 4-11: Location and design of Tactile/Braille station identification devices. (MBTA, 1990)

ADA has mandated two important additions to the design guidelines for station identification devices. Braille and tactile identification plaques are now required at a standardized location to the right of each station entrance (See Figure 4-11). This locational consistency will help visually impaired users to find the devices as they enter the MBTA system. Braille/tactile identification devices are also required on platforms for exiting and transferring passengers. Only one tactile device is required on each platform and is to be located near the foot of the main entry staircase or (in the case of multiple entry points) in a central location on the platform.

4.2.4 Maps

The standard set of maps that was introduced by the 1966 Design Manual is still used in the current edition. More detailed instructions are provided on where specific types of maps should be deployed within a station, although the basic requirements are the same. Map displays should be located in the unpaid area, the paid area of the mezzanine (if one exists) and on all platforms. Provisions for locating maps on bus platforms are also included for the first time.

A new Commuter Rail map has been added to the arsenal and is to be located with other maps on the platforms and in the mezzanines of any station with a commuter rail connection. These maps only provide a graphical representation of the commuter rail system and give no additional information about fares or schedules. The updated Design manual also introduces a Schedule Case as a means of displaying information

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[10] This is despite language in the original document that insisted that the murals were not art at all and decried the public art program as "idiosyncratic expression" that can "only perform a decorative function, and as such has little relevant place in the transit system."

that may change frequently. Specifically, these cases are designed to hold bus and commuter rail schedules and route maps. They are wall mounted and should be installed in the unpaid area in any station with significant local bus service.

Two additional criteria must be met when implementing the system of MBTA maps. The deployment scheme must allow passengers to study the maps without interfering with the regular traffic flows in the station. The placement of maps at major decision points should be limited because these locations can easily become bottlenecks and create congestion. The ADA Accessibility Guidelines further require that passengers be able to study all maps closely, allowing those with partial visual impairments to use them. Maps must be located in accessible areas where passengers can stand within two inches of the map surface without blocking other passenger traffic.

4.2.5 Directional Devices

There have been no changes to the standard directional devices used by the MBTA. ADA now mandates that all accessible paths and entrances by marked clearly as such. All accessible paths must be labeled clearly using a combination of words, text and arrows. At any decision point at which a path becomes non-accessible, directional elements to an accessible one must be provided in such a way that a passenger would never need to backtrack to find their destination. In addition, non-accessible station entrances are required to give explicit directions to the nearest accessible station entrance. This requires a different type of directional device because the path to the entrance is not within an MBTA controlled environment. Therefore, all of the directions necessary to complete the trip must be provided by a single device located at the non-accessible entrance. These directions can be complex or simple, depending on the situation and they typically use

Figure 4-12: This non-accessible entrance to the Harvard Square station includes direction to an accessible entrance utilizing text, a non-standard arrow and the accessibility icon.

text coupled with arrows and the standard accessibility pictogram as shown in Figure 4-12.

4.2.6 Accessibility

Almost all of the major additions and changes to the wayfinding standards introduced in the most recent edition of the Design Manual are related to the accessibility of stations as defined by the Americans with Disabilities Act. The legislation recognizes three major groups of disabled passengers that require special consideration in wayfinding design; those with physical, visual and hearing impairments. Many of the design features for the first two groups have been introduced already, so only additional items of importance will be discussed here. Overall station accessibility for the mobility impaired is not guaranteed at all stations so a full catalog of those that are accessible must be available before a passenger begins his trip. Therefore, all RTL maps must indicate which stations are accessible to persons in wheelchairs. The same is true for the commuter rail system.

Visually impaired passengers require a wayfinding system that is almost entirely separate from the visual system previously designed by the Design Manual. Both Braille and tactile information is now required to label station entrances, platforms and all permanent rooms within a station. All graphics used in wayfinding devices must be explained using a Braille/tactile device whenever possible. While this can be a simple exercise for some of the more basic pictograms (like those for bathrooms or stairs), the more complex graphics (like maps) present a substantial challenge. Tactile descriptions of these types of graphic devices are not required by ADA. Therefore passenger comprehension of the system structure and orientation within it, the main goal of the wayfinding system, is not readily available to the visually impaired.

Directional devices are not required to have tactile counterparts. This is an extremely important formatting omission, as it effectively requires all visually impaired passengers to travel with a companion until they have learned each station well enough to navigate on their own. Directional devices are extremely important for blind passengers even in architecturally simple stations as these passengers cannot make full use of the architectural clues provided by the station itself. In addition, station identification for visually impaired passengers exiting trains can be difficult as previously noted. In order to combat this problem, on-board audio announcements of station names are also required.

Deaf passengers require some special attention when information is conveyed audibly. This situation is most commonly encountered when a Public Address (PA) system is in use either in a station or on a train. PA systems are typically used to provide frequently updated information or instructions in emergency situations. It is important that a deaf person be able to obtain this information in a timely manner. Variable message systems are therefore required in as many locations as necessary in order to ensure that this important information is visible to all passengers. This requirement applies to on-board transit vehicles in addition to in all stations where ADA requires audible announcements of all station arrivals.

The ADA legislation has very strict requirements for the design of textual elements, all of which are met by the MBTA standard font. Legibility is improved by requiring high contrast levels between text and background colors and by requiring lettering at least three inches high. The black and white combination favored by the Design Manual easily meets these criteria.

In matters of design, there have been very few changes to the Design Manual over a period of almost 30 years. The original concepts and guidelines that were introduced in 1966 remain essentially unchanged to the current date. However, the introduction of a multitude of ADA requirements has changed the format, quantity and deployment of many wayfinding elements. These new requirements have been integrated into the existing system with a few remaining concerns that can be remedied. Even with these improvements, some of the user groups introduced in chapter 3 of this thesis have not been fully accommodated by the MBTA and their designers. Other changes have simplified the design of wayfinding elements in order to reduce costs, simplify maintenance and standardize installation.

Overall, the system remains intact as a complete wayfinding system. Standardization and consolidation throughout the system will continue to provide identity and orientation to passengers while making the transit system usable for a large segment of the population. The next section will look at to what degree these design guidelines have been followed during implementation.

4.3 EXISTING CONDITIONS

All of the MBTA stations have been updated since the last station survey was conducted in 1962. The wayfinding devices used in all stations very closely resemble the design standards presented in the Design Manual. Some adhere very strictly to the guidelines while others take more artistic license due to unique circumstances. For example, both the color coding scheme and the "Name Band" standards have been implemented successfully throughout most of the system. Photomurals exist at many stations. Most station entrances are marked with appropriate signage. System maps and directional signage are successfully deployed at most of the periphery stations although the success of directional wayfinding at the transfer stations is arguable, at best. However, some aspects of the wayfinding system have not been executed as designed. In addition, a new type of wayfinding device has been recently added to the system that is not present in any incarnation of the Design Manual. These new devices adhere to neither the MBTA nor ADA guidelines. A quick tour through some stations as they exist today will do well to illustrate these and other specific points.

4.3.1 Color Coding

The color coding scheme that was introduced by the 1966 Design Manual has been implemented throughout the MBTA system. The line colors help to create strong identities and are used for both accent coloring in architectural design as well as in wayfinding devices. As individual stations have been renovated, the color coding has taken on an even more prominent role in station design than in some of the older stations. Many renovated stations are now designed using their official line

Figure 4-13: Color confusion on the Green Line platform at Park Street.

color as an accent color. The color scheme has also been implemented at transfer stations, although with somewhat limited success. While platforms can be easily color coded, mezzanines and entrances at these stations are more difficult to categorize and are dealt with differently at each station. For example, Figure 4-13 shows a Green Line platform at the Park Street station that uses gray, red and yellow, but no green.

This color coding problem is more pronounced on the newly opened Silver Line. The silver color was selected because of its modern connotations, not for graphical convenience. Much of the MBTA system (vehicles, stations and other hardware) are already painted various shades of gray and this often makes the newly added 'silver' difficult to distinguish from the colors already in use. In order to combat this problem, and to improve the image of the fledgling bus rapid transit service most of the Silver Line stations use metallic silver elements for wayfinding devices, as shown in Figure 4-14. These elements have been designed to resemble the traditional MBTA wayfinding devices by using the same layout, fonts and graphics. While the difference in materials is striking it has created a situation in which many devices do not adhere to the standard design criteria. Further, the excessive glare produced by these elements may cause them to be out of compliance with the ADA design guidelines, as well.

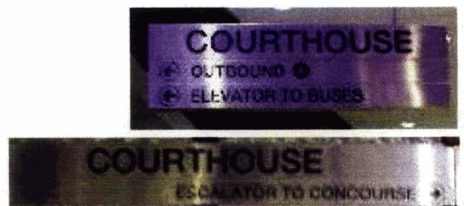

Figure 4-14: Silver wayfinding elements on the Silver Line. (2006)

Two of the main destinations served by the Silver Line do not make use of the newly designed silver wayfinding devices. Both South Station and the airport use a different system of wayfinding devices. In the Silver Line areas of the new transfer point at South Station both red and gray color coding are combined with the Silver Line logo for wayfinding, as shown in Figure 4-15. The MBTA is planning on replacing the red elements with the correct color (Boylan, 2006). The platform itself uses a gray version of the traditional elements that coordinates with the nearby red line platform, instead of the metallic silver design, which does not coordinate well with the other stations on the Silver Line. At the airport, the Silver Line functions as a bus, and as such its stops are substantially different than those that are grade separated. The stops are barely visible among the myriad of other transportation options and do not use the more visible silver elements.

Figure 4-15: Clockwise from bottom (a) Directional device at South Station using only the Silver Line logo. (b) The Silver Line platform at South Station is colored both gray and red. (c) The South Station mezzanine incorporates red and gray color coding in addition to the logo.

Recommendations

Implementation of a color coding scheme requires system-wide consistency in order to have a discernable effect on passengers' wayfinding experience. All identification devices, maps and informational signage must use the same colors to enforce their meanings. Colors on all elements must be selected carefully so that they match completely and are distinguishable from the other colors. Time has a fading effect on most colored devices and especially increases the similarities between the orange and red used by the MBTA.

Color coding is a purely visual means of separating elements, and cannot easily be transferred to a non-visual medium. For those passengers who do not see color, the colored lines become just names. Therefore, the information conveyed through the use of colors must be provided by some additional means that is accessible to those with visual impairments. Textual descriptions of line names should be included in addition to tactile/Braille descriptions wherever color coding conveys important information.

The 1990 Design Manual set aside the color aqua for accessible paths, stations and entrances. Accessible elements are split between this color and the standard black text. Standardizing the color used for accessible paths could greatly improve the usability of the system for those passengers who require them and could be easily implemented so as to make accessible elements more visible to passengers.

Bus Rapid Transit is still a relatively novel type of service, and its introduction is still somewhat new in American cities. The MBTA has attempted to integrate the Silver Line into the existing rapid transit system as fully as possible. It is therefore important that the stations (and stops) adhere to the same design criteria as the other stations in the system, including their wayfinding. While the difference between gray and silver is slight, one color must be selected to represent the Silver Line at all stations. As the various shades of gray have already been designated for other uses in the MBTA color coding scheme, the metallic silver has the strongest identity. The metallic silver elements should be incorporated into the wayfinding design of the Silver Line platforms at South Station by replacing the gray and red elements with their silver counterparts. While the Silver Line is typically identified by its logo, the use of silver colored wayfinding elements should be encouraged to merge the Silver Line with the rest of the MBTA system.

4.3.2 Inbound/Outbound Orientation

The inbound/outbound directionality convention remains substantially intact today, although with some additional clarifying elements. Platforms and station entrances are labeled as outbound or inbound, although very few platform endwalls are painted with the color-coded stripes initially recommended by the 1966 Design Manual. This convention is still confusing for many passengers, especially (although not limited to) tourists and newcomers.

Two additions to this convention that were not included in any of the design standards have surfaced in order to alleviate the confusion and make it more comprehensible. The use of terminal names to convey directionality is frequently implemented in other transit agencies, and is used as a secondary clue at many MBTA stations. At the transfer stations, where the inbound/outbound directions make little sense, it may be used exclusively, as shown in Figure 4-16. At these stations it is therefore necessary for customers to know the name of the terminal station towards which they are traveling, whereas at all other points in the system it is sufficient to know the line and direction of travel.

Figure 4-16: Using terminals to define directionality.

Another device that has been developed to explain this often confusing convention is to include textual explanations. Underneath the "inbound" or "outbound" element, further explanation is provided by listing a few of the key stations on the train's route. An "inbound" platform at a downtown station would therefore indicate whether the train will be going "via Park" or "via State" to define the directionality at these locations. This convention has also been adopted at many of the periphery stations for clarity, and platforms may be labeled as "Inbound via Park" as shown in Figure 4-17.

Figure 4-17: Major stations are often used to clarify the "inbound/ outbound" convention.

Recommendations

The use of an imaginary point as the center of the system is not readily apparent to users and can cause significant confusion to passengers who are unfamiliar with Boston's regional geography. Travel websites and guidebooks have to explain the convention because the "subway system is slightly confusing in that directions are often marked "inbound" and "outbound", rather than with a destination." (WikiTravel) Even after explanations, visiting passengers can get confused, as I witnessed one night at South Station. A visitor asked for directions to Harvard and was (correctly) told to get on the Red Line inbound. He nodded, and proceeded towards the outbound platform. When I corrected him and asked him about his mistake, he replied that Harvard was obviously outbound from the city.

Even for Boston natives, this convention poses serious problems at the central stations and thus several methods for detailed explanation have been incorporated into the wayfinding system. Standardization is necessary in order to incorporate the most useful of these solutions into a workable directionality convention. Using the terminal stations to establish directionality provides several benefits over other possibilities and is already used to label the trains themselves. This convention is useful because the directional name of a train does not change along the route. Further, in a system with branching lines, this convention includes both the directionality and the final destination of the train. Finally, this convention does not require significant structural knowledge about the system or the city, and passengers only need to know the name of the terminal towards which they are traveling. Silver Line service should incorporate the same conventions as the rest of the system. The Individual vehicles are currently labeled by their route numbers (SL1, for example, goes to the airport), and this convention should be extended to the Silver Line as well.

4.3.3 Station Identification

Four different types of station identification elements were recommended by the Design Manual, all of which have been successfully implemented to some extent in the system. Within the neighborhoods, the 'T' symbol sign can be found outside almost every station. (See Figure 4-18) Unfortunately, they are not always visible from all pedestrian approaches, making it problematic to always locate the station entrance. These elements were originally designed with backlighting to increase nighttime visibility. Due to maintenance and budgetary concerns the lights in these devices are either not turned on at night or were never electrified in the first place. The traditional Station Entrance signs have been installed above most entrances, although they also are often difficult to see at night.

Figure 4-18: No 'T' symbol sign identifies this entrance to the Davis Square station. (2005)

On-platform identification elements have been also been installed successfully throughout the system. The "Name Bands" have been installed on both sides of the tracks, although they are not always visible from all locations in a car. This requires that passengers use other means to distinguish stations from one another. The audio announcements that are now made on board trains and their accompanying variable message signs serve this purpose. Differences in the design treatments used on platforms, although slight, can also provide important clues. This can include photomurals, which are not as prevalent as initially envisioned in the 1966 Design Manual, though they are successful where they do exist. The concept was expanded at several stations to include elements beyond photographs, such as the historical mural at Kendall Square.

Station identification for the portion of the Silver Line that operates below grade is similar to the methods employed by the rail lines. As discussed in section 4.3.1, the Name Bands used in the Silver Line stations do not completely match the design standard as the whole element (including the Information Band) is silver. Ensuring the visibility of the Name Bands is easier on the Silver Line where both platforms and vehicles are shorter than in the other lines. The Silver Line also uses distinctively shaped silver roofs on its stations and bus shelters as an additional street-side identification device. Photomurals have not been implemented in the Silver Line stations.

As previously mentioned, on-board announcements and variable message systems provide identification for passengers with visual and hearing impairments and back-up the visual platform identification elements. These systems make it possible for passengers to know which station they are in without having direct visual access to the text on a Name Band. Braille/tactile identification elements can be found on most platforms and at most station entrances. This full compliment of accessible identification elements is necessary in order to combat the occasional failures of the electronic systems and to accommodate a wide range of user groups.

Recommendations

Taken together, the Design Manual presents a fairly comprehensive system of station identification that works on both platforms and street level. Visibility of street-side identification elements is not adequate in the MBTA wayfinding system. Adding some color to the 'T' symbol sign may slightly decrease the ability of passengers to find it quickly, but it may make it stand out more in a cluttered streetscape while providing important information to potential passengers. Implementing the back-lighting of this device would greatly increase its visibility at night. The visibility of station entrance signage could also be improved by increased lighting.

Non-visual identification devices guidelines have been created are in order to meet the minimum ADA requirements. However, the scarcity of tactile devices may not provide the necessary level of usefulness on long platforms with multiple entrances. The ADA Accessibility Guidelines require that all tactile devices "be placed in uniform locations...to the maximum extent practicable" and the inconsistency of the locations of the on-platform identification devices may prove difficult for passengers with visual impairments to locate. The use of on-board announcements for all station arrivals may help to alleviate this somewhat, but standardizing both the location and orientation of tactile identification devices helps users to find and use them (Whitehouse, 2000).

4.3.4 Maps

Existing maps mostly follow the Manual design conventions although required maps are often missing from specific locations. Up until late 2005, RTL maps system-wide were designed and installed before 1990 and only showed the stations were accessible at that date. (A note was included on the maps indicating that additional accessible stations were expected to come online during the spring of 1990.) In the past several months, updated maps which include the Silver Line have been printed on vinyl stickers and placed over the outdated maps. The new RTL maps also include commuter rail transfer information which was not included in previous incarnations. The new stickers are not vandal proof and have frequently been marred in various ways as shown in Figure 4-19. In response to this, the MBTA has begun placing Plexiglas covers over the new maps in some stations. These vinyl elements are significantly cheaper than the old porcelain enamel versions ($60 each versus $5000 each) and therefore easier to replace (Boylan, 2006).

Figure 4-19: A newly ruined RTL map in Davis Square. (2005)

The most glaring omission from the required maps is the Neighborhood Map which is included in very few stations (See Figure 4-20 for an example.) Some Green Line stations and those on the southern portion of the Orange Line do have them. These maps were designed to connect the platforms and station areas with the surrounding urban neighborhoods. The expense in time, effort and money for designing and fabricating customized maps for each station is the probable reason why this standard was not widely implemented. The need for them remains, and many stations have non-standard maps that have been sponsored by local institutions as shown in Figure 4-21. The permanent nature of these maps does present another problem: in order to be useful, they must be kept current. Any new development or changes to bus service in the area renders these maps instantly out of date. The MBTA has recently begun a project to update these maps system-wide using vinyl sticker maps (Boylan, 2006).

Figure 4-20: A standard Neighborhood Map on the platform at Arlington Station on the green line.

Figure 4-21: The "Neighborhood map" at Davis shows mostly the Tufts campus. The station area is shown only in the lower right corner.

Station Lists are provided in a wide range of locations including platforms and mezzanine areas. They are also available at most decision points inside stations. They have also been included in the wayfinding system in the Silver Line stations. Labeling of these elements is extremely important, especially when they are located on platforms and used as directional devices. It is essential that these maps be labeled as "inbound" or "outbound" if there is any hope of this directionality convention

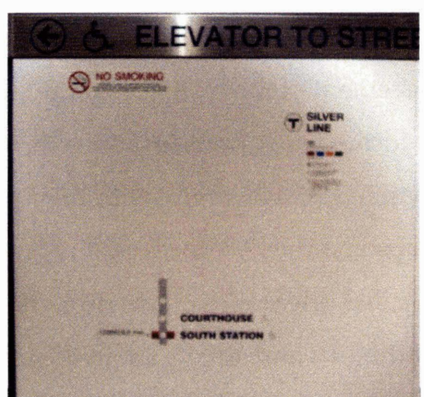

Figure 4-22: An unlabeled Station List at the Courthouse station.

being understood by passengers. (See Figure 4-22)

Recommendations

The system of maps designed for the MBTA provides almost all of the necessary orientation information required by transit passengers. None of the maps adequately address the connections between the rail and bus networks although the Neighborhood maps incorporate bus service on a local scale.

The most challenging element of this map system is the implementation of the Neighborhood maps, which must be designed in detail for each individual station. If passengers were ensured that an accurate Neighborhood map could be found at their destination station, they may be more willing to use the transit system. The program to implement these maps should be resurrected with some of the same technical improvements that have been used on the new RTL maps. These elements quickly become out of date and therefore should be printed on a material that allows for easy replacement and updating without falling victim to vandalism. While this is especially true for Neighborhood maps, the whole map system would benefit from this flexibility. The Washington Metro system installs cheap, paper neighborhood maps behind glass that can be easily replaced. All maps used in MBTA must be updated and replaced whenever substantial changes occur to ensure that passengers have access to current information. Regular map updates to account for incremental service changes and local development will also be necessary on an annual or biennial basis.

The major problem with the layout scheme for the map system lies with the placement of the Neighborhood Maps. These very important and useful devices are to be located at various locations throughout the stations with easy access for exiting passengers. However, with their placement limited to areas inside the stations, the maps and their "You-Are-Here" markers can serve only provide information and not detailed orientation to wayfinders. Passengers are easily able to ascertain what landmarks and streets are in the immediate vicinity of the station from these maps. In some stations with very few entrances, it may be possible to ascertain where in the urban fabric one will emerge from an underground station. However, to make full use of the Neighborhood map as deployed by the Design Manual, it would be necessary for a wayfinder to keep the image of the map in their head until they reached the surface. This is hardly a practical method for using the orientation and directional information that these maps convey. Without simultaneous visual access to both the map and the built environment it is very difficult to determine which direction one is facing or in which direction lies a desired destination. Mandating the installation of Neighborhood Maps outside of all station entrances would improve their usefulness for transit users and general pedestrian traffic in addition to increasing the visibility of these entrances and advertising bus services.

Customers must be able to determine not only their location on a Neighborhood map, but in which direction they are facing. This orientation can be provided using several methods; however it always requires map users to be able to match elements on the map to elements in the environment around them. Frequently this results in orienting maps so that "forward motion is equated to the up direction on the map." (Devlin, 2001) Another common option is to orient north as up on every map, which must be accompanied by defined cardinal directions (like a compass rose) in the environment as well. Although most wayfinders need only be able to locate two map elements in the built environment to adequately orient themselves, those without high-level spatial skills may not be able to perform this wayfinding task.

Maps of the interior of complex stations have not been introduced in any edition of the Design Manual. One station map was found in existence in the MBTA system; a map highlighting the locations of public art throughout the station at Alewife is shown in Figure 4-23. These devices may only be appropriate at the most complicated stations, such as transfer points, intermodal stations and large terminal stations. The growth of Transit Oriented Development in the Boston area may cause stations to grow larger and more complex to the point that such that maps may become necessary and desirable. Many stations have already grown to this

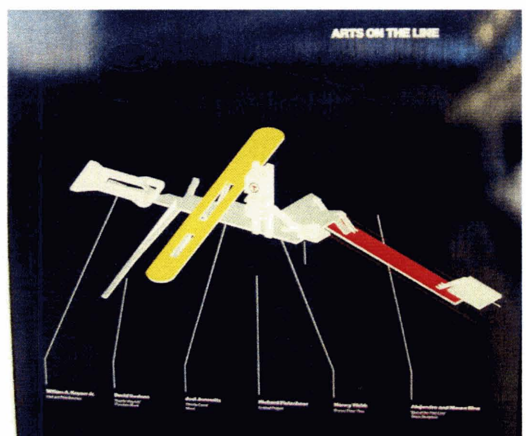

Figure 4-23: Map of the Alewife terminal station designed to point out public art of interest. (2004)

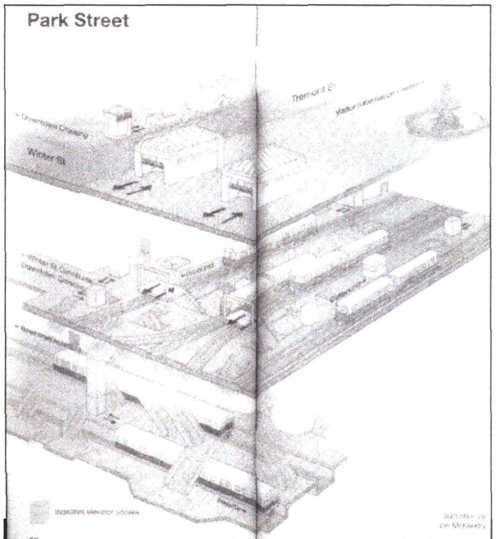

Figure 4-24: A sample of an interior station map for Park Street Station. (Getting Around Boston)

point, with the most obvious example being South Station. As stations continue to grow and provide more services a standard for this type of map should be developed for use on an as necessary basis. Samples of these maps have already been attempted for use in the MBTA's "Getting Around Boston" pamphlet, as shown in Figure 4-24, but have not been deployed in any stations (2004).

Finally, the 1990 Design Manual recommends that Schedule Cases be located "near the exit to the bus way" in the unpaid area of the station. In addition, locating full schedules and route maps for connecting bus services near the Neighborhood maps (which shows the locations of the various bus stops) would be extremely helpful for transferring passengers.

4.3.5 Directional Devices

The permanent directional devices used in the MBTA system closely follow the guidelines in the Design Manual. These devices are generally effective, but in complex stations they can also be confusing and difficult to read when many are clustered together. While the general design of these elements is good, special attention is necessary during implementation at the large transfer stations.

The secondary source of directional information on platforms is the Information Band which is paired with the upper Name Band. This band strictly uses black text on a white background. The only color used is the color of the Name Band above it which must coordinate with the color of that line. Therefore, at the transfer stations there is no way to use the color of the second line to increase the visibility of this directional information. As a recent solution, the colored sections of Name

Figure 4-25: Newly implemented color changes in the Upper Name band highlight directional content in the Information Band. (2006)

Bands have been replaced with another color where appropriate, as shown in Figure 4-25.

Strict arrow conventions were developed for use in the MBTA and most wayfinding elements adhere to them. Several ambiguities in these conventions exist and have not yet been resolved. The differences between the up, down and forward arrows are the most confusing, as will be discussed later. There has been no study to date of passenger comprehension or confusion caused by the arrows in stations, though such a study would be useful in helping the MBTA to improve their directional devices. Many examples of non-compliance can be found throughout the system, although these devices are usually comprehensible (See Figure 4-26).

Figure 4-26: Examples of non-conforming arrows at Park Street. The "oops, you missed it!" arrow is shown in the lower image. (2005)

In 2004, the MBTA installed temporary directional devices in order to help orient some of the heavy traffic anticipated for the Democratic National Convention that was held in Boston that summer. These signs were located at points of heavy traffic and highlighted important features of the system like transfer points and commuter rail service. Printed on white plastic boards, these signs were frequently incorrect, easily vandalized and missing important pieces of information. They were not maintained after the initial installation and many lost pieces or completely fell down and were discarded and never replaced.

Again, at the end of 2005 new signs of this type began appearing throughout the MBTA system giving directions to exits, busses, transfers and platforms. This time, these elements are part of a more comprehensive wayfinding system, however they still use some of the same temporary, piecemeal design techniques (See Figure 4-27). These devices are more visible than the traditional, permanent signage because they are larger and altogether different. They sometimes use directional arrows that are adhered using tape, non-standard colors and multiple non-

Figure 4-27: Temporary signs at (clockwise from left) 1) Davis Square without an arrow 2) Park Street entrance and 3) Arlington platform. (2005)

standard fonts on each device. As such these devices conform neither to the MBTA's internal design guidelines nor to the ADA regulations for wayfinding. They are extremely prone to vandalism and have not been well maintained. Most frequently, these devices are missing their directional arrows. Some at the MBTA realize that the addition of these very visibly temporary and un-maintained devices adds visual clutter to the once streamlined stations and returns the MBTA back to the uncoordinated wayfinding system that was prevalent in the 1960's. However, others insist that their existence points to a wayfinding need unmet by the system as designed. (Boylan, 2006)

Recommendations

The basic design of the directional elements is good and consistent with other wayfinding elements in the system. Prominence is given to the text making the directional devices very visible and legible. The use of the Information Band for directional information is not as visible, as the text is somewhat smaller and often in visually cluttered locations. The least visible type of information in the Information Band is transfers directions to other lines, because the use of color is not permitted. Allowing limited use of color within the "Information Bands" at transfer points could help transferring passengers find their next train more quickly. ADA regulations on text contrast make using colored text improbable; however inclusion of a block of color inside the Information Band next to the text is a possible solution.

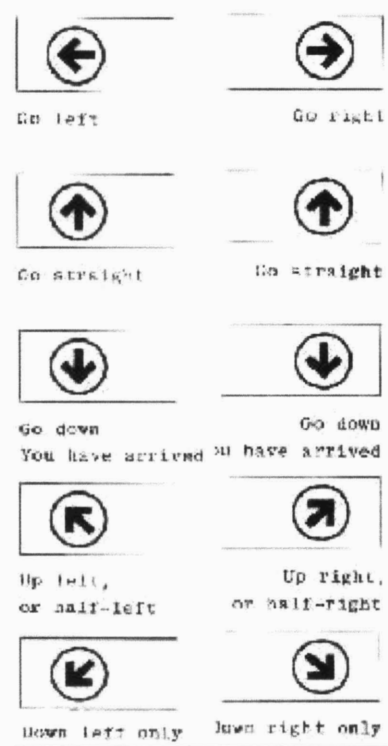

Figure 4-28: Arrow conventions used in the MBTA Design Manual. (1966)

The directional devices designed in the Manual are simple and include only two elements: text and an arrow pictogram. The use of the arrow is probably the most common pictogram used in wayfinding design; however its use can present significant complications when implemented carelessly. There exists some general confusion throughout the world about whether, on an overhead element, an upwards or a downwards arrow indicates forward motion. (Arthur & Passini, 1992) The Design Manual attempts to avoid these problems by creating arrow conventions as shown in Figure 4-28. Forward motion is clearly defined by these conventions, although most passengers do not have access to the Design Manual to determine the correct convention. Several of the standards have multiple meanings, which may or may not be clarified by the station context. In addition, there is no arrow convention designated for going "up straight", a common condition in transit stations. Another possible solution for this problem is to include text descriptions of directional movements with any ambiguous arrows (such as "Exit, ahead" instead of using only a forwards arrow.)

The traditional directional devices have been supplemented by a new type of directional device. These new devices have been installed for a reason, and efforts should be made to provide this necessary information using the standardized designs for directional devices that have already been developed. If the larger text used on these new elements proves to be an important factor in their usefulness, then it may be necessary to improve the design standard to incorporate a larger font size. Until institutional support and funds become available for updating the directional wayfinding system using permanent devices, any temporary ones must be designed in accordance with ADA design guidelines most especially their fonts. Again, developing a method for fabricating wayfinding devices that are easy to update and difficult to vandalize is of utmost importance.

There is one additional type of directional content that would help to enhance the station identification system discussed in Section 4.3.3. The installation of some type of directional devices within the neighborhood surrounding a transit station would help guide passengers to the station entrances. Traditional signs using the 'T' symbol and directional arrows are a standard type of device that can serve this purpose, and should be located at major intersections within a one or two block radius of the station. These signs are also visible by drivers looking for the station which provides an added benefit to the community. Another option is to create trails on the sidewalk that lead to the station entrance using paint or pavement imprints.

4.3.6 Accessibility

Station accessibility has improved greatly and has largely been carried out in accordance with the Design Manuals. Some elements for the physically, visually and hearing impaired exist. Accessible paths and entrances are clearly marked at most stations. Technological advances have encouraged the proliferation of variable message signs and Public Address systems. There are still some areas that need improvement to improve the overall accessibility of the MBTA for all user groups. Of specific concern is the availability of wayfinding devices for the visually impaired. A class action lawsuit was filed against the MBTA in 2003 because the system had not met the standards introduced by ADA (Greater Boston Law Services, 2003). One of the complaints cited in this suit is "failure to provide adequate and accessible directional signage" and it seeks to ensure that all of the required devices "are in place, fully operational, and can be used by consumers in a safe manner."

A wide range of wayfinding devices exists to aide passengers with visual impairments. PA systems are used on trains to identify stations and in stations to broadcast pre-recorded messages. Occasionally these systems are used to make time sensitive announcements about service delays, but they do so with very poor sound quality. Braille/tactile identification devices can be found at almost all station entrances and platforms. Most platform edges are lined with 18 inches of a tactile surface of raised semi-circles as a warning to blind passengers. Directional and orientational information for the visually impaired is completely missing from the MBTA's wayfinding system. Tactile maps and non-visual directional devices have not been implemented anywhere in the system.

Figure 4-29: The icons used in the on-board safety cards are not comprehensible without the use of explanatory text. (2005)

Several other groups of users may have difficulty using the MBTA wayfinding system for a wide variety of reasons. First, the entire wayfinding system, including all maps and directional signage, is designed in English, even in areas where English is not the primary language. However, some warning and informational elements on-board vehicles are also translated into Spanish. The use of pictograms in the wayfinding system is encouraged in order to overcome language and reading barriers;

however a complex transit system requires a wide range of pictograms. Many of the pictograms are inconsistently used around the system and are not easily understood without textual explanations (see Figure 4-29).

Tourists are another group for whom wayfinding elements are extremely important. As designed, the wayfinding system only shows the locations of popular tourist destination only on the small-scale Neighborhood Maps at the stations nearest them. The branching structure of the Green Line is especially confusing for tourists and therefore a signage element has been installed at Park Street, as shown in Figure 4-30. Further information is available on-line, and this resource will be discussed further in section 4.3.7.

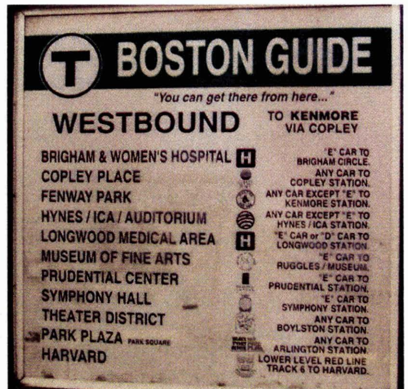

Figure 4-30: Guide for tourists on the Green Line platform at Park Street

Recommendations

Two types of information are unavailable to passengers with visual impairments: directional and orientational. The inclusion of directional devices for all possible paths in even a simple station would be expensive and may not be an efficient use of limited resources. Some method of providing directional information to the visually impaired must be implemented in MBTA stations, whether it is in the form of physical tactile devices or some sort of audible technology as introduced in Chapter 3. For example, "talking signs" have been met with some success by providing audible directions and identification to passengers carrying special transmitters during tests in both the San Francisco Municipal Railway and Bay Area Rapid Transit systems. (Bentzen et al,

Figure 4-31: An example of tactile directional elements in a Japanese subway station. (Courtesy of Jeffrey Sriver)

1999) Alternatively, many transit systems in Asia utilize tactile paths installed on the ground to create paths that can be followed by blind passengers using canes. (An example is shown in Figure 4-31.)

Orientational information typically comes from various types of maps, none of which are available in non-visual formats. Implementation of tactile maps within a transit system requires a different approach than visual maps, as discussed in Chapter 2. Tactile transit system maps are more useful to visually impaired passengers when they able to carry them during their trip in order to reference the many types of information that they contain (Landau, 1999). The availability of a set of tactile maps of this type would allow visually impaired passengers to navigate through the MBTA system without requiring the installation of extensive tactile mapping systems in every station.

The MBTA (like many other transit agencies) suffers from frequent elevator and escalator breakdowns. When an elevator breaks, it renders a formerly accessible station temporarily inaccessible. The MBTA provides this information via their website and a telephone hotline. Inside the stations themselves or while in transit, this information is not available. Further, in the class action suit against the MBTA several of plaintiffs claim that the hotline is frequently inaccurate. (Greater Boston Legal Services, 2003) The suit continues to request that a new, improved system be implemented that includes "clear and audible announcements made over the public announcement system on the trains as well as in the station, and signs posted in conspicuous locations on the subway trains, as well as in the station, alerting consumers to the location of the station where the elevator is out of service, and providing directions to the nearest station with an operational elevator." Implementing this type of system at the MBTA would allow mobility impaired passengers to use the system without the fear of being unable to reach their final destination.

4.3.7 Real Time Information

The availability of real time information fills the need for some types of content that cannot be provided by traditional, static wayfinding elements. The implementation of real time information technology takes many forms throughout the MBTA system. Transit agencies now have the means to make this valuable information available to their passengers through the use of various different technologies. Currently, the MBTA uses their PA system to periodically update passengers of service delays. Variable message signage is an opportunity to ensure that information is always accurate and up-to-date and their primary use in transit stations is to convey messages about schedules and service delays.

Many stations do have variable message signs installed but these powerful tools are not used to their fullest potential as most of the time they display only standard stock messages and warnings as shown in Figure 4-32. All stations on the Orange Line have variable message signs installed, but they are not in use. Some Red Line stations had these type of signs installed, but they were recently removed in order to prepare for a new system upgrade planned for 2006 (Boylan, 2006). Silver Line stations make extensive use of these elements though their use is limited to standard stock messages and to display the time. However, all Silver Line stations use variable message signs to display scheduled service frequencies. Unfortunately, the stops along Washington Street are known for their inaccurate and malfunctioning variable message devices. (Mello, 2003) This is the closest that the MBTA has gotten to estimating actual vehicle arrivals and departures.

Figure 4-32: A variable message sign used only to display stock messages.

Another technological advance that can provide real time information to wayfinders is the internet. Maps, schedules and a variety of other tools are made available online for potential passengers to plan their trips at their own pace on their own time. However, this information is only available to those passengers with access to the internet. The most powerful tool available on the MBTA website is a trip planner that allows users to easily plan multimodal trips. Users are able to search destinations by various categories and can easily reference popular tourist destinations. The internet site is also the most comprehensive source of information about the MBTA system as system hours, policies and fare information are all available to the savvy user. This is one of the only places that all of this information is easily available. It is also easy and relatively cheap to update. The internet is an excellent tool for making infrequent riders more comfortable with the system, and therefore more likely to use it.

The other main source of real time information in an MBTA station is the station attendant. Unfortunately, these important resources spend most of their time behind glass in booths selling tokens. Lines are common at the busier stations, which discourage customers from asking questions unless absolutely necessary. However, the introduction of automatic fare collection technology will allow these staff members to leave their booths and address the wayfinding needs of passengers.

Recommendations

The MBTA has an opportunity to use recent technological advances to improve wayfinding for its passengers. Variable message signs have the potential to convey much more pertinent information than the stock warnings displayed today. Using vehicle tracking technology these systems can provide accurate information about train arrival times and keep passengers updated about service delays throughout the system. Using these elements in this way could help overcome the acoustical challenges of station PA systems but also requires significant investment in vehicle tracking systems. Stock messages can also provide more useful information than those currently in use, including bus schedules. This saves the time and money involved with replacing paper schedules throughout the system every time the bus system is changed when control is centralized. Another important use for real time information is during emergency situations. PA systems are used in these situations, but variable message signs are important as backup and for use by deaf passengers. In order to be effective, staff must have the ability and an incentive to access and program these devices in real time. Service delays, train (and bus) arrivals and emergency evacuations are the three primary applications that should be implemented to ensure that these expensive elements are put to good use. A project is currently underway in order to implement these systems in MBTA stations.

The MBTA maintains a fairly comprehensive website that provides most of the information that passengers need to plan a transit trip (although not necessarily in an easy to use format). One specific element that should be added in the first and last train times at each station. In order for the MBTA website to serve its full purpose, passengers and potential passengers must know that it exists. The MBTA must therefore ensure that the website is adequately advertised. The public must know what tools are available on the website and how to access them in order to make use of it. This great resource can also help to improve the image and identity of the MBTA if utilized to its fullest potential.

The MBTA is currently in the process of phasing out tokens and introducing electronic fare media. The "Charlie Tickets" will be sold by machine, and will make station attendants available to provide other key services. They will no doubt be required to help customers using the new machines, but will also be available and accessible to provide important wayfinding information to customers. In order to deal with a wide range of customers including those with physical and mental impairments and those with limited English proficiency, new training for these employees will be necessary. Station attendants can also be used to provide other types of time sensitive information to passengers, including service delays and elevator breakdowns. Placing a new focus on customer service through these station attendants can greatly improve the customer experience in the MBTA system.

4.4 Conclusion

In 1966 the MBTA developed a solid basis for wayfinding design in and around its stations in its Design Manual. Subsequent editions of this Manual have served to add items that had been omitted and to prune those guidelines that were not useful, attractive or possible to implement. The only major changes to the original document have been those spurred by the ADA of 1990 which required many additions and some changes in order to make stations accessible to passengers with a wide range of disabilities. The resulting system, which follows the design guidelines closely in most situations, provides most of the necessary information to passengers. Some of the major benefits of the existing system include:

- Strong individual line identities by enacting a color coding scheme for all stations
- Removal of visual clutter by enforcing a "maximum simplicity" rule for wayfinding
- Creation of a "sense of place" at most stations through the prominent use of station names and photomurals
- Ensuring that almost all of the necessary maps and information devices are located at or near the necessary decision points

- Detailed rules for designing wayfinding devices with text that is highly visible and legible
- Marking accessible paths and entrances at all stations for those passengers with mobility impairments

There are also some areas that need improvement in order to provide information to the whole passenger population and make the existing wayfinding system friendlier for current users, including:

- Make the street-side station identification devices more visible in the urban environment, especially at night
- Develop a directional orientation convention that is more intuitive than the current "inbound/outbound" system. Perhaps by using terminal stations to determine directionality.
- Increase the visibility of directional devices in a manner that conforms with ADA standards for legibility
- Introduce Neighborhood Maps to all stations and on the internet. These should be of the "you-are-here" type of maps and should also be located on street level wherever space and the budget allow
- Develop a type of wayfinding device that can be easily updated while being vandal-proof
- Make directional and orientational information about the system available to visually impaired passengers
- Improve the use of variable message signs to include real time information wherever possible
- Re-train station attendants to better serve customer wayfinding needs as the token system is phased out

These and other possible improvements were discussed in further detail in the previous sections. These are only the big-picture recommendations and the details can be found in this chapter.

The Design Manual has not been officially updated in over ten years and another edition will be necessary in the near future. This decade long apathy appears to be on its way out, as the past several months has seen a flurry of wayfinding activity in stations throughout the system. New directional elements, RTL maps, schedule cases, informational devices and variable message signs have begun appearing all over the system that do not coordinate with the elements based on the Design Manuals. These improvements seem to indicate that the MBTA is once again focusing on the needs of passengers by providing them with the wayfinding tools that they need to make use of the MBTA system.

By way of comparison, the next chapter will look at the wayfinding system and design guidelines used by the Chicago Transit Authority. Analysis and recommendations for the CTA can be found in Chapter 5. Chapter 6 will use these two important case studies as a basis for a more general discussion about wayfinding design in transit stations.

5. CASE STUDY: CHICAGO TRANSIT AUTHORITY

This chapter will analyze the recent development of wayfinding design in the Chicago Transit Authority's (CTA) rapid transit system. This will begin with an analysis of the formal written design standards that have been developed and implemented in CTA stations and will then compare these standards with the current conditions in these stations. Detailed explanations of the design standards and existing conditions will be followed by recommendations made in accordance with the informational and design requirements developed in Chapter 3. This will improve our understanding of the functionality of the CTA's wayfinding system for the full spectrum of possible users.

The historical development of wayfinding in the CTA system will serve as a foundation for this analysis, as many stations still utilize many of the older devices. The current basis for wayfinding design in the CTA is provided by the "CTA Graphics Manual" the most recent edition of which was compiled in 2002. This set of comprehensive design standards governs wayfinding in the CTA today, but has been supplemented by additional designs and programs. In an attempt to update and standardize the CTA's wayfinding system, a new design standard was prototyped in 2001, but only applied at one station. Additionally, the "Front Door Program" which was initiated in 2003, deals with some wayfinding issues.

Each of these guidelines has impacted the current state of the wayfinding system used in CTA stations and the impact of each must be analyzed. Additionally, the current conditions will be compared with the formal 2002 standards to determine what types of informal changes have been implemented over the years. It is expected that few, if any, stations will have completely implemented the standards as published due to budgetary and site constraints. This comparison will be used to formulate a set of recommendations based on the existing wayfinding conditions and guidelines at the end of the Chapter. These, combined with the recommendations developed for the Massachusetts Bay Transportation Authority in Chapter 4 will be used to formulate generalized guidelines for wayfinding systems in transit stations in Chapter 6.

5.1 CTA Graphics Manual

A comprehensive set of design guidelines was developed by the CTA in 2002 that dealt with wayfinding in both the rail and bus systems. The first edition of this Graphics Manual was compiled in 1966 as part of the overall station design guidelines and the wayfinding standards have been periodically updated since that time. The current Graphics Manual focuses on providing three types of information to passengers: "1) information about the setting they are in, such as how it is organized and where they are in it; 2) information directing them to their destination; and 3) information identifying the destination upon their arrival." (CTA, 2002) These foci are essentially the same as the orientational, directional and identificational wayfinding categories that were introduced in Chapter 2. Absent is an explicit focus on informational elements, though the Graphics Manual does include design standards for these types of elements.

The Graphics Manual emphasizes the cognitive process of wayfinding as the basis for design and implementation of the CTA's signage system. To improve the wayfinding experience of passengers, the Graphics Manual highlights four goals for the system: consistency, continuity, simplicity and repetition. By applying these five goals to stations throughout the system, the CTA has crafted a wayfinding system that provides important information at the necessary locations in a user-friendly format.

Standardization of graphic devices throughout the CTA system is the primary goal of the Graphics Manual, which provides standard designs to be used in a wide range of stations. This standardization of each station strengthens the CTA identity and adheres to the previously stated goal of consistency. The intended goal of this standardization is to integrate the individual stations into a comprehensive system by creating continuous conditions at discontiguous stations. Repetition is mandated by including multiple copies of the same type of information in different formats at all necessary locations within each station. All wayfinding devices are designed for maximum simplicity so as not to overload passengers with unnecessary information.

The Graphics Manual presents standard designs for a wide range of wayfinding devices in stations and on vehicles. Many of the elements were simply alterations of the signage systems that had been used previously in CTA stations. The most important aspects of the wayfinding system which will be discussed in this thesis include line identification, station identification, directional devices, orientation devices, accessibility and the use of real time information.

5.1.1 Line Identification

Before transit service in Chicago was consolidated under the CTA in 1945, five separate companies operated transit in the city and lines were identified by these companies. After consolidation the elevated rail lines were named primarily according to their terminal stations (Howard-Jackson Park and Ravenswood, for example.) however the Linden to Howard line was called the "Evanston Line" because of its location. Other lines were named for their direction of travel like the West-Northwest Route or for the streets they paralleled like the Lake Street Line or the Congress Branch, as shown in Figure 5-1 (Garfield).

Figure 5-1: Line identification element in the 1972 Graphics Manual

The CTA renamed all of its rail lines in 1995, by designating a different color for each. The seven colors that were selected are used to visually differentiate lines from one another. This color coding scheme is still used today, and the Graphics Manual requires that many types of wayfinding devices be colored according to their line. This includes station identification elements, maps and directional devices. Using color coding in the design of wayfinding elements at stations along each line standardizes the appearance of each station thereby creating a set of unique line identities.

Any type of wayfinding device that refers to a specific rail line is supposed to use the designated color for that line. This is the primary use of color in the Graphics Manual, and this scheme uses almost all of the available colors that are easily discernable. In order to avoid confusion, other wayfinding elements are designed to use neutral, unassigned colors which include gray, black and white. Black is used as the background on most identification and directional devices, including all exit signs. Other elements in the system are also color coded in order to make them stand out. Red, in addition to its use on the Red Line is also to be used to highlight emergency and safety information. Blue is used to denote paths, entrances and elevators that are wheelchair accessible in addition to identifying platform edges.

While identifying each line is important for customer understanding of a transit system, they must also be able to determine in which direction the trains are traveling. The CTA's directional convention relies on the use of terminal stations to define the direction of each train. Most of the lines have two terminal stations and travel through the downtown "loop" between them, while the Brown and Orange Lines (which have only one terminal station each) use the "loop" as their downtown 'terminal.' This convention is made easier to use by combining these terminal stations with the color coding scheme. Wherever the use of terminal stations is required, they are displayed (with few exceptions) using white text on a background of the appropriate line color, as shown in Figure 5-2. (The Yellow Line uses black text for visibility.) In order to accommodate the branching of the Green and Blue lines a variation of this standard was implemented. Instead of using the colored background, one branch of each line is coded with colored text on a white background, as shown in Figure 5-3. The standard design for the terminal stations are used on both wayfinding elements in stations and to label the rail vehicles themselves. This allows passengers to easily distinguish between different lines and branches, which is especially useful on platforms that are served by multiple lines. It is especially important that passengers rushing to board a train be able to quickly determine the branch and line of a train, and this color coded directional convention allows this to happen.

Figure 5-2: The standard devices used to denote directionality on the system.

Figure 5-3: Color variations for branching service on the Blue Line.

Another method used to identify specific lines or directions is the addition of simple pictograms to the color coding scheme. Both of Chicago's major airports are served directly by the CTA rail system, and an airplane icon is to be used in conjunction with the "Midway" and "O'Hare" terminal designations on all wayfinding materials. Especially important to note are the additional identification elements associated with the Yellow Line. Not only represented by a color and terminal station, the Yellow Line has its own identifying icon (which is shown in Figure 5-4) that serves to

Figure 5-4: The Yellow Line's identifying icon.

uniquely identify this short line. Further, this is the only line that is still commonly called by its original name, the Skokie Swift despite being officially renamed.

5.1.2 Station Identification

Stations in the CTA system, with very few exceptions, are named after the cross streets on which their main entrance is located. Those stations located at an intersection or in the loop are named after both cross streets. In a city where many streets are over twenty miles long, this naming system can result in multiple stations with the same name, even on the same line. The most egregious example of this is Western Avenue, on which there are five stations named Western. A few stations throughout the system are named for nearby landmarks such as Library in the loop and the two airport stations. These stations do not encounter the problem of name repetition.

Once station names have been established each station must be labeled appropriately so that passengers can tell at which they are. To provide this service to all passengers using a transit station, station identification devices must be provided in two locations: in the neighborhood on the street and on the platform. Street-side identification devices are located on street level within a neighborhood and are used by passengers entering the system. These elements announce the presence of a station and usually identify it by name. Identification devices that are located on a platform are used by passengers who will be transferring or exiting at the station and therefore enter the station by train. Both types of device are addressed to some extent in the Graphics Manual, although more attention is given to the latter.

The standard street-side device presented in the Graphics Manual is an entrance sign. These elements are to be located outside the station above each entrance. The design includes the line color and the terminal stations of that line, as shown in Figure 5-5. They are also to include the "train" icon, which is the only element that is to be included outside of every station entrance throughout the system. Flexibility in this design standard allows special

Figure 5-5: A standard station entrance sign is to be installed above each entrance.

circumstances to be accommodated, such as the need for a farecard at a particular entrance or part-time station hours.

Station Entrance signs are to be installed above every station entrance. However, they are only meant to be visible from a limited distance as they are only 16 inches tall. These elements are not readily visible from all angles of approach or from any significant distance. Therefore, these elements are not very useful for alerting passerby to the presence of a station. Further, these entrance signs do not include the name of the station. No standard exists for displaying the station name outside of the station and this is important information that should be included at this location, as discussed in Chapter 3.

There are two primary elements that compose the on-platform station identification system, the Station Name sign and the Symbol sign. The Station Name sign is for use by passengers arriving at the station by train, and is therefore designed to be read quickly and to be visible from the inside a train (See Figure 5-6). They are installed every car length along one side of the platform at a height of approximately eight feet. Three important pieces of information are conveyed by this standard: the station name, the line(s) serving the station and the street address of the main station entrance. Chicago's street grid determines addresses, as each cross street increases the street addresses by 100 in the four cardinal directions, starting from the baseline intersection of Madison and State streets. For passengers who are familiar with the city, the street addresses of the station can be used as coordinates to determine their exact location. A variation on this standard has been implemented at some stations that includes a pictogram overlaid on the colored tabs as shown in Figure 5-7. These pictograms represent unique elements surrounding the station and serve to further identify the station from others on the same line. Further, they make these stations easier to recognize for passengers who cannot read the station names.

Figure 5-6: Standard station name sign for use on platforms by exiting passengers includes line colors, station name and address.

Figure 5-7: The station name sign at Rosemont includes a rose icon.

Also located on the platforms at each station are Symbol signs. These smaller elements are mounted facing the tracks at a lower height, making them more visible to seated passengers. Symbol signs appear frequently along the length of the platform and prominently display the first letter of each station name, as shown in Figure 5-8. The full station name, line names and their terminal stations are also displayed, though these elements are quite small and typically not visible from inside the train. The single large letter is thought to be enough of a unique symbol that it can be used to help passengers quickly and easily recognize their desired station. At some stations, more than a single letter is used in order to better identify the station.

Figure 5-8: Symbol signs are deployed on platforms

5.1.3 Directional Devices

Directional signage elements play a crucial role in all wayfinding systems by providing detailed instructions on how to reach specific destinations. The Graphics Manual dictates that directional devices should be installed "at pathway decision points to guide riders into safe paths of movement." (CTA, 2002) By providing directions at all points where traffic flows merge, split or turn, a station can be navigated with minimal confusion. These elements must be easily legible so that customers do not need to slow or stop walking in order to make the correct wayfinding decision. In a visually complex environment like a transit station it is also necessary that these elements be highly visible so that they can be easily found by all passengers who need them.

The design of directional devices is simple and uses a combination of text, pictograms and arrows (see Figure 5-9). White text on a black background is used for all directional devices which enhances the visibility and legibility of their text. When the destination is a platform, colored blocks featuring the terminal station names are included on the device. All pictograms are standardized and the most common are the CTA's bus and train icons.

Figure 5-9: A standard directional device using an icon and the KDR arrow. (CTA, 2002)

The standard KDR (Kennedy-Dan Ryan) arrow which was introduced when the Kennedy and Dan Ryan lines opened in the late 1960's, is used on all directional devices because of its ability to be rotated and used at any angle. The Graphics Manual does not define arrow conventions for the meaning of different directional arrows, specifically the up and down arrows.

One quirk of the directional devices used in the CTA is the text used on their exit signs. With the exception of emergency exit signs (which are required by ADA to be red) all CTA station exit signs are black and refer to the exit as the "way out." The standard design for directional exit devices uses only the word "out" with an arrow, as shown in Figure 5-10.

Figure 5-10: Standard directional element to an exit.

5.1.4 Maps

Maps are among the most important types of wayfinding devices used in a transit system because they provide the structural and orientational information that is essential to accurately plan and execute a transit trip. These maps should be provided wherever passengers need a geographical understanding of where they are traveling. Only four maps are introduced in the Graphics Manual as being necessary for successful navigation of the CTA system.

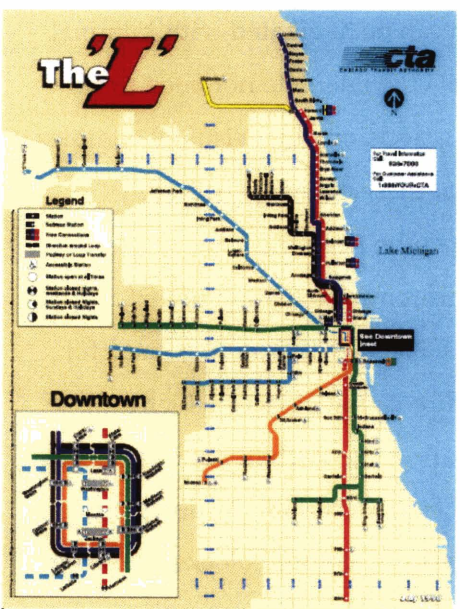

Figure 5-11: The standard Rail Transit System Map includes a wealth of details about the CTA rail network and its stations.

The Rail Transit System Map, shown in Figure 5-11, is the only map that is required to be installed inside the stations. They are to be installed both on platforms and in the station house. While the main focus of this map is the rail network and stations, other important information is also included that orients those passengers with basic understanding of Chicago's geography. The most prominent Chicago landmark, Lake Michigan, is shown in addition to the political boundaries of the city. Chicago is constructed of a very regular grid of streets that stretches the entire length and breadth of the city and allows people to determine addresses from street names and vice versa. The inclusion of the urban street grid on this map (with some of their street addresses) therefore provides important orientation to passengers who are familiar with this system. This information can also be coordinated with the street addresses which are to be included on the on-platform Station Name Signs, as discussed in section 5.1.2. Also included on the map are icons indicating which stations are wheelchair accessible and which have dedicated parking facilities. The map also includes the hours of operation for each individual station, although this information is not readily visible without a very detailed reading.

Two types of Car Card maps are to be installed inside all rail cars. A full system map is included which shows each station and a detailed explanation of travel in the loop (see Figure 5-12). None of the geographical information available on the in-station system map is included in this version, although the structure and geometry of the system remains intact. Due to the shape of the car cards used on CTA trains, north is to the right of this map instead of up. This may confuse some passengers who have seen only the in-station version of the Rail Transit System Map. A north arrow is included, which should help passengers rectify this inconsistency.

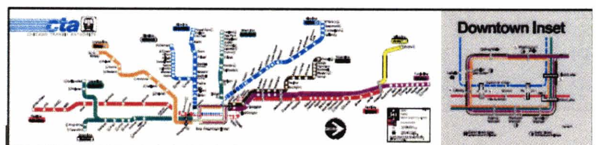

Figure 5-12: A system car card map shows the system rotated 90 degrees to the right.

Each car is also equipped with car card maps detailing their specific route. This map, which flattens the geometry of each route into a straight line, shows the order of the stations along an individual line. Transfer points are clearly marked along with the wheelchair accessible stations. Underground stations are differentiated from elevated or at grade stations by using a dashed line instead of a solid line. The orientation of these maps differ from line to line, but in an attempt to match the orientation of the system car card, the northernmost branch of each line is always shown on the right. However, this does not

Figure 5-13: The Blue Line car card map simplifies the line into a straight line.

always equate with north being on the right as the northernmost section of the Green Line points to the western edge of the city. In fact, due to the distorted geometry that must be used to fit each line on a car card, north arrows are not applicable on these elements, and must be used in conjunction with the system maps in order to understand the full system geography. A separate car card map has been created for each line, and an example is shown in Figure 5-14.

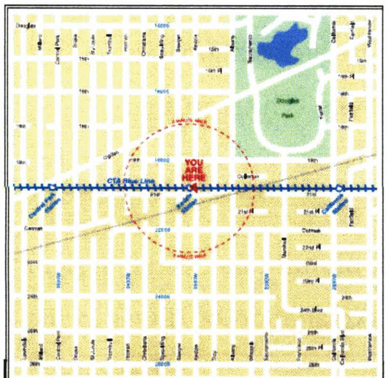

Figure 5-14: Neighborhood Map for Kedzie station.

A new addition to the Graphics Manual in 2002 was the Neighborhood Map which is designed to include the local street grid, street addresses and some local landmarks. This you-are-here style map also includes a circle indicating the area accessible by a 5 minute walk. An example of this map is shown in Figure 5-14 and is to be deployed in the paid, unpaid and platform areas of each station.

5.1.5 Accessibility

There are many issues that must be considered when designing for accessible wayfinding devices, some of which are specific to individual user groups while others are beneficial for a wider range of passengers. This post-ADA Graphics Manual adheres to the ADA design guidelines for transit stations. Wayfinding devices are provided separately for many different user groups that allow most people to make use of the system. Textual design is approached mainly from an accessibility perspective; all wayfinding elements are designed to be legible and visible for a large portion of potential passengers. The contrast between text and its background is a matter of importance, and the combinations of white text on colored backgrounds generally meet the design guidelines imposed by ADA (except for the white text on an orange background.) In the few instances where colored text is used on a white background, the text is outlined in black to adhere to these guidelines. All wayfinding elements in the CTA system use Helvetica Medium as the standard font which meets the ADA requirements for legibility and letter design. Letter spacing and font sizing is all done in accordance with ADA, with a three inch minimum letter height on most elements.

As previously noted, the color blue is used to represent accessible stations and paths in addition to its use on the Blue Line. In keeping with the rest of the design standards presented in the Graphics Manual, all accessible elements use white text and icons on a blue background. The universal symbol of accessibility (see Figure 5-15) is used to denote all types of accessible elements, including ramps and elevators.

Figure 5-15: Universal symbol of accessibility.

ADA requires Braille/tactile devices to identify all permanent rooms and areas, and a standard for this type of device is included in the Graphics Manual, as shown in Figure 5-16. Identification elements must be consistently placed at all station entrances and platforms so that visually impaired passengers can easily locate them. The varied and often outdated design of many CTA stations makes uniform placement of these elements difficult, especially on platforms which have multiple points of entry. In an attempt to standardize their placement, tactile identification devices are to be located within "the two-car berthing area of the platform." Braille/tactile elements are to be provided at major decision points as well.

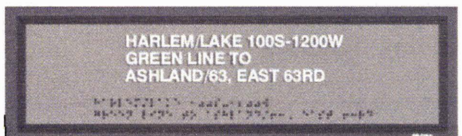

Figure 5-16: Standard for Braille/ tactile identification devices.

Several other user groups besides the visually and hearing impaired are accounted for in the Graphics Manual's standards. Public Address (PA) systems are to be used to provide information and instructions to the visually impaired. In order to provide the same information to the deaf, the installation of variable message signs is promoted. Both of these systems will be discussed further in the following section. Many CTA passengers cannot read English and therefore many of the warning and informational station devices are designed in both English and Spanish. Tourists are also partially accommodated in the Graphics Manual through some allowable variations to design standards that highlight unique tourist attractions near a specific station. (See an example in Figure 5-17.) For the tourist user group, standards are presented for the

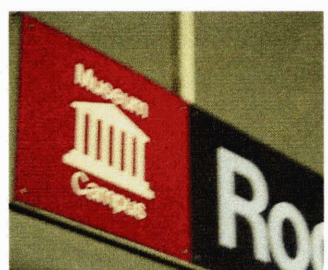

Figure 5-17: Roosevelt is the closets station to the Museum Campus, which is highlighted on its station ID devices.

design of Landmark signs that identify local points of interest, although the Manual dictates that they will only be installed at a few locations.

5.1.6 Real Time Information

Technological evolution has created a plethora of opportunities to improve the operation of public transit systems, including the ability to access information in real time. Transit agencies now have the means to make this valuable information available to their passengers. One specific application for this type of device is used only at terminal stations to indicate which train will be departing the station next, as shown in Figure 5-18.

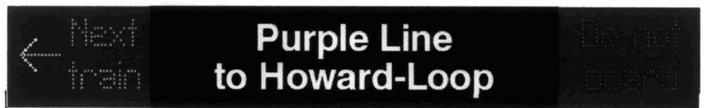

Figure 5-18: Train boarding sign used at terminal stations.

A pair of connected systems is introduced in the Graphics Manual to convey important information to passengers in real time. Variable message signage is an opportunity to ensure that information is always accurate and up-to-date and their primary use in transit stations is to convey messages about schedules and service delays. The CTA uses LED technology in conjunction with audio PA systems to provide frequently changing information. The LED messages are to be synchronized with prerecorded and live audio announcements over station PA systems. A strobe light next to the LED display is used to alert deaf passengers in emergency situations. The Graphics Manual does not specify what content is to be conveyed on these systems.

The CTA Graphics Manual creates a standardized wayfinding system for use in all CTA stations. Line and station identities are established through the use of color coding and several types of identification devices. The design of all types of devices is consistent and meets the criteria set forth in the Americans with Disabilities Act. There are some oversights that were not adequately addressed in this Manual and many of them have been addressed by other CTA projects that will be analyzed in the sections that follow. The conditions that exist currently throughout the CTA system do not match these guidelines except in brand new stations. These conditions will also be discussed later in this chapter, while presenting recommendations for improving the CTA wayfinding system.

5.2 FRANKLE-MONIGLE STANDARDS

In 2001, the CTA attempted a complete overhaul of their wayfinding system by enlisting the aid of outside consultants. The new system was heavily influenced by wayfinding in other transit systems and abandoned the old design standards (Garfield). The philosophy governing the new wayfinding system (named after the consultant teams who created it) was to provide "customers with the right message in the right place at the right time." (Frankle-Monigle, 2001) The designers of this system sought to create a unified, graphic identity for the CTA that was completely ADA compliant. The simplification and modernization were to improve the image of the CTA to Chicago natives and visitors alike.

The Frankle-Monigle wayfinding guidelines were intended to be implemented throughout the CTA network; this never occurred. A pilot program for the new wayfinding system was initiated at the major transfer station of Clark/Lake, a challenge for any wayfinding system. This is the *only* station in which these devices were ever installed, and even there the full complement of wayfinding elements was not included. This section will look both at what was intended by the creators of these guidelines, and what was actually accomplished at Clark/Lake.

Some important changes were made to the graphic design of wayfinding elements in these guidelines. The standard colors were changed slightly in order to increase their brightness and contrast, both of which should make them easier to read. The standard font is also changed from the Helvetica Medium that had been used by the CTA since 1972 to the "FF Transit Front Positive Normal" shown in all of the sign examples in this section. New arrows were also designed in order to coordinate with the font change. Several important content areas were also addressed by these guidelines including station identification, line identification, geographic information and directional devices.

5.2.1 Station Identification

The first aspect of station identification that was addressed by the Frankle-Monigle standards was the names of the stations themselves. Many of the suggested changes refer to semantic details like punctuation and formatting. While the practice of naming stations after their cross streets is retained the guidelines do recognize the problem of repeated station names that was introduced in Section 5.1.1. "The same station…name may be used on different rail lines because, before entering the rail system, the customer will have selected the specific line and destination point using the geographic information on the rail system map." While the guidelines continue to dictate that the same name should not be used for multiple stations on the same line, the detailed list of renamed stations still shows three "Westerns" on the blue line.

On-platform identification of stations was still to be accomplished through the use of long name signs lining the platform as shown in Figure 5-19. These devices employed the color coding scheme, but use more neutral colors including gray and black. The station name, line color(s) and terminal stations were to be included in addition to any local attractions and directions to important elements in and around the station. The devices include directions to station exits, bus connections and general station amenities. Transfers were clearly marked on these elements using a colored circle surrounding a 'T' symbol. The inclusion of all of this information inevitably made the text smaller and more difficult to see from inside a train. The Frankle-Monigle wayfinding standards do not recommend the continued practice of identifying stations by the first letter of their name, and therefore includes no counterpart for the Graphics Manual's symbol signs.

Figure 5-19: Standard for on-platform station identification elements.

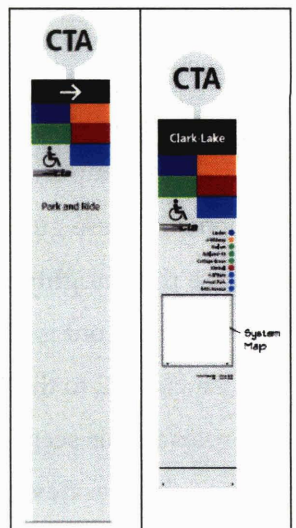

Figure 5-20: Station Marker designs are similar. The "remote" (left) was to be 12′ tall; the "intimate" (right) is 10.5′.

The new standard addressed another omission from the Graphics Manual by introducing "station markers." These devices were designed at two different scales to be readily visible throughout the neighborhood surrounding the stations. Both types are designed to attract the eye of potential passengers through the use of an instantly recognizable logo that could be seen from a distance. The "remote" marker, at 12 feet tall, included the lines served at a station and a large arrow that directed passengers to the station entrance. Additional information including the station name, hours of operation and a system map would be provided at the "Intimate Station Marker" standing 10.5 feet tall and located outside of each station entrance (See Figure 5-20). This system provides increasingly more detailed information to passengers as they proceed along their path. The station markers rely heavily on the selection and implementation of a standard CTA logo and would be most useful if they were consistently implemented throughout the system so that potential riders always knew what they were looking for.

Figure 5-21: Can you see the station marker? Can you find the station entrance? The unlabeled door leads directly to it, not to 'self park'.

The station markers essentially replaced the station entrance signs from the Graphics Manual; they have no counterpart in the Frankle-Monigle designs. The station markers are installed some distance away from the actual entrance in order to improve their visibility, and therefore some type of device is necessary to label the entrance itself, especially in the busiest of urban environments. (See Figure 5-21) However, the station markers were not installed outside every station entrance at Clark/Lake, further exacerbating the problem. Because the station is part of two buildings, passengers are wary of walking through strange, unlabeled doors. Further, these locations are used by

Figure 5-22: Can you find the station entrance? The CTA has an entrance in the food court of the Thomson Center, where large, bright signage is the norm. No one would know it was there unless they mistakenly tried to buy

thousands of people everyday, and without proper entrance and station identification signage, the CTA is foregoing an excellent advertising opportunity. (See Figure 5-22)

5.2.2 Line Identification

The Frankle-Monigle guidelines create (another) different naming scheme for the CTA's rail lines. The color-coding is retained for each of the different lines, but is used only as a visual identifier, not a name. "Because a rail line may have more than one end point, a rail line is referred to by the name of its end point, not by its color." This results in line names like "Harlem-Ashland/Harlem-King" instead of the Green Line. However, both of the branches of this line would still be identified by the color green. It seems unlikely that passengers would use the new, longer name when the colors can still used as identifiers. This system does place added emphasis on the names of the terminal stations, which were also included in the color-coded naming scheme. An additional complication would occur should any line be lengthened, creating a new terminal station; wayfinding devices throughout the system would have to be changed in order to reflect the new line name.

5.2.3 Directional Devices

Another focus of the Frankle-Monigle wayfinding system was directional devices. A system of "breadcrumb[11]" devices was designed to clearly mark paths between important locations within a station. The devices were to be installed at all possible decision points and as reinforcement where necessary. All directional devices for rail-to-rail transfers were to use white text on a color coded background, while other information was presented using black text on a neutral gray background (See Figure 5-23 for an example). Exits, still called the "way out" are highlighted by using white text on a black background. A new type of arrow was used, which was also white on a black background. These design guidelines also do

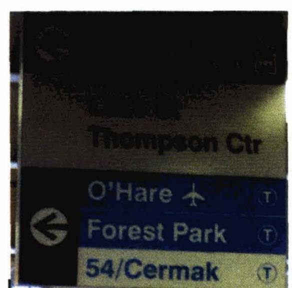

Figure 5-23: A "breadcrumb" style directional device at Clark/Lake.

[11] See Hansel and Gretel by the Brothers Grimm

not define specific conventions for use with these arrows.

In practice, the breadcrumb devices were not sufficient to make wayfinding at Clark/Lake easy. Whether this is due to the design of the devices, their deployment in the station or the design of the station itself has not been determined. What is clear is that additional devices are needed to help reinforce wayfinding decisions especially along very long, complicated paths (as are found at Clark/Lake) and in large lobby areas with mixed circulation patterns. Wherever the environment changes drastically, directional devices should be installed as reinforcement (Arthur & Passini, 1992) as is necessary in Figure 5-24. It is in these types of situations that passengers appear to be the most confused and need to backtrack most frequently[12].

Figure 5-24: The doors at the end of this large lobby lead to the Blue Line subway. No directional devices are present, and these doors look more like exits.

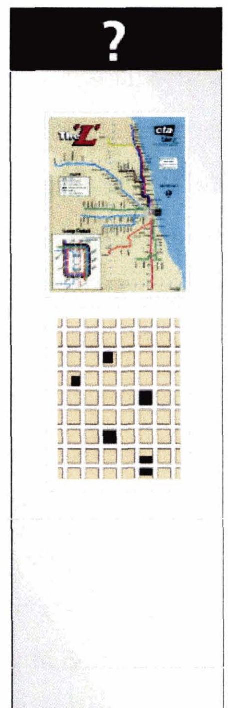

Figure 5-25: Information marker with rail system map on top and a neighborhood map below.

5.2.4 Geographic Information

Three types of maps are included in the Frankle-Monigle guidelines: the rail system map, the rail line maps and neighborhood maps. The rail system map is essentially the same as the Rail Transit System Map from the Graphics Manual. The only major addition that is recommended is to include major Pace and Metra transfers. The Rail Line maps are similar to the Rail Line Car Cards that were introduced in section 5.1.4, however they are designed to be located both on-board trains and on platforms. The guidelines state that north should also be oriented upwards on these geometric representations, but does not include an explanation of how this can

[12] I have spent significant time studying the Clark/Lake station. My observations about passenger behavior at this location come from four days spent observing and analyzing the wayfinding system there.

be done in the car card format.

The final element added to the map system by these guidelines is a Neighborhood map. These elements were to include the local street grid around a station in addition to transfer opportunities, taxi stands and local landmarks within a half-mile radius. These maps are again to be oriented so that north is always pointing up, and are to be located both outside and inside stations. A special information marker was designed in order to display the neighborhood maps near all of the other information necessary to plan and execute a transit trip including bus schedules and rail system maps as shown in Figure 5-25. Neither the neighborhood maps nor the information markers were ever implemented.

This system was implemented as a pilot program only at the largest and most complex station in the CTA system. Five of the CTA's seven lines meet at Clark/Lake and it is the biggest transfer point in the system. The station itself is located between two buildings, with station entrances inside each, making it one of the most difficult to sign effectively. The station identification elements and the directional devices have been installed throughout the station, except on the Blue Line platform. Outdoor station markers were installed near only two of the many station entrances. In addition to the elements discussed above, information kiosks which allow for more detailed displays of fare policies, system hours and bus transfers were installed at various locations throughout the station, as shown in Figure 5-26. The success (or lack thereof) of the pilot program can best be measured by the fact that the Frankle-Monigle wayfinding standards have not been implemented at a single other station, including the recent renovation of the Cermak branch of the Blue Line which reverted back to the Graphics Manual's standards.

Figure 5-26: Information kiosk at Clark/Lake.

5.3 THE FRONT DOOR PROGRAM

In 2003, the CTA allocated funds for the beginning stages of the "Front Door Program" which was intended to improve the appearance and design of the entrance areas of some of the CTA's stations. Because it was understood that funding for massive station renovation would not be forthcoming at all stations, this program was designed to implement incremental improvements at stations not on the priority list for renovation. The structure of the program meant that only a handful of stations could be improved in any given year, but the expectation is that this project will have multiple phases in order to improve as many stations as possible. As the project name indicates, the primary focus of this project was station entrances and their appearance within the neighborhood. The improvements authorized by the Front Door Program included many different types of projects which were headlined by station identification improvements. Of primary import to this thesis are two improvements designed to affect station entrances: station identification signage and entrance canopies.

As noted in section 5.1.2, the Graphics Manual has no standard for a station identification device that can be seen from a distance. This type of device is necessary to alert the community to the presence of a station by providing a highly visible and easily recognizable landmark. The Front Door Program addresses this oversight by developing standards for this type of device. Several installation standards were developed based on the same initial design in order to accommodate the varied conditions found at CTA stations. Many CTA stations are elevated, and there station entrances are typically found under the elevated tracks. This only serves to further decrease the visibility of the existing station entrance signage. Therefore, a large scale device that can be installed on the track structure that would be readily visible by people on the street or the sidewalk is shown in Figure 5-27. Using the same basic design element other versions were developed for installation at other types of stations including the wall mounted example shown in Figure 5-28. All of the station identification elements developed through this program are

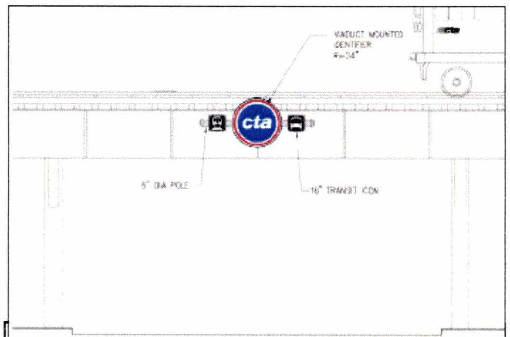

Figure 5-27: Viaduct mounted station identifier for the Front Door Program.

Figure 5-28: Wall mounted "Front Door Program" station identifier.

graphical variations on the design shown here using the new CTA logo in red and blue and the appropriate transit icons. Neither the station name nor the transit line can be determined from these elements.

Another important standard developed by the Front Door Program is for subway entrance canopies. A small portion of CTA stations are underground stations serving the subways and many of these do not have above ground station houses. Entrances at these stations are thus limited to simple stairwells in the sidewalk and are typically labeled with the standard Station Entrance signage as detailed by the Graphics Manual. The addition of canopies over these stations is primarily to add lighting and protect passengers from inclement weather. However, the unique structure also increases the visibility of the station entrances and helps passengers to find them (See example in Figure 5-29). The additional lighting also improves their visibility from a distance at night.

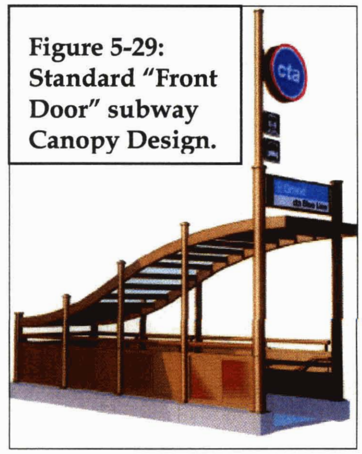

Figure 5-29: Standard "Front Door" subway Canopy Design.

These elements are not a part of the current standards governing wayfinding in the CTA and are only to be installed at stations selected for participation in the Font Door Program. As only a few stations can participate each year (seven stations were selected in 2003) it will take a long time for these elements to proliferate through the system. Currently, the first stage of this program has been planned, although no time line for implementation has been set.

5.4 EXISTING CONDITIONS

Throughout the CTA rail system a wide range of station conditions can be found. Stations can be found below, above and on grade and in areas of both high and low density. Stations of different sizes with different levels of bus and rail service present a wide range of station conditions that must be addressed by the Graphics Manual and subsequent wayfinding programs. While fairly comprehensive guidelines have been developed for most wayfinding needs, most stations do not adhere to these guidelines.

The wayfinding systems at some stations simply have not been updated recently (decades, in some cases) some stations have additional non-standard elements that have been added due to unique circumstances. This section will look at the conditions as they exist throughout the CTA system, but will necessarily not be able to adequately address every station. Therefore, the average conditions will be presented, in addition to any special, standout wayfinding elements at particular stations. Recommendations for improvements to both the existing conditions and the design guidelines will be presented in this section as well.

5.4.1 Line Identification

The standard methods for line identification have proceeded largely as planned in the Graphics Manual. Colors are used as originally intended to identify each of the seven rail lines and their branches. Terminal stations are used to define directionality, with sparing use of icons. While all maps and most directional signage has been updated to reflect this system since the lines were renamed in 1995, individual stations have frequently not been brought into accordance with the design guidelines. The status of specific elements will be discussed further in later sections.

Beginning in 1948, CTA rail service was run as a "skip-stop" system in order to increase train speeds. Under this system, not all trains stopped at each station and trains and stations were designated either "A", "B" or both. In order to determine which stations were served by which trains, a color coding scheme was developed that could distinguish between the three types of stations: "A" stations were red, "B" stations were green and "AB" stations were blue. The wayfinding devices at each station were color coded accordingly and all symbol signs listed the type of station. In order to avoid the need for a full wayfinding renovation whenever a stations' type changed, a new standard was developed that used the CTA's official color, blue, for all station wayfinding elements.

Unfortunately, neither the cessation of skip-stop service in 1993 nor the renaming of the rail lines in 1995 was accompanied by a system-wide updating of wayfinding devices. In stations where the old symbol signs have been retained on the platforms, the area on the sign that indicated the station type was frequently just painted over using colored paint, as shown in Figure 5-30. Some stations, regardless of their line, were outfitted with blue wayfinding elements in order to avoid the need for future wayfinding updates as service patterns continued to change. The result is that many of the older stations still use combinations of old color coding standards in their wayfinding systems and it is possible to find many differently colored identification elements on a single platform. This can cause true confusion for passengers at stations who have no idea what line they are on.

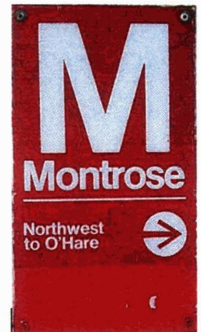

Figure 5-30: A symbol sign on the Blue Line with the text "A Station" covered.

As CTA stations throughout the system have undergone modernization and renovation, the Graphics Manual's color coding scheme has been implemented on a station by station basis. Both of the recent line renovations on the Green Line and the Cermak branch of the Blue Line have fully implemented the system. In addition to updating the wayfinding systems to the current color coding system architectural design is sometimes also based around this color (see Figure 5-31). Accent colors are frequently selected based on the line color to make the stations more aesthetically pleasing. Stations that are easily identified with a specific colored enforce a strong connection between the station and its line. Creating a whole line of stations that can be grouped together based on this type of unifying element help to enforce a distinct identity for each line.

Figure 5-31: The Red Line platform at Roosevelt enforces the line identity by using the color red where possible.

Blue is one of the more visible colors on all platforms because it is used as a warning strip on the edge of the platform as shown in Figure 5-32. This is another example of a station design standard being implemented in order to accommodate the

Figure 5-32: What line does this platform serve? Not Blue. The Green, Orange & Brown line platform at

CTA's official color. Any platform from a distance then, appears to be a blue line platform if correctly colored wayfinding devices are not also readily visible. This further complicates the situation at stations that have not fully implemented the current color coding scheme and highlights the need to make this information clearly visible.

Recommendations

The purpose of color on wayfinding devices is not to make individual stations more recognizable to passengers arriving by foot or by train. (That wayfinding need will be addressed fully in the next section.) The type of color coding scheme that has been implemented by the CTA serves to identify the individual *lines* by standardizing (to some extent) the design of stations along each line. Strengthening line identities is important to help passengers understand the structure of the transit system. Color is a powerful means for accomplishing this goal because it can be used in many different ways on all types of wayfinding elements. In addition, wherever it is possible and appropriate, some architectural elements should be color coded to strengthen these identities beyond traditional wayfinding elements. However, passengers may be unable to make full use of the color coding scheme it is not implemented at all locations. It is therefore crucial that station identification signs (and all other colored wayfinding devices within a station) be colored to support this important system-wide goal. An update is necessary at all stations who are displaying the wrong colors to ensure that the whole system is adhering to the standard.

Also important to passengers' comprehension of any color based system is consistency. The same shades of each color must be used at all times and on all types of devices in order to be fully utilized by passengers. The Graphics Manual does provide standard colors that are used on most wayfinding elements in the CTA system. While most wayfinding elements do use these standard colors, there are some examples of devices that use non-correct colors that are not used in any of the color coding schemes. The Graphics Manual attempts to print terminal station names inside line identifying color blocks (as shown in Figure 5-33) on

Figure 5-33: All color coded devices should also include terminal station names.

all wayfinding devices, and this should be encouraged as it can help to overcome issues of non-standard and incorrect colors.

The CTA rail line with the strongest line identity is arguably the Yellow Line, with its unique icon and name. These types of icons are very powerful tools that should not be overlooked for the rest of the lines in the system. The use of terminal station names already provides a secondary method for distinguishing lines from one another beyond the colors. The "loop" destination is one 'terminal' station that would benefit greatly from the use of an icon. Many stations already include graphic displays showing an urban downtown (see Figure 5-34) on platforms heading to the loop in order to help define the term "loop" for passengers (especially tourists). A similar loop icon could be implemented on the destination signs for the southbound Brown and northbound Orange Lines, which would be the as helpful as the airplane icons in the Midway and O'Hare terminals.

Figure 5-34: "Loop" icon on the southbound platform at Rosemont.

As the color coding scheme becomes more ubiquitously implemented throughout the system, the colors should be used to reinforce the scheme wherever possible. This is especially true at transfer points and stations that serve multiple lines. All directional devices with platforms as their destinations should use the line colors, and if possible the terminal stations as well. Using the colors allows people who don't speak or read English to find the correct platform and all increases the visibility of these elements. See Figure 5-35 for an example where this recommendation should be implemented.

Figure 5-35: The use of color on this directional device would help draw attention to it.

Color coding stations at stations that serve multiple lines, especially those in the loop, is a complicated proposition. The older color coding schemes designated only one color for each station. However, both the Graphics Manual and the Frankle-Monigle system present wayfinding solutions that allow for multiple colors on station identification elements. While good from an informational perspective, neither of these standards for transfer stations create a strong identifying link with a specific line. This is especially true at the loop stations which maintain a "loop" identity instead of identifying with any one line. On platforms that serve only one line, every effort should be made to identify it as part of its line. However, on loop stations and north-side stations where the Red, Brown and Purple Lines sometimes share platforms each of these three colors must be featured with equal prominence.

The main recommendation presented in this section is that the line identification system, as articulated through the CTA's color coding scheme, should be updated to be consistent at all stations in the system. The magnitude of the system ensures that this will be a costly endeavor that the CTA would like to only have to undertake once. Many possible service changes in the near future have the potential to once again radically change the naming scheme for the CTA's rail network. Some of these changes that the CTA is contemplating include:

- Linking the Brown and Orange Lines after completion of the Brown Line reconstruction project
- Separating the Cermak branch from the Blue Line and sending it through the loop via the Paulina connector as either a separate line or a part of the Green Line
- Construction of a new rail line (perhaps the proposed Circle Line)

Each of these proposed service changes would affect the color coding of the lines by either requiring a new color or consolidating two colors into one. Before the CTA attempts to implement the color coding scheme at all of its stations, these service questions should be answered so that all of the new devices do not to be redone again in the not-too-distant future.

I will not discuss the optimal service configuration here, only what options are available for the CTA's naming convention as service continues to evolve. Should the CTA opt to connect the Brown and Orange Lines, one of the colors must be selected to represent the line. Based on ridership levels, the new line should keep the Brown designation. However, with the current renovation project occurring on the Brown Line, the opportunity exists to redo the brown line wayfinding system to match the Orange Line. One benefit of the wayfinding standards in the Graphics Manual is that the colored tabs on the station Name signs are removable and could easily be changed from Brown to orange at a later date.

There are many possible future scenarios in which service would be operated using an eighth line. Informal research conducted for the CTA in 2004 looked at other large transit agencies around the world and concluded that the maximum number of rail lines that can be differentiated by using a color coded naming scheme is eight. The CTA currently operates with seven lines, which leaves one additional line that could be added without a problem (probably pink or silver). If the Brown and Orange lines are consolidated, one of those colors will also become available, allowing for even further expansion. The color coding naming system is very effective in rail systems, and if possible should be continued. Another option for expanding this scheme would be to take yellow away from the Skokie line. This line has several other identifying factors including a name and an icon and only serves two stations. Skokie could theoretically operate without a color or it could be graphically added to the Red Line as a northwest extension from Howard or as an alternative northern branch of the Purple Line.

No matter what operating pattern is selected for future CTA operations, an appropriate naming scheme must be developed. Once a naming scheme has been established that incorporates all of the proposed service changes, then the wayfinding system should be updated accordingly. One additional color should be reserved in the event that an additional line is built. By accommodating the future growth of the system, the CTA will avoid the need to completely redo the wayfinding systems of each station again in the not-too-distant future.

One final note must be made about the use of color coding schemes. While color coding is a powerful means of categorizing information, wayfinding designers must take care to ensure that it is not the only method used. Many passengers cannot see colors and therefore the use of color must be accompanied by textual and tactile explanations of the meaning of the different colors. In some situations, it is enough to use the text names of the different lines in addition to the colors themselves. The Graphics Manual specifies that wherever possible the names of terminal stations should be included with their colors. This does serve to identify the lines for color blind passengers.

5.4.2 Station Identification

Street side station identification at CTA stations takes many forms, including the standard station entrance signs design by the Graphics Manual. These signs have been installed as required by the Manual above many station entrances. Not all stations use this standard, and many of the older stations use older entrance signage that was printed in blue, the CTA's official color. (See Figure 5-36) None of these elements show the station's name and the only element that is repeated regularly on almost every element is the train icon.

Figure 5-36: The station entrance sign outside of Midway station.


Figure 5-37: Pylons for station ID on the rebuilt Cermak branch.

Station markers, which indicate the presence of a station within a neighborhood, are an essential part of transit stations' wayfinding systems. While the Graphics Manual does not provide for these types of elements, both the Frankle-Monigle and the Front Door programs have addressed this need. In addition, a wide range of identification devices have been developed for use at individual stations, as needed. None of the Front Door devices have been installed yet, although three stations are expected to receive them in the near future. Only two of the Frankle-Monigle standard station markers were installed, as previously noted. The recently re-built Cermak branch of the Blue Line created its own standard device that is used outside of stations, as shown in Figure 5-37. Other, larger devices of varying design can be found at some of the peripheral and median stations which exist in less dense urban areas. The UIC station is one example of station identification being incorporated fully into the architecture of a station, as shown in Figure 5-38.

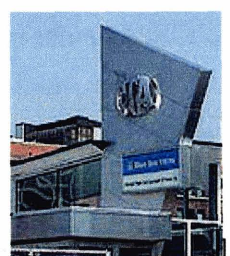
Figure 5-38: UIC station identification

The on-platform station identification elements have largely been deployed as called for in the Graphics Manual as individual stations have been renovated. As noted in the previous section, many stations have out-of-date name and symbols signs on their platforms that are not only of an older design but also the wrong colors. Name signs are installed high above the platforms and symbol signs are below them, both occurring at least once every car length. In addition to the sparing use of identifying icons on the colored tabs of some stations, these areas of the name signs can also be used for directional information, especially the location of accessible elements.

Recommendations

The first issue that must be addressed in this category is the individuality of station names. As noted, there are frequent cases of repeated station names in CTA's system. Stations should have unique names so that they can be easily differentiated by passengers. In some cases the line color can be used to differentiate between two stations of the same name (Ashland-Green and Ashland-Orange, for example), but this is not always possible when multiple stations on the same line have the same name (there are three Westerns on the Blue Line). Using the line or terminal station names in conjunction with the existing station name (Western-Cermak, for example) will uniquely identify the stations, but in the event that the color designations change (see the previous section) or the a line is extended, the station names would also need to change. In order to avoid this possible complication, the stations with duplicated names could be amended to include the names of the nearest intersecting street, regardless of whether or not there is an entrance on that street. This could ensure that there any never any duplicated names in the system and that they never need to be changed.

Street-side identification is important in order to establish strong identities for both individual stations and the CTA system as a whole. None of the station markers that have been standardized including those found in the Frankle-Monigle system, the Front Door Program or used on the Cermak branch renovation feature the station names. These devices are meant to be seen from a distance, and station names are not necessary at this scale. However, at a closer scale station names should be visible on the outside of the station so that people in the neighborhood are able to identify the station without prior knowledge of the system.

It is also important to alert people to the presence of a CTA station in their neighborhood and the full extent of the CTA system. This involves creating an identity for the CTA that is readily identifiable with its services, so that when people see a CTA station, they instantly know that they are using part of a vast rail network. In order to accomplish this one standard symbol should be deployed on the outside of every rail station that visually connects them and creates the image of one system. This also makes it easier for people to find a specific station as they will know exactly what to look for in order to find it. Standardized station markers should be installed outside of each station so that they are visible from some distance away and from all possible directions of approach.

Station identification for passengers arriving by train is made easier in the CTA's system because of the prevalence of elevated stations. These outdoor stations each have different surroundings, and therefore a different view is presented to the passenger at each station. This is not true at subway or median stations, where the view from inside a rail car is very similar due to the use of standardized wayfinding elements. The platform area of each station looks substantially the same (after the installation of current wayfinding devices) except that a different name and letter will appear on the wayfinding devices. Therefore, at these types of stations it is especially important that passengers be able to see the name signs. The use of pictograms in the color tabs and other unique identifying elements such as public art should be encouraged at these stations in order to provide further identifying elements.

ADA requires that these name elements be visible on both sides of the train, from both a sitting and standing position. The current standard for installation of name signs places them eight feet above the platform, which is too high to meet this requirement. The renovated Cermak branch stations all have installed these elements at a lower height, but sightlines from the inside of CTA rail cars should be investigated to ensure that all passengers have visual access to these important elements.

5.4.3 Directional Devices

The quality of directional wayfinding systems varies significantly between stations. Stations that have been renovated within the past five years tend to have relatively good systems that provide all of the necessary devices. However, many of the older stations do not have the wall space to accommodate the full compliment of directional devices. Maintenance and upkeep have also been a problem at many of the older stations, which has caused gaps along some paths. Bringing these systems up to date should be a focus of the CTA's wayfinding program.

A study was conducted in 2003 by the Regional Transportation Authority (RTA) to analyze the condition of the stations of its service agencies (CTA, Metra and Pace.) One of the conclusions of this study was that while each agency takes care of wayfinding in its own stations, very little coordination occurs at locations where these services intersect. At these locations, where passengers are likely to be transferring, directional wayfinding between service agencies is often lacking as shown in Figure 5-39.

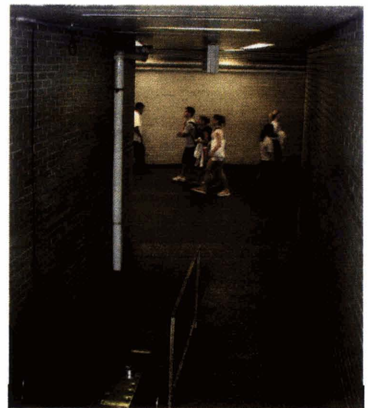

Figure 5-39: Upon exiting Metra at Jefferson Park, no signs indicate directions to CTA bus or rail transfers.

Recommendations

The purpose of directional devices is to guide passengers along a path from one point to another. As such, these devices must be deployed at any point in a station at which confusion could occur. Therefore, the primary location for directional devices is at decision points; locations where traffic flows merge, split or turn. This is already the policy for deployment of directional devices according to the Graphics Manual, and should be followed strictly at all stations. Two more types of locations should be targeted for directional devices as well: long corridors and spaces of undefined circulation. Long corridors or any long uninterrupted path requires directional devices as reassurance for passengers. The locations do not have to be straight corridors, but can also include long stairways and elevators. Large open spaces, like lobbies and mezzanines require a lot of directional devices because the space is undefined and passengers can be coming from many possible directions. All of these requirements should be considered when developing wayfinding plans for CTA stations.

There are a wide range of station elements that could be included in a system of directional devices. Of primary importance are the platforms and station exits, but other elements such as elevators, bus connections, bathrooms and telephones could also be included in the system. As previously noted, the wayfinding connections between agencies are not very good and this should be improved through interagency coordination, perhaps organized by the RTA. However, the CTA needs to do a better job of signing for intermodal transfers between its rail stations and nearby bus connections. Coordination between the three operating agencies is important in order to provide an integrated transit experience that it easy for passengers to use. Directions to bus connections will help make transfers easier for passengers and should be provided wherever a bus stop is located near a rail station. Wherever possible these elements should include the route numbers. At stations with multiple exits, a street name should be provided on the directional devices to allow passengers to distinguish between them.

The design of the directional devices used throughout the CTA system, including the Frankle-Monigle prototypes, provides all of the necessary information in a usable design. The use of arrows and other pictograms is appropriate. As previously noted, directional devices with platforms as their destinations should include their line color according to the color coding scheme. Color should also be included on any directional device directing passengers to accessible elements, as shown in Figure 5-40. The use of color in both of these situations will increase their visibility for passengers who need them. Using two different shades of blue might allow passengers to distinguish between accessible elements and Blue Line elements, although the colors would not distinguishable for passengers with visual impairments.

Figure 5-40: A directional device for an elevator is color coded blue.

5.4.4 Maps

The three maps presented in the Graphics Manual have been deployed as planned throughout the stations and the rail cars. The car card maps are frequently subject to vandalism and theft, problems that do not drastically affect the in-station elements. The Graphics Manual calls for the installation of the Rail Transit System Map throughout a station, including on platforms. Despite this requirement many platforms do not have the maps installed. Even on platforms with the map installed, many have very few maps (sometimes only one) on the entire length of the platform.

The RTA has developed a system map that includes CTA and Metra rail services in addition to some of the CTA and Pace bus routes. These maps are not produced or paid for by the CTA, but have been installed at many stations, including interagency transfer points and the airports. These maps allow passengers to make better use of the full spectrum of transit options available in and around Chicago.

The Sox-35th station on the Red Line is the only station to have a Neighborhood Map installed in the whole CTA system. The map was designed and installed by the station's entrance, with north oriented as up on the map. This map shows the local street grid, CTA rail services in the area and two important local landmarks (the White Sox stadium and the IIT campus.) No other details about the area are provided including information about connecting bus routes (of which there are three[13].) This type of map is not included in the Graphics Manual, and therefore no instructions about where similar elements should be deployed are provided.

The CTA makes system maps available to all passengers by providing paper maps at most stations. This detailed map show both the rail and the bus network and is extremely useful for anybody who wishes to use the system. In addition, the CTA makes available "tourist maps" at certain stations that include rail network maps and detailed information about downtown service. These maps also include information about popular tourist attractions and hotels in the loop area and are available at both of the airport stations.

Recommendations

The Neighborhood map developed for use at Sox-35th is an important first step towards improving the CTA's wayfinding system. These devices have the potential to help passengers to find their final destinations after they exit the transit system. However, in order to be truly helpful in this task they must provide more information than the current version does. Additional landmarks, including local hotels should be included for use by tourists. Some of the street addresses should also be shown on the map (similar to what is currently standard on the Rail Transit System Map) for those

[13] See the Regional Transportation Asset Management System for details about bus/rail connections. <www.rtams.org>

who do not know the Chicago street grid well. One of the most important things that should be added to these maps is local bus services in the neighborhood. Bus routes should be shown along with their route numbers, in addition to showing the locations of bus stops. This will help people who wish to transfer in addition to advertising these services to any passenger who uses the map. For stations that are near Metra stations or Pace terminals, the locations of these services should also be shown in order to make the transfer easier.

Chapter 2 presented the theory that all maps of the "you-are-here" type (which the Neighborhood map is) should be oriented so that they are parallel to the environment so that people do not have to rotate the map in their mind. This results in North not always being up, but allows people to line the map up with the environment around them. While this is still a sound argument, Chicago may be an exception to that rule because of its strict adherence to a grid system that is oriented North-South. Any mental rotations that must be performed are therefore limited to multiples of 90°, an easier cognitive task (Devlin, 2001). However, for passengers who do not know the grid pattern of the city, some method of establishing their orientation when they emerge from a station must be established.

CTA management has expressed their intention of installing compass roses outside each station to accomplish this. The process has begun throughout the CTA system, and every station on the renovated Cermak branch has a compass rose directly outside of each entrance, as shown in Figure 5-41. By combining the orientational information provided by the compass rose and the Neighborhood map, CTA passengers will be able to effectively locate their final destinations. In order to simplify their use as much as possible, Neighborhood maps should be located so that users must stand facing north whenever feasible in order to ensure that the map does parallel the environment.

Figure 5-41: Standard compass rose used on the Cermak branch also includes the station name.

Another area that the CTA's map system overlooks is that of stations themselves. Maps of station interiors are only necessary at the more complex stations, usually transfer points that serve multiple lines. Station maps that show the station interior, platforms, exits and the stations' interactions with the surrounding building would be helpful to passengers transferring at both Clark/Lake and State/Lake. Both of these stations serve five different lines on four platforms, and when transferring to the Red Line at State/Lake passengers are actually required to exit the system and walk outside. A station map at this location would help passengers understand where to go and reduce the number of confused and lost customers. Other possible candidates for station maps include Howard and Roosevelt, with its underground connections between platforms.

The final concern with the CTA's mapping system relates to deployment of these elements within the stations. As previously discussed, the Rail Transit System Maps should be located frequently throughout the stationhouse in both the paid and unpaid areas in addition to along the platforms. Neighborhood maps should be available near every station exit. Station maps, where they are necessary should be available on platforms, near exits and entrances and at major decision points throughout the station for use by entering, exiting and transferring passengers. The inclusion of an in-station version of the line specific car card maps would be helpful so that passengers would be introduced to the device before boarding the train, as indicated by the Graphics Manual's goals of rehearsal and repetition. These elements should be located near the full transit system maps in station houses and on platforms.

5.4.5 Accessibility

Since the most recent edition of the Graphics Manual was designed after ADA was enacted, all of the stations that were designed in accordance with the Manual also are intended to meet the ADA design guidelines for transit stations. Unfortunately, many stations throughout the system do not meet the CTA's design criteria, as has been already mentioned in previous sections. Some elements for the physically, visually and hearing impaired have been installed at many stations.

CTA customer assistants are trained to provide additional assistance to all wheelchair-bound passengers, and they use a "gap filler" that is placed between the platform and the train car to make the transition easier for these users. Other wayfinding elements designed to ease the travels of physically impaired passengers include the Rail Transit System Map which shows every station that is accessible for passengers in wheelchairs. In many stations, elements indicating the locations of elevators and other accessible elements are colored blue. The rebuilt portions of both the Green and Blue lines use white 'accessibility' symbols (the wheelchair symbol) in the colored tabs of station name signs, as shown in Figure 5-42. This wheelchair symbol is used to indicate an elevator, despite the fact that the official meaning of this icon is accessibility. The Frankle-Monigle signage uses the internationally accepted symbol for elevators. Icons for escalators are also found in stations, as shown in Figure 5-43.

Figure 5-42: Accessible elements are shown in white on the colored tabs of the name signs at Clinton.

Figure 5-43: Standard icons for vertical circulation elements.

A range of devices exist to aide passengers with visual impairments. PA systems in stations are used to make announcements during emergency situations and are used on board trains to announce each station in turn. Further information about PA systems can be found in the next section. Braille/tactile devices are required by the ADA to identify stations both at their entrances and on platforms. While no directional devices are required by this legislation, some can be found in CTA stations as shown in Figure 5-44. The design requirements for these types of directional devices were discussed in depth in Chapter 3. No orientational information is available to visually impaired passengers.

Figure 5-44: This tactile directional device at Clark/Lake does not include the arrow provided for sighted passengers.

Most wayfinding information is readily available to deaf passengers, with the exception of the announcements made via the PA systems. Alternatives to the PA systems will also be discussed in Section 5.4.6.

Recommendations

The Graphics Manual stipulates that all accessible elements are to be color coded blue. This has not been fully implemented throughout the system, but it would be a powerful tool for helping physically disabled passengers find accessible paths. These paths should be marked with the elevator icon instead of the wheelchair icon for accuracy and so that other passengers who may want to use the elevator (like travelers with luggage) know where to go.

When an elevator breaks, it renders a formerly accessible station temporarily inaccessible. However, there is currently no method for knowing before the start of a trip whether or not the elevator at your destination will be functioning. Many transit agencies around the country centralize their information on these types of breakdowns and provide a system-wide list of broken equipment at the entrance to each station. Implementing this type of system at the CTA would allow mobility impaired passenger to use the system without the fear of being unable to reach their final destination.

As noted, ADA requires that Braille/tactile identification elements be located in a consistent location outside of each entrance. The Graphics Manual does not assign a location for the installation of these devices, and this oversight should be remedied so that visually impaired passengers can readily identify each station. Two types of information are unavailable to passengers with visual impairments: directional and orientational. The inclusion of directional devices for all possible paths in even a simple station would be prohibitively expensive and time consuming and may not be practical. Some method of providing directional information to the visually impaired must be developed for CTA stations, whether it is in the form of physical tactile devices or some sort of audible technology as introduced in Chapter 3. For example, "talking signs" have been met with some success for use in public transportation systems by providing audible directions and identification to passengers carrying special transmitters. (Bentzen et al, 1999) Alternatively, many transit systems in Asia utilize tactile paths installed on the ground to create paths that can be followed for blind passengers using canes.

4.4.6 Real Time Information

The implementation of real time information technology takes many forms throughout the CTA system. On-board trains, the PA systems have been integrated with a system of variable message signs and are used to announce station names upon arrival as mandated by ADA. The in-station system outlined in the 2002 Graphics Manual has been implemented in some stations, particularly on the Green Line. These systems announce the impending arrival of trains via both the PA systems and variable message signs. Most of the CTA rail lines however, are not equipped with this technology.

The RTA has undertaken several attempts to implement intelligent wayfinding devices using real time information in their three operating agencies. In 2003, the Active Transit Station Signage (ATSS) program began with the goal of providing train arrival information at several CTA stations. (See Figure 5-45) At the four stations selected to participate in the test phase of this program (O'Hare, Midway, Cumberland and Davis) received variable message signs that were synchronized with the stations' PA systems which announced all impending train arrivals. In addition to these standard ATSS elements, on-platform elements counting down the estimate time until a train arrival were installed at Cumberland, as shown in Figure 5-46. Currently, these elements provide only estimates of train arrival times (and they are not particularly accurate estimates) and some of the ATSS signs have been programmed by RTA project administrators to display bus schedules that change to show the most current schedules based on the time of day.

Figure 5-45 – Standard ATSS signage outside of Midway.

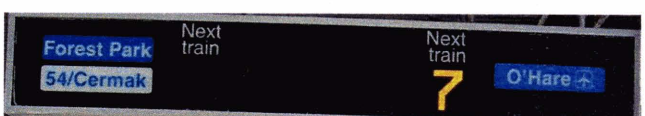

Figure 5-46 – The train arrival signage at Cumberland station.

The CTA's website is another technological advance that helps passengers plan their transit trips. Maps, schedules and a variety of other tools are made available online for potential passengers to plan their trips at their own pace and on their own time. The most powerful tool available on the website is a trip planner that allows users to easily plan multimodal trips on the CTA, Pace and Metra. This tool was developed and is maintained by the RTA. Users are able to obtain step by step instructions on how to reach their destination and can start with either street addresses or chose from a list of landmarks. The internet site is also the most comprehensive source of information about the CTA system as system hours, policies and fare information are all available to the savvy user. This is one of the only places that all of this information is easily accessible and is also easy and relatively cheap to update. The internet is an excellent tool for making infrequent riders more comfortable with the system, and therefore more likely to use it.

The RTA is currently working on several updates to the existing trip planner that would incorporate alternative access modes, including driving. The updated system would combine a traditional online mapping service with a transit planner and also will also provide detailed accessibility information in a web-based format. In addition, the RTA developed new technology that would integrate the functionality of a trip planner with detailed information about attractions and events throughout the region[14]. This web-based tool is to be made available at various locations throughout the RTA service area in the form of stand alone Multi-Modal Traveler Information Kiosks (MMIK) that would print final trip plans and itineraries on-site (See Figure 5-47). Only one CTA station was selected to receive one of these kiosks (Midway) as part of the initial trial project with the rest being located at various tourist attractions around the city[15]. None of the kiosks have been installed yet.

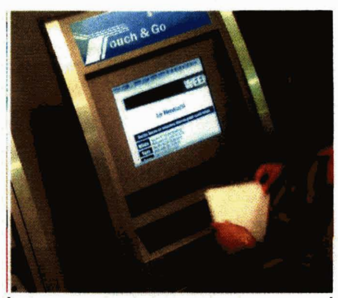

Figure 5-47: Prototype MMIK developed by the RTA will be installed at Midway. (RTA)

[14] "Multi-Modal Information Kiosk (MMIK) Project Task 1:Concept of Operations", RTA, 2002
[15] Regional Traveler Information Kiosk Feasibility Study, RTA, 2003

Customer Assistants (CA's) are another important source of up-to-date information in CTA stations. As their name implies, CA's are trained in customer service and are located at each station to answer questions, help people use the automatic fare machines and provide general assistance. CA's are no longer permitted to sit in their booths and are required to be in the unpaid area of the station to help whenever passengers are present. While most stations have only one full or part-time CA, the busier stations including both of the airports, have multiple CA's on duty at all times to provide information, assistance and maps to newcomers and improve their initial impression of the CTA system.

Recommendations

The use of real time information technology in the CTA system has resulted in varying levels of success. The most successful project was the train arrival announcements that were implemented as part of the Green Line renovations. The system is consistent and reliable at all stations along the line. Further, the variable message signs which announce an impending train arrival are free to display any other type of information between trains including safety warnings and public service announcements. They can also be used to provide directions during emergency situations. Projects like this one should be encouraged on other CTA rail lines as reconstruction allows.

The success of the ATSS pilot program is markedly different at the two terminal stations than at the mid-route stations. At the terminals, the devices must only display the time until train departure, which is much easier to predict than arrivals since schedule adherence at terminals tends to be high. It is unlikely that these powerful devices will proliferate throughout the CTA until the RTA sponsors a program to do so, however the CTA should investigate the benefits of this program and take ownership of the more beneficial elements of the devices. One specific benefit of this system over the CTA's Green Line program is that devices are located outside of the stations as well, allowing passengers to know the time to departure before entering the station. This has the potential to decrease average in-station waiting time by allowing passengers to do other things before entering a station if they know they have a certain amount of time before a train arrives.

The CTA's website is a powerful tool that must be well advertised in order for passengers to take advantage of it, especially since the web address is not particularly intuitive. The content available is fairly comprehensive, although some additions could be beneficial. Specifically, making neighborhood maps available online allows passengers to plan their whole transit trip at one tome without having to use multiple mapping tools at once. These maps should be similar in form and in content to those recommended in section 5.4.4.

The condition of wayfinding in CTA's stations varies considerably based on the age of individual stations. Some stations adhere to the guidelines presented in the Graphics Manual, while others use a hodgepodge of elements from the past century. Most of the pieces necessary for an effective wayfinding system can be found at various locations in the system, and the CTA must focus on bringing them together and implementing them consistently at all locations. This will ensure ease of use for passengers, encouraging people to use the CTA for all of the transportation needs.

5.5 CONCLUSION

The CTA has shown dedication to the ideal of good station wayfinding systems through its implementation of multiple programs geared to improve those systems. The Graphics Manual, the official guidelines for wayfinding design in CTA stations is updated frequently to reflect changing needs and conditions. Other trial programs have been implemented by both the CTA and RTA in an attempt to fulfill passengers' wayfinding requirements using high quality designs and modern technology. This has resulted in a wayfinding system that provides many benefits to its users, including:

- A strong wayfinding philosophy that demonstrates an understanding of the wayfinding process
- A clear and understandable directional convention that uses color coding and terminal stations to determine train destinations
- Good on-platform station identification elements that allow passengers arriving by train to know when they have reached their destination
- A system of visible and legible directional devices

- A rail system map that provides a lot of information about transit services in addition to detailed geographical context
- ADA compliant Graphics Manual that incorporates tourists, non English speakers and other groups into the wayfinding system
- An understanding of the applications of real time information technology and a willingness to try new systems

Unfortunately, the sheer size of the CTA's system has made it difficult to implement any of these programs system-wide and most are limited to individual lines or stations. Wayfinding conditions vary significantly by station making it difficult for passengers to be able to efficiently navigate all stations. A wide range of recommendations have been made in this chapter that would ensure that the system is easier to use for the whole passenger population. Some of the more important of these are:

- Establishment of a station naming convention that ensures unique identifying names for every station
- Development and deployment of a single standard station marker that would be easily visible and readily identifiable from within the neighborhoods
- Establishment of strong line identities by implementing a consistent color coding scheme at all stations using the in-station wayfinding devices. This scheme should account for future service changes and expansions in order to avoid the need for another system-wide renovation
- Coordination with other local operating agencies in order to assure smooth transfers
- Development of design guidelines and implementation standards for Neighborhood maps at each station and on the internet
- Installation of directional and orientational information available to passengers with visual impairments
- Ensure that all variable message signs are being employed to their highest purpose and implement programs to install train arrival signage at all stations

The main goal for CTA wayfinding at the current time should be consistency. The implementation of a single wayfinding system at all stations allows passengers to use stations easily after learning the wayfinding conventions at a single station. It will also help to solidify the image of the CTA rail network by creating strong identities for the system, the lines and each station. Further, it will allow more passengers to feel comfortable on the system and hopefully increase their usage of the CTA network.

This chapter has looked extensively at wayfinding in the CTA rail network and can be compared with the similar analyses presented for the MBTA in Chapter 4. The next chapter will look at a wide range of wayfinding system requirements including information, format, deployment and maintenance that can be applied to any transit property.

6. Generalized System Requirements

This thesis has introduced a wide range of design criteria for wayfinding in transit stations. Background from the existing literature was provided in Chapter 2 which outlined the definitions of wayfinding upon which the rest of the thesis has been based. The design requirements that were developed for twelve user groups in Chapter 3 addressed the technical areas of content, deployment and formatting. Using these criteria, case studies of both the MBTA and CTA systems were analyzed. The goal of this chapter is to use all of this information to provide generalized design recommendations that can be utilized by any transit agency seeking to provide accessible wayfinding elements.

The detailed wayfinding requirements were individualized for each potential user group in Chapter 3. This chapter will work within the structure of these requirements to aggregate and consolidate the wide range of devices that should be implemented in an inclusive wayfinding system. The three technical areas of content, deployment and formatting that have already been introduced will be supplemented by one additional area, lifecycle considerations, whose need was highlighted in the case studies. Of specific interest are implementation and maintenance, which must be addressed during the design of a wayfinding system in order to ensure that the system can evolve as transit service continues to change and expand.

Content requirements will be addressed first by using the four functional categories that were developed earlier in this thesis. They will be aggregated across user groups to provide one comprehensive list. Deployment requirements for each type of content will be addressed next, again by looking at each of the functional categories without regard to the individual user groups. Formatting requirements will be addressed by comparing passenger needs with the available technologies and design options. It should be noted that throughout this chapter that I refer to all of the requirements as necessary and give no ratings of relative importance. This is because the goal of this thesis is to provide universally accessible wayfinding systems that do not give preference to any one group of users.

6.1 CONTENT REQUIREMENTS

As has been previously illustrated, there is a great deal of information that a passenger needs to complete his or her trip. Ensuring that all of this information is provided is the primary goal of any wayfinding system. In this section, a comprehensive list of the content requirements of passengers in a transit station will be compiled. These requirements will be analyzed based on the four functional categories of wayfinding devices that were introduced in Chapter 2 so that designers can address each type of device separately.

6.1.1 Identification

Elements in this category serve to label and identify all locations that are potential destinations. This requires that a multitude of locations throughout a transit system be labeled with these devices. In addition, this category of devices can be used to create and promote unique identities for specific areas, including the transit system itself. In this regard, identification devices can also be thought of as performing an advertising function for the transit agency. All of these functions have been introduced in detail in previous sections, and so only a brief explanation will be provided here. The content requirements that must be fulfilled by identification elements include:

- System
- Stations
- Entrances
- Accessible entrances
- Lines
- Line directionality
- Connecting transportation services
- Identification of amenities
- Vertical circulation elements
- Station exits

The creation of identities is necessary in many areas of the transit system. The first item on the list is the creation of a unique identity for the transit system which serves to unify the system and can function in an advertising capacity. Each station must also be identified, not only so that it can be recognized upon arrival, but so that it can be referred to as a unique point on the transit network. Complex transit systems with multiple lines must also provide some way to distinguish between the lines. In addition, the directionality of any vehicle must be clearly established in order to ensure that boarding passengers get on the correct vehicle.

Entrances must be clearly identified so that passengers know where to enter the system, and should be identified as wheelchair accessible where appropriate (although ideally all entrances would be accessible for all users.) Exits must be similarly labeled and distinguishable when stations have multiple exits. Any possible destination, including intermediate ones, must be identified for passengers. This includes bathrooms, telephones, concessions and customer assistance locations. Multiple modes of transportation often converge at transit stations, and as such it is necessary to identify any connecting services available at any station including bus stops and commuter rail platforms. The final item on the list identifies vertical circulation elements in order to both draw attention to them (in the case of elevators) and to warn passengers. Stairs and escalators may prove dangerous to blind passengers who are not prepared for them.

6.1.2 Orientation

Devices in this category serve two related purposes. Their first purpose is to provide structural information about stations by showing how spaces are connected. This type of information is necessary at several scales throughout a transit system. The secondary purpose is to precisely locate a passenger within the overall system structure by showing their location and orientation. Passengers must be oriented within the city, the transit system, individual neighborhoods and the station itself. The orientational content requirements that have been developed include:

- Relation of transit lines to one another
- Relation of the transit system to the urban region
- Location of a station within its neighborhood
- Relation between station entrances and exits and their immediate surroundings
- Geography of the neighborhood around a station
- Relation of station entrances and exits with the platforms

The best way to convey this type of content will be discussed further in the section on format requirements. However, there are multiple elements that must be included in each of the elements listed above that will be accounted for by the formatting decisions. The structure of the transit network may be the most important content in this category. These elements must explain to passengers which stations are on which lines, where the lines intersect in addition to showing where both their origin and destination station are located within the system. The order of the stations along each line should also be included.

In order to provide orientation at a city-wide or regional scale, passengers must be able to understand how the transit system interacts geographically with the city that it serves. This information helps passengers to discern where they can go on the transit station and may help with identifying the directionality of trains that was discussed in the previous section. In systems which operate primarily below grade, this information becomes more difficult for passengers to understand without adequate wayfinding devices. Transit access to local tourist attractions, hotels, conference centers and other points of interest should also be shown on these devices.

Orientational information is also required in order to explain how each individual station interacts with the neighborhood directly surrounding it. While many people see transit stations as non-dimensional points on a map that exist only under (or above) ground, this is obviously not accurate. Stations have significant length and different entrances to the same station may be geographically distant from each other on the surface. Orientational devices at this scale must include locations of station entrances and exits in addition to other important content about the neighborhood like surface street names, addresses and locations of major landmarks. Cardinal directions are also necessary to make navigation of the neighborhood easier.

In some complex stations, orientation devices may also be necessary in order for passengers to navigate inside the station itself. Especially in transfer stations with substantial amenities, passengers should be able to know how the station is structured in order to find their desired destination.

6.1.3 Informational

The devices in this category provide a wide range of information about the services available at each station. The content requirements for this type of device are substantial and may vary at each station. There are, however, certain requirements are more universal and these include the following:

- Hours of operation

- Fare policies
- Transfer policies
- Bus schedules and route maps
- Accessible stations
- Anticipated train arrival
- Special conditions at entrances
- Emergency instructions
- Service delays
- Elevator functionality

Specifying hours of operation for the whole system is not sufficient, as many stations and entrances have their own specific hours. Also required is a "last train time" posting for each direction at each station. Schedules and route maps for local bus routes and commuter rail connections should also be provided at stations with these types of service. Fare policies must also be posted that explain how much a trip costs, how tickets may be purchased and explain transfer policies. For accessibility purposes, passengers must be able to determine which stations on the transit network are wheelchair accessible, which also requires knowledge of which elevators are functioning on a daily basis. Many possible special conditions exist that require informational devices such as an entrance that requires a farecard.

6.1.4 Directional

The content requirements for the devices in this category entail marking paths between desired origins and destinations. Origin-destination pairs within a station that are likely to be paired together to create a path will require directional wayfinding connections. The primary paths that require directional signage include:

- From station entrances to platforms via fare arrays
- From platforms to station exits
- Between platforms at transfer stations
- Between platforms and bus stops
- Accessible options for all of the above paths
- Directions to accessible entrance at all non-accessible entrances

All of these paths should be labeled for passengers traveling in both directions along these routes. In all stations where the accessible and non-accessible paths are separate, the accessible path must be marked separately utilizing the 'wheelchair' icon[16]. All of the same destination pairs that are cataloged in the list above must also be demarcating separately as accessible paths when necessary. Directions to accessible entrances must also be provided at any non-accessible station entrances.

Besides these primary paths, many possibilities for secondary paths exist that include destinations such as bathrooms, concessions, bus loading areas or information booths. Not all of these destinations will exist at all stations, and therefore do not need to be included as a secondary path. The number of directional paths that are marked depends on the complexity of the station and the number of areas that are highly used.

The content requirements for a transit station that have been cataloged in this section are substantial. The requirements have been divided into four functional categories that can be easily referenced by transit agencies and wayfinding designers. These content requirements meet the collective needs of all potential transit passengers as outlined in chapter 3. The success of the MBTA and the CTA in meeting these criteria was discussed in Chapters 4 and 5, respectively. Providing this information is not sufficient to design an effective wayfinding system. The next technical area that must be addressed is how to properly deploy this content. The deployment requirements will also be presented according to their functional categories and will meet the needs of all users.

6.2 DEPLOYMENT REQUIREMENTS

Having developed content requirements for the full range of user groups, it is now necessary to determine how the information must be deployed within the stations. Section 3.1 divided the content requirements into the four functional wayfinding categories in order to simplify this set of complex requirements. In this section, each of these functional categories will be revisited in order to determine the optimal deployment strategy. Within each category, the deployment requirements for each individual content item will be specified. At the end of this section, these requirements

[16] ADA Accessibility Guidelines

will be re-categorized by location for easy reference for wayfinding designers creating deployment plans for their own systems.

6.2.1 Identification

Elements in this category provide a wide range of important content to transit passengers, as discussed in section 6.1.1. In general, identification elements must be included in a wayfinding system in order to label and identify potential destinations and important locations in and around a station. In order to perform this function, identification devices must be located near the element that they are identifying. The specific deployment requirements for each piece of identification content are detailed in the checklist below and are an aggregation of the requirements detailed in Chapter 3 for each user group. Each white box in the list represents a content requirement, and the white circles represent a corresponding deployment requirement. The black boxes are deployment details that must be considered when developing a wayfinding system for a station.

- ❑ System Identification
    - o Outside of station
        - ▪ Visible from all possible approaches
        - ▪ Visible above other urban signage in the area
- ❑ Station Identification
    - o On platform
        - ▪ Parallel to tracks
        - ▪ On both sides of tracks
        - ▪ At least one every car length
        - ▪ Visible by both sitting and standing passengers
    - o Outside of station
        - ▪ Visible from all possible approaches
        - ▪ Visible above other urban signage in the area
    - o On train
        - ▪ In each car
- ❑ Station Entrance Identification
    - o Outside of the station
        - ▪ Include accessibility, if necessary
- ❑ Line Identification
    - o On platform
    - o Outside of station
    - o On train
- ❑ Directional Identification
    - o On train

        - Each car
    - On platform
        - Only at platform entrance on side platform
        - Along platform on a center platform
    - Outside of station - only if entrance leads to only one specific platform
- Station Exit Identification
    - At exit
        - Exit accessibility, if restricted

Several other elements may be present in transit stations must be identified as well. All connecting transportation services and station amenities must be labeled. Elevator door must also be labeled. Other vertical circulation elements should be identified for passengers with severe visual impairments. These devices should be consistently located at a consistent near the top and foot of every staircase (or escalator). Many of these types of content also require directional devices, as will be addressed in section 6.2.4.

6.2.2 Orientation

Devices in this functional category provide the information necessary in order to plan and execute a trip on a transit system. As such, these devices must generally be deployed throughout a station so that passengers can study them and use them as reminders as they make their wayfinding decisions. To be most helpful, they should be deployed near all decision points. However, because of the level of detail presented in many of these devices, passengers may need to study them in order to make their decisions. Therefore, these elements should be located outside the flow of traffic whenever possible to avoid congestion in narrow corridors. Their deployment should be coordinated with the system of directional devices to ensure that the correct information is available at each decision point.

Each of the orientation content requirements presented in section 6.1.2 must be available throughout the station. This includes the platforms, en route to the platforms and in both the paid and unpaid areas of the mezzanine. The geography of neighborhoods surrounding stations should also be located outside of the station as this is the final decision point along a passenger's route that is within the domain of the transit agency.

6.2.3 Information

The devices in this functional category are subject to a wide range of content requirements. Informational devices must be deployed primarily at locations where decisions must be made or important transactions must occur. In addition, most of these elements must be made available in some format outside of the system (like an online website), although the actual format requirements will be discussed in section 6.3.

System hours of operation should be available in the unpaid area of every station, in addition to some location outside of the system. Station hours of operation are also necessary in the unpaid station area, and must include the last train to depart the station each night. Part-time station entrances should be identified with their hours of operation outside of each entrance. Also necessary outside of entrances is whether farecards are available for purchase inside of that entrance.

Fare policies including how and where to pay for a trip and the cost of a transfer should be made available before a passenger pays for their trip in the unpaid area of the station. Again, these policies should be made available outside of the system as well. At stations with connecting bus or commuter rail service, route maps and schedules must be included. These elements should be deployed in the unpaid area of the station near the station exits nearest to these services.

For passengers with mobility impairments, it is essential that the accessibility of their destination station be ascertained before they depart. Both the general accessibility of all stations in the network and the functionality of elevators at all stations must be deployed in the unpaid area of each station. This information should also be available outside of the system before passengers leave their homes.

Emergency instructions must be available throughout the system, in all locations where passengers might be. Of specific concern are any locations where passengers spend significant time and include on-board trains, on platforms and in the unpaid area of the station. The design and deployment of emergency signs are closely regulated by various government agencies including the National Fire Protection Association.

Information about train arrivals and service delays is important for all passengers. Passengers that are waiting on the platform should be able to determine when the next train will be arriving. It is also helpful for passengers entering the station to be able to determine when their train will arrive. Deploying this information in the unpaid area of the station allows passengers to determine if they have time to run errands before heading to the platform or if they should proceed directly to catch their train. Significant service delays should be made available before passengers leave their homes so that they can make alternative transportation plans, if necessary.

6.2.4 Directional

The deployment of directional devices is determined by the paths that were specified by the content requirements that were specific in section 6.1.4. These paths, including their accessible counterparts (where necessary) are almost all located entirely within the station and will require deployment throughout the station. Directional devices for all types of paths should be located at decision points along the specified route. In addition, in any long corridors without decision points, directional devices should be included for visual reinforcement. The only type of directional device that is not located within the station is directions to entrances from within the neighborhood. This type of device is required by ADA for accessible entrances and do not have the option of being located at all decision points. They should be deployed in locations that never require a passenger to backtrack in order to find the path to their desired destination. All directional devices should be deployed so that they are perpendicular to the direction of travel so that they can be read by moving passengers.

6.2.5 Content by Location

The deployment requirements that have been aggregated in the previous sections were organized according to their functional categories. This section provides a deployment checklist by location to ensure that the requirements are met by wayfinding designers. Table 6-1 below shows the content requirements listed vertically, while the major locational divisions are listed across the top. Together, each cell shows the deployment requirements for each location and each content requirement.

The table illustrates the complexity of the deployment requirements for even a simple transit station. Each of these requirements must be met when designing the deployment scheme for each individual station, although not all elements will be required at each station. Each type of content and all of their deployment requirements are indicated to be exactly that: requirements. While individual transit agencies may decide to omit some of them in order to achieve other goals (often cost minimization), the goals of Universal Accessibility and the user groups defined in Chapter 3 dictate that all of the shaded boxes represent a *requirement.*

Table 6-1: Deployment Requirements by Location

	Home/ Office	Outside of Station	Unpaid Area	Paid Area	On Platform	On train	As Needed
System ID		■					
Station ID		■			■	■	
Entrance ID		■					
Line ID		■			■	■	
Directional ID		■			■	■	
Amenities ID							■
Vertical circulation ID							■
Station exit IDs			■				
Connection transp. IDs			■			■	
Neighborhood Map	■	■	■	■	■		
Transit Network Map	■		■	■	■	■	■
City-area map	■		■	■	■		
Station Map			■	■	■		
Line structure map						■	
Emergency Instr.			■		■	■	
Service delays	■		■		■		
Estimated train arrival			■		■		
Entrance Accessibility		■					
Ent. operation hrs		■					
Exit accessibility			■	■			
Station operation hrs	■	■	■				
System operation hrs	■		■				
Last train times	■		■				
Fare policies	■		■				
Transfer policies	■		■				
Bus route & schedule	■		■				
Station accessibility	■		■			■	
Elevator functionality	■		■				
Directions to acc. ent.		■					
Directional Devices							■

To illustrate the use of this table, we can look back to the two case studies that were analyzed in Chapters 4 and 5. Table 6-2 shows the success of the MBTA's wayfinding deployment strategy when compared with the deployment and content requirements that have been developed in this chapter. The success of the MBTA in meeting these criteria is determined by the existing conditions throughout the MBTA system, not according to the guidelines that cuurently govern wayfinding.

Table 6-2: MBTA's wayfinding success

	Home/ Office	Outside of Station	Unpaid Area	Paid Area	On Platform	On train	As Needed
System ID		▒					
Station ID		▒	▒	▒	▒	▒	
Entrance ID		▒					
Line ID	▒	▒	▒	▒	▒	▒	
Directional ID		▒			▒	▒	▒
Amenities ID							▒
Vertical circulation ID							▒
Station exit IDs			▒				▒
Connection transp. IDs			■			■	▒
Neighborhood Map	■	■	■	■	■		
Transit Network Map	▒		▒	▒	▒	▒	■
City-area map	▒		▒	■	■		
Station Map			■	■	■		
Line structure map			▒	▒	▒	▒	
Emergency Instr.			■		■	▒	
Service delays	■		■		■		
Estimated train arrival			■		■		
Entrance Accessibility		▒					
Ent. operation hrs		▒					
Exit accessibility			▒	▒			
Station operation hrs	■	■	■				
System operation hrs	■		▒				
Last train times	■		■				
Fare policies	▒		▒				
Transfer policies	▒		▒				
Bus route & schedule	▒		▒				
Station accessibility	▒		▒	▒	▒	■	
Elevator functionality	▒		■				
Directions to acc. ent.		▒					
Directional Devices							▒

■ -Unfulfilled requirement ▒ -Fulfilled requirement

As can be seen from the table, in some content areas the MBTA meets or exceeds the deployment requirements that have been developed. In other areas, there are significant deficiencies in the deployment scheme that must be rectified in order to provide a comprehensive wayfinding system. A similar analysis could be completed for the CTA system, which would yield similar results, as shown in Table 6-3.

Table 6-3: CTA's Wayfinding Success

	Home/ Office	Outside of Station	Unpaid Area	Paid Area	On Platform	On train	As Needed
System ID		■					
Station ID		■			▒	▒	
Entrance ID		▒					
Line ID		▒			▒	▒	
Directional ID		▒			▒	▒	
Amenities ID							▒
Vertical circulation ID							▒
Station exit IDs			▒				
Connecting transp. IDs			■			■	
Neighborhood Map	■	■	■	■	■		
Transit Network Map	▒		▒	▒	▒	▒	▒
City-area map	▒		▒	▒	▒		
Station Map			■	■	■		
Line structure map						▒	
Emergency Instr.			▒	▒	▒	▒	▒
Service delays	■		■		■		
Estimated train arrival			■		■		
Entrance Accessibility		▒					
Ent. operation hrs		▒					
Exit accessibility			▒	▒			
Station operation hrs	■	■	■				
System operation hrs	▒		▒				
Last train times	■		■				
Fare policies	▒		▒				
Transfer policies	▒		▒				
Bus route & schedule	▒		▒	▒			
Station accessibility	▒		▒			■	
Elevator functionality	■		■				
Directions to acc. ent.		■					
Directional Devices							▒

■ -Unfulfilled requirement ▒ -Fulfilled requirement

Table 6-3 illustrates that the CTA's wayfinding system is not fulfilling all of the content and deployment requirements necessary for a truly accessible wayfinding system. The missing devices are different, but this table provides and outline about which areas the CTA needs to address the most. The CTA performs slightly better than the MBTA according to these tables; the MBTA has 28 unfulfilled requirements while the CTA has only 26.

So far this chapter has aggregated the content and deployment requirements that are necessary in order to accommodate all of the user groups detailed in Chapter 3. The next section will look in detail at the format requirements that have already been introduced for individual user groups in order to create a complete listing of the design criteria that must be followed in order to achieve universal accessibility.

6.3 FORMAT REQUIREMENTS

The content and deployment requirements that were introduced in the previous sections were based on the corresponding requirements developed for individual user groups in Chapter 3. These requirements are essentially usable by all of the groups, allowing a wayfinding system to fulfill the goals of Universal Accessibility. The technical area in which it is the most difficult to meet these goals is formatting. This is also the area that is most frequently addressed by other wayfinding studies.

Accommodating all passengers using a single format is impossible and therefore requires a combination of multiple strategies and formats. So many design and media options are available in which to convey the necessary content at the appropriate locations that it is impossible to recommend a single strategy for use in every transit station. For each of the four functional categories of wayfinding devices there are multiple design methods that can be employed to meet the needs of the different user groups. This section will investigate the format options that are available for each of the categories and specify which formats are compatible with the characteristics of which specific user groups. This enumeration of formatting options will allow wayfinding designers to select a combination of formats that meet the needs of their passengers.

6.3.1 Identification

This section will investigate the methods that are available to identify locations at both large and small scales. There are a wide range of formats that can serve this purpose, and the major ones are listed in Table 6-4. Boxes that are not shaded indicate that a user group is unable to utilize a specific type of wayfinding device. Gray boxes indicate that the device described would be usable for a given user group and hatched boxes would be usable by some members of a user group. In order to create these tables the simplifying assumption has been made that users in any group are assumed to belong *only* to that group.

Table 6-4: Identification Devices by User Group

	Architectural			Text				Audio	
	Color Coded Areas	Texture Coded Areas	Entr. & Exits	English	Other Lang.	Pictures /Icons	Tactile /Braille	English	Other Lang.
Habitual Riders	Usable	Usable	Usable	Usable	Not Usable	Usable	Not Usable	Usable	Not Usable
Commuters	Usable	Usable	Usable	Usable	Not Usable	Usable	Not Usable	Usable	Not Usable
Infrequent	Usable	Usable	Usable	Usable	Not Usable	Usable	Not Usable	Usable	Not Usable
Non Riders	Usable	Usable	Usable	Usable	Not Usable	Partially Usable	Not Usable	Usable	Not Usable
Tourists	Usable	Usable	Usable	Usable	Not Usable	Partially Usable	Not Usable	Usable	Not Usable
Mobility Imp.	Usable	Usable	Usable	Usable	Not Usable	Usable	Not Usable	Usable	Not Usable
Visually Imp.	Not Usable	Usable	Not Usable	Not Usable	Not Usable	Not Usable	Usable	Usable	Not Usable
Hearing Imp.	Usable	Usable	Usable	Usable	Not Usable	Usable	Not Usable	Not Usable	Not Usable
Color Blind	Not Usable	Usable	Usable	Usable	Not Usable	Usable	Not Usable	Usable	Not Usable
Mentally Imp.	Partially Usable	Partially Usable	Usable	Usable	Not Usable	Partially Usable	Not Usable	Usable	Not Usable
Illiterate	Usable	Usable	Usable	Not Usable	Not Usable	Usable	Not Usable	Usable	Not Usable
Ltd Eng. Prof.	Usable	Usable	Usable	Not Usable	Usable	Usable	Not Usable	Not Usable	Usable

-Usable -Partially Usable -Not Usable

The formatting options presented in Table 6-4 can be used to fulfill all of the content requirements for identification devices. Colors and textures can be used to identify important areas within a station area, similar to how MBTA stations are color-coded by line. (For example, all elevator doors could be painted bright pink, allowing passengers to look for the color when they enter a station.) Textures can be used similarly and are frequently used as a warning along the edge of platforms. The architectural design of entrances and exits is can be used to enhance the visibility of these types of elements. (For example, doors with windows allow passengers to be certain that they are exiting a station instead of traveling within it.) The rest of the format options are used to label important elements using various visual, tactile or audio means. These formats can be used to fulfill any of the identification content requirements including system, station and line identification.

As shown in the table above, some formats cater to a wider range of users than others, while some user groups are only able to make use of specifically designed devices. For example, color-coding an area is a formatting choice that is accessible to almost all of the defined user groups. Similarly, there are only a few formatting choices available that are accessible to visually impaired passengers. Using this table, we are able to see that there is no single format that can accommodate the wayfinding needs of all of the user groups. The goal of an accessible wayfinding system must therefore be to select an array of identification formats that combined will account for all user groups (i.e. fills a whole column with gray boxes).

Each content and deployment requirement will not be addressed individually in this thesis; however an example should serve as a guide for wayfinding designers. Let us take on-platform station identification as our example. The text devices introduced in the MBTA case study in Chapter 4 must be supplemented by devices cater to three user groups: the visually impaired, the illiterate and those with limited English proficiency. When we add in the audio-announcements required on-board trains by ADA the visually impaired are accounted for. To provide accessible formats for the final two groups identifying icons can be used in conjunction with the textual devices. This combination is shown in Figure 6-5.

Groups	Text	Audio	Icons
Habitual Riders			
Commuters			
Infrequent			
Non Riders			
Tourists			
Mobility Imp.			
Visually Imp.			
Hearing Imp.			
Color Blind			
Mentally Imp.			
Illiterate	Icons		
Ltd Eng. Prof.	Icons		

Table 6-5: On platform station ID format solutions.

There are several other options that would also fulfill the formatting requirements for on-platform station identification, as can be discovered through careful study of Table 6-4. This method allows wayfinding designers to design the devices that will be most appropriate for their individual systems. Each of the other functional categories of wayfinding devices will be addressed similarly in the sections below.

6.3.2 Orientation

This section will analyze the available formats that will allow wayfinding designers to achieve the goals of Universal Accessibility for orientation devices. These devices are designed to help wayfinders orient themselves within the city, the transit system or a station. The same format will be used in this section as for identification devices in the previous section. There is again a wide range of formatting options available to fulfill the content requirements for orientation devices. Table 6-6 lists the most important formatting options in this category and their applicability for the full range of user groups that were defined in Chapter 3.

When used together, the formatting options presented in the table below can fulfill all of the orientational content requirements that were cataloged in section 6.1.2. Many types of architectural landmarks can be used as wayfinding devices in urban areas and inside buildings, even though the elements may not have been designed explicitly for that purpose. These landmarks are usually visual and can only be used be sighted wayfinders as shown in the table above. Using street addresses as an orientational device is only useful for passengers who are familiar with the city. Compass roses provide orientation by defining the cardinal directions. These types of devices must be installed in a fixed location and can be designed as either visual or tactile devices. While the visual versions cannot be used by those with significant visual impairments, the tactile version will usually contain visual elements as well and can therefore be utilized by a wider range of user groups.

The major format used to convey orientational content is maps. This format allows for complex geographical and structural information to be read by most passengers. Most of the structural information introduced by the content requirements can be (and usually are) presented in a map format. The scale of the map does not drastically affect its format characteristics and all visual maps have primarily the same audiences with few exceptions. Most large scale tactile maps (including those of a transit system, city or neighborhood) require multiple layers of information and are not readily comprehensible by passengers without visual impairments. Station maps, on the other hand, are frequently also readable without prior knowledge of Braille or other tactile conventions allowing them to be used by a wider range of user groups. Tactile maps of all types are inaccessible to non-riders as they are not available outside of the station.

Table 6-6: Orientation Formats by User Group

			Visual		Tactile		
	Arch Landmark	Street Address	Maps	Compass Rose	Station Map	Large Scale Map	Compass Rose
Habitual Riders	Usable	Usable	Usable	Usable	Usable	Not Usable	Usable
Commuters	Usable	Usable	Usable	Usable	Usable	Not Usable	Usable
Infrequent	Usable	Usable	Usable	Usable	Usable	Not Usable	Usable
Non Riders	Usable	Usable	Usable	Usable	Not Usable	Not Usable	Not Usable
Tourists	Usable	Not Usable	Usable	Usable	Usable	Not Usable	Usable
Mobility Imp.	Usable	Usable	Usable	Usable	Usable	Not Usable	Usable
Visually Imp.	Not Usable	Usable	Not Usable	Not Usable	Usable	Usable	Usable
Hearing Imp.	Usable	Usable	Usable	Usable	Usable	Not Usable	Usable
Color Blind	Usable	Usable	Usable	Usable	Usable	Not Usable	Usable
Mentally Imp.	Partially Usable	Partially Usable	Partially Usable	Partially Usable	Not Usable	Not Usable	Usable
Illiterate	Usable	Not Usable	Partially Usable	Usable	Partially Usable	Not Usable	Usable
Ltd. Engl. Prof.	Usable	Partially Usable	Partially Usable	Usable	Partially Usable	Not Usable	Usable

-Usable -Partially Usable -Not Usable

Again, an analysis of this table illustrates the fact that no one format can address the needs of all user groups. In order to achieve the goal of universal accessibility in transit stations, wayfinding designers must develop the combination of formats that will satisfy the needs of the full range of user groups. A simple example would be to combine a visual and a tactile compass rose into one element that would be usable by members of each user group.

6.3.3 Information

Devices in this category must convey many different types of content to transit passengers. The content requirements determine to a high degree the available formatting options. Table 6-7 presents the limited choices of formats that fulfill some of these requirements and the audiences to which they cater. The two major informational formats available are the internet and traditional textual devices. These two formats must both be included in a wayfinding system because they are deployed in different locations. Devices in languages other than English fill in the gap for the user group with limited English proficiency while tactile information addresses the format requirements of the visually impaired. For information that changes frequently, the two complementary systems of variable message signs and public address systems together can satisfy the requirements for all passenger groups.

One of the major differences between this set of format requirements and those that have been introduced in the previous two sections is that multiple formats are required in order to fulfill the three sets of requirements. In fact, each of the format options that are included in Table 6-7 is necessary to meet all of the content and format requirements that were developed in Chapter 3.

Table 6-7: Information Formats by User Group

	Internet Info	Textual Info (English)	Textual Info (Not English)	Variable Message	Public Address System	Tactile Info
Habitual Riders	Usable	Usable	Not Usable	Usable	Usable	Not Usable
Commuters	Usable	Usable	Not Usable	Usable	Usable	Not Usable
Infrequent	Usable	Usable	Not Usable	Usable	Usable	Not Usable
Non Riders	Usable	Not Usable	Not Usable	Not Usable	Not Usable	Not Usable
Tourists	Usable	Usable	Not Usable	Usable	Usable	Not Usable
Mobility Imp.	Usable	Usable	Not Usable	Usable	Usable	Not Usable
Visually Imp.	Not Usable	Not Usable	Not Usable	Not Usable	Usable	Usable
Hearing Imp.	Usable	Usable	Not Usable	Usable	Not Usable	Not Usable
Color Blind	Usable	Usable	Not Usable	Usable	Usable	Not Usable
Mentally Imp.	Partially Usable	Usable	Not Usable	Usable	Usable	Not Usable
Illiterate	Not Usable	Not Usable	Not Usable	Not Usable	Usable	Not Usable
Ltd. Engl. Prof.	Not Usable	Not Usable	Usable	Not Usable	Not Usable	Not Usable

[shaded] -Usable [vertical hatching] -Partially Usable [blank] -Not Usable

6.3.4 Directional

Directional devices provide directions to specific destinations within a transit station. Again, there are many possible formats for directional devices which are presented with their user audiences in Table 6-8. Traditional directional devices are visual and use a combination of text, graphics and arrows. The graphics used to identify destinations were already discussed in section 6.3.1, and will not be addressed again here. In the table, a text only device uses words to direct passengers instead of arrows. These devices can be designed using language besides English, as well.

Tactile devices are designed using both raised letters and Braille, which accounts for the format requirements of most passengers with visual impairments. Audio devices can also be used to accommodate passengers with visual impairments, and allow those without the ability to read tactile devices (a common issue for the elderly) to obtain the directional content that they need. Audio devices that run on a constant loop can be utilized by all users except the hearing impaired and those with limited English proficiency. Devices that require special transmitters or receivers in order to receive the audio message are only usable by those wayfinders who carry the required device, who will typically be well-prepared visually impaired passengers.

Table 6-8: Directional Formats by User Group

	Text Only - English	Arrows - English	Text Only - Non English	Arrows - non English	Tactile	Audio - constant loop	Audio - receiver req'd
Habitual Riders	Usable	Usable	Not Usable	Not Usable	Not Usable	Usable	Not Usable
Commuters	Usable	Usable	Not Usable	Not Usable	Not Usable	Usable	Not Usable
Infrequent	Usable	Usable	Not Usable	Not Usable	Not Usable	Usable	Not Usable
Non Riders	Usable	Usable	Not Usable	Not Usable	Not Usable	Usable	Not Usable
Tourists	Usable	Usable	Not Usable	Not Usable	Not Usable	Usable	Not Usable
Mobility Imp.	Usable	Usable	Not Usable	Not Usable	Not Usable	Usable	Not Usable
Visually Imp.	Not Usable	Not Usable	Not Usable	Not Usable	Usable	Usable	Usable
Hearing Imp.	Usable	Usable	Not Usable	Not Usable	Not Usable	Not Usable	Not Usable
Color Blind	Usable	Usable	Not Usable	Not Usable	Not Usable	Usable	Not Usable
Mentally Imp.	Partially Usable	Usable	Not Usable	Not Usable	Not Usable	Usable	Not Usable
Illiterate	Not Usable	Not Usable	Not Usable	Not Usable	Not Usable	Usable	Not Usable
Ltd. Engl. Prof	Not Usable	Not Usable	Usable	Usable	Not Usable	Not Usable	Not Usable

-Usable -Partially Usable -Not Usable

The goal of an accessible wayfinding system is to provide the necessary content in formats that are accessible to all user groups. None of the formats that are shown in Table 6-8 meet this goal on their own, though filling in the holes left by the traditional devices is possible by using some of the more specifically designed formats. Selecting the combination of formats that meets all passengers' format requirements for directional devices is the task of wayfinding designers.

The formatting requirements that have been developed in this thesis must be used in conjunction with the content and deployment requirements to design all aspects of a comprehensive wayfinding system. A fully accessible wayfinding system can be created by combining these three technical areas. In each of the functional wayfinding categories, there is no single format that can satisfy the needs of all passengers at once. This necessitates a combination of complimentary formats and designs. The wide range of devices that can be used allows designers of wayfinding systems to choose the formats that best suit the needs of each particular situation. However, whatever array of formats is selected must be able to convey all of the content requirements at all of the necessary locations to all of the user groups defined in Chapter 3. The success of any wayfinding system depends on its ability to perform this complicated and difficult task.

These three technical areas represent the complete set of design consideration for the creation of wayfinding systems in transit stations. The design of individual wayfinding devices and coordinating their deployment is not sufficient to ensure that a fully accessible wayfinding system is available in all stations. The full lifecycle of a wayfinding system must be considered during the design process to account for changing conditions and upkeep. These issues will be addressed in the following section.

6.4 LIFECYCLE CONSIDERATIONS

The three technical areas that have already been addressed in these recommendations have created comprehensive design guidelines for a wayfinding system and its component devices. Content, deployment and formatting guidelines were found in the MBTA Design Manual and the CTA Graphics Manual that met many of the criteria in this chapter. The case studies of these two systems clearly illustrated that good design recommendations are not sufficient in order to ensure that a high quality wayfinding system exists at each station. The CTA case showed modern, up-to-date design guidelines that had been implemented at only a fraction of CTA stations because of a lack of funding and administrative support. The MBTA guidelines had been implemented much more widely, but the agency had been unable to maintain current information as the system transit system continued to evolve.

The difference between design guidelines and existing conditions was obvious in both case studies and they teach valuable lessons about the difficult of transferring design guidelines into reality. These lifecycle issues must be addressed by transit agencies who wish to display comprehensive wayfinding systems in their stations and not just on paper. This section will address the related issues of implementation and maintenance and provide some recommendations based on the analysis of the two case studies. The first section will highlight the importance of institutional support, particularly in the form of financing, in order to effectively implement a well-designed wayfinding system. Maintenance will be addressed in the second section where the focus will be on keeping wayfinding devices operational and legible in the face of adversaries such as time, weather and vandalism. Combined with the design requirements that have already been developed in this chapter, this section can help to create an institutional environment in which wayfinding has some priority.

6.4.1 Implementation

All of the guidelines that have been presented in this thesis, including the case studies in Chapters 4 and 5 and the recommendations that have been developed in this chapter, have required system-wide standardization of wayfinding devices in order to create a coherent system. The CTA case study in Chapter 5 clearly illustrated some of the problems that can occur when a single set of design standards are not implemented in all stations. In order to achieve the level of standardization required in a wayfinding system there must be institutional support within the agency for wayfinding projects. Without this administrative support, and the financial help that comes with it, wayfinding will never be able to meet the standards set out in this thesis.

Any transit agency looking to implement a new wayfinding system should ensure funding to complete the entire project. Ideally, wayfinding systems should be upgraded at every station simultaneously to ensure continuity, but this may not realistically be possible. If a phased project is required, then it is essential that all stations are included in the phasing within the life of the project. Updating wayfinding systems piecemeal as individual stations are renovated does not produce the type of standardization necessary for an effective system, as was clearly illustrated by the CTA case study.

Another important scenario occurs when stations are first being built or are undergoing a significant renovation. Under these circumstances it is essential that wayfinding be included in all plans for station design from the outset of a project. All stations should be designed for maximum architectural clarity and visibility and to accommodate wayfinding devices where necessary. Wayfinding systems represent only a small portion of total costs in projects of this magnitude, but they must be included in initial cost estimates to ensure that the system will be implemented as designed (Arthur & Passini, 1992).

The organizational structure of a transit agency should reflect the importance of wayfinding in their facilities. At the CTA, for example, the Graphics Department is responsible for all issues dealing with signage and wayfinding. This structure creates a center within the agency for wayfinding knowledge and creates a "home" for the issue. By including someone from this department on all station design project teams the agency is able to ensure that wayfinding issues are adequately addressed.

Both of the agencies analyzed in this thesis have shown varying levels of institutional support for wayfinding projects throughout the period studied. The MBTA, for example, began in 1966 with a comprehensive look at in-station wayfinding and general station design that was implemented throughout the system. Neither the design guidelines nor the in-station devices received this level of attention again until several updates occurred in the 1990's. A recent flurry of wayfinding installations has begun to update the system's badly outdated devices. The CTA's initial attempt at wayfinding design (also in 1966) was not followed by significant additional support through the financially lean years of the 70's and 80's. Recent years have seen the formation of the Graphics Department and frequent attempts to update the design guidelines.

One additional design criteria that must be considered during all design projects is cost. There is significant pressure to minimize costs within a transit agency, and wayfinding is no exception. The costs of each individual element must be considered in order to select designs and materials that meet the criteria that have already been set forth in this thesis while minimizing costs. Additionally, the number of elements that must be installed can increase costs, and devices should be combined where appropriate.

6.4.2 Maintenance

Once an accessible, standardized wayfinding system has been designed and installed at all transit stations, the task is not complete. The framework of systems engineering realizes that no system is stagnant and dictates that plans must be made to maintain the system throughout its lifecycle. This section will address the needs of a wayfinding system after the initial design and installation have been completed. This area is essential to ensure that the wayfinding system remains accurate and usable and in order to determine the true cost of implementing a comprehensive wayfinding system. All of the issues that will be addressed in this section are important parts of designing a complete wayfinding *system,* instead of a series of devices. Several maintenance issues must be incorporated into the design requirements for a wayfinding system to ensure that a complete system redesign will not become necessary in the near future, including monitoring, format maintenance and content updates.

Even when designers have accounted for all of the content, deployment and formatting requirements that have been developed in this thesis, the implementation may not be perfect. The system, especially in its early phases must be monitored at each station in order to be certain that it is working properly and providing the information that passengers need. If any errors or omissions are found, they should be corrected as soon as possible, and the initial project planning should account for this need.

Maintenance must play an important role in any wayfinding program and should be incorporated into the design process as much as possible. Once installed, wayfinding devices are exposed to a wide range of factors that can cause them to deteriorate including time and weather. Fading colors, failing fasteners and aging electronic elements must be accounted for during the system design phase as an annual expense after installation is complete. When designing wayfinding elements in accordance with the format requirements, a wide range of physical media can be used.

Materials must be selected that will age well and will be able to withstand these effects to minimize the costs of maintenance throughout the life of the transit station. The creation of elements that are easy to maintain should be included as a design criteria along with the three technical areas of content, deployment and format.

Another major issue in transit stations which frequently affects wayfinding devices is vandalism. The MBTA case study showed some examples of how vandalism can affect these devices (See Figure 4-18) although the damage can be more severe than shown in this particular image. In order to decrease the potential costs of maintenance, wayfinding elements should be designed to withstand the efforts of vandals. This can include materials that cannot be marked or otherwise destroyed or materials that can be easily cleaned when vandalism does occur. Many durable materials are available that can serve this purpose.

The need for maintenance of a wayfinding system is a certainty, and the needs of maintenance workers must therefore also be considered during its design. Complex wayfinding elements that are difficult to repair or replace only serve to increase the overall costs of the wayfinding program. Elements that require extremely frequent maintenance also increase these costs, and should be avoided where possible. The unionization of labor in transit agencies presents another maintenance problem that should be considered by designers. Specific types of maintenance work in these systems must be done by specific groups of workers, some of which will cost more or have more demands on their time.

In addition to the maintenance of the wayfinding format, the content of each device must be maintained as well to keep the devices accurate. Any service changes will require content updates to multiple wayfinding devices in locations throughout a transit system. Even small changes, such as a change in bus route or schedule, will require updates in several locations. More complex service changes, such as the removal of skip-stop service that was introduced in the CTA case study in Chapter 5, can require huge changes system-wide.

One of the problems that develops from designing wayfinding devices with long lifetimes that are vandal-resistant is that they are expensive, permanent, difficult to update and infrequently replaced. Some balance between the goals of permanence and flexibility must be reached that will allow for updates as needed while not falling victim to decay and vandalism. The MBTA, for example, has begun covering their outdated porcelain enamel system maps with new versions on stickers covered by plastic covers.

The applicability of the wayfinding design guidelines must also be maintained as the system ages. If done frequently, only incremental changes will be necessary. Both the CTA and the MBTA left decades between their design guidelines of the 1970's (1972 and 1978 respectively) and the next edition in the 1990's (1998 and 1990). While it is unlikely that anything will again change the wayfinding landscape as significantly as did the ADA in 1990, frequent updates will still be necessary in order to avoid the costly prospect of a complete system redesign.

This chapter has provided full requirements for the design, implementation and maintenance of wayfinding systems in transit stations. Based on the requirements developed for each of twelve individual user groups in Chapter 3, this chapter has provided detailed criteria that satisfy the needs of *all* potential users. The three technical areas of content, deployment and formatting were detailed by the functional categories of wayfinding devices, in order to provide a detailed checklist that can be used by wayfinding designers at any transit agency. Finally, additional requirements based on the implementation and maintenance of wayfinding systems throughout its lifecycle were introduced as added considerations. The final chapter will provide some final conclusions, in addition to pointing towards some directions for future research into wayfinding.

7. CONCLUSIONS

This thesis has applied the framework of systems engineering to the design of wayfinding in transit stations. This process requires the development of a complete listing of user requirements that can be used to design individual wayfinding elements as part of a coherent system. The characteristics of transit passengers had to be used to develop this 'requirements document.' Incorporating the design philosophy of Universal Accessibility requires that all potential passengers be represented in this document.

Since there is no single definition that includes all transit passengers, the user population had to be broken down into groups with definable characteristics. Twelve distinct user groups were necessary in order account for the full range of use patterns and physical and cognitive conditions. These groups and their defining characteristics were introduced in Chapter 3. Based on these definitions, design requirements were developed for each group in three distinct and complementary technical areas: content, deployment and format. When combined, these three areas provide guidelines for what information must be included, where it should be located within a station and what form it should take.

Case studies were then presented for both the MBTA and CTA wayfinding systems. In Chapter 4 the Design Manual that governs wayfinding design throughout the MBTA system was analyzed for the necessary content, deployment scheme and accessible formatting. The conditions currently found in MBTA stations were also analyzed for their compliance with the Design Manual and to evaluate the MBTA's success at implementation. In Chapter 5, a similar analysis was conducted for the CTA wayfinding system based on their Graphics Manual and other recent wayfinding-related programs. The differences between these design guidelines and the existing conditions at many of the CTA's stations were drastic. Specific recommendations for improving conditions at stations throughout both of these systems were also provided.

Chapter 6 aggregated all of these recommendations into a set of generalized guidelines that can be used by any transit agency. The first section looked at all of the content requirements that had been developed and separated them by the four functional categories of wayfinding devices that had been developed in Chapter 2. This provided us with a complete catalog of the content requirements that are necessary in a transit station. The content requirements were then paired with their necessary locations to develop a complete list of the deployment requirements that must be fulfilled. The third section provided the available formatting options for each of the four types of wayfinding devices and created a framework that can be used by designers to create the wayfinding system appropriate for their transit system. Systems engineering dictates that system design is not the only concern; designers must account for the whole life of the system. In the fourth section we looked at some of the requirements necessary for successful implementation and maintenance of wayfinding systems.

7.1 General Conclusions

This thesis has been devoted to developing detailed design requirements that can be used to create or improve wayfinding systems in transit stations. The content requirements alone are substantial, but are made even more complex by the formatting requirements that result in multiple repetitions of the same information. Because there are multiple formatting options that will fulfill the requirements developed by this thesis, no two transit systems will necessarily select the same options. It is therefore impossible (and unnecessary) to create a single standard for wayfinding design to be applied by all agencies. The variety of systems allows for flexibility based on the needs, constraints and available technology of each individual system and station.

The work in this thesis has detailed the immensely complex problem of wayfinding design by breaking it into manageable pieces. While the requirements that have been developed here should prove to be useful for wayfinding designers in transit agencies across the country, the study has highlighted some important aspects of wayfinding systems that cannot be expressed as part of a checklist. Specifically, deployment must be an integral part of the design for a wayfinding system. This requires that designers have expertise beyond graphic design, but that they also understand how people navigate through complex stations.

A second area that must be considered during the design phases of a wayfinding system is maintenance and system upkeep. The issues that were raised in Section 6.4

illustrate that wayfinding cannot be thought of as a static system of elements with an infinite life-span. Even when materials are selected that will last twenty years, it is extremely unlikely that the content will remain valid during that time. Therefore, wayfinding advocates must ensure that there is financial and administrative support for projects to periodically update the wayfinding system.

From looking at just two case studies, it is apparent that transit agencies and wayfinding designers are not blind to the needs of their passengers. ADA has required transit agencies to provide wayfinding for many different user groups, and both the MBTA and the CTA worked to implement wayfinding devices that can be used by various specific user groups. They have developed many of the standards and guidelines that are necessary for these important devices; however they may not have been implemented with the goal of universal accessibility in mind. The next step for many agencies will be to blend their user-specific devices into one coherent system that provides access to all passengers.

Improvements will be possible in the near future as transit agencies across the country and around the world realize the importance of the customer experience. This shift in thinking has created additional institutional support for wayfinding design and improvement projects that seem to indicate a new level of priority for wayfinding. Should this trend continue, it may be possible for many agencies to upgrade their wayfinding systems with full support from the upper levels of management.

Changes in technology are making many of these improvements possible at an affordable price for the first time. Variable message signing, vehicle tracking, GPS systems and the internet have all made the dissemination of accurate, up-to-date information more feasible than ever before. American transit agencies have not yet taken full advantage of these technologies, and where they have been implemented, quality is often lacking. There is a distinct difference between the information systems available in transit systems in Europe and Asia than in the United States. Agencies in the US need to learn from the experiences of their foreign counterparts in the implementation of these systems.

The final observation that has come from this research has been the sometimes drastic differences between the design and implementation phases of wayfinding design. No matter how good the initial designs are, they do not help passengers unless they are implemented correctly and completely throughout the system. This requires continuous monitoring of the system in order to ensure that it meets all of the needs identified in this thesis and continues to do so throughout its life.

7.2 Future Research

The systems engineering approach to studying wayfinding design that was used in this thesis has many steps; I have covered requirements gathering in great detail. After requirements gathering, there are three other steps in the process that must be addressed, and each of these areas entails an opportunity for additional research based on this work. Implementation and system monitoring represent areas in which significant work is needed. This thesis has already illustrated the level of disparity that can exist between the system as-designed and the system as-built. Methods for improving implementation should be investigated, including the organizational structures and institutional policies that have proven to be most beneficial to wayfinding systems.

Many experiments have been conducted in the past that determine the effects of various architectural layouts and wayfinding devices on navigation through a space. Most of these have been conducted in educational settings (in various university buildings) and have involved generic wayfinding devices. Transit stations differ significantly from these types of buildings, and an investigation into the success of various types of wayfinding devices in these situations would further help designers to select the best option. This type of research is necessary not only to test the success of the various formatting options, but to determine the usefulness of many types of content as well. A similar project would create a metric for measuring the success of a transit station's wayfinding system and identify weak points to allow designers to make the necessary corrections.

This thesis has not dealt directly with the costs of wayfinding systems, but this is a very important area that must be addressed and is of the utmost concern to transit agencies. The costs of various formatting options, and also for different deployment schemes could help transit agencies to make more accurate decisions. Another area that deals with cost would be a cost-benefit analysis that deals with each of the user groups developed in this thesis. By using cost information about the different format and deployment options in conjunction with demographic data about transit riders, it would be possible to determine which devices are the most helpful on a cost-per-rider basis. However, any research along these lines should account for the difference between absolute barriers to mobility and relative ones that only make travel slightly more difficult.

Research similar to this thesis may also be necessary for use in other types of transportation facilities. Specifically, airports provide one of the biggest wayfinding challenges available and no generalized requirements exist for these facilities. The goal for wayfinding design in airport terminals is the same as in transit stations (including the goal of universal accessibility) but the content, deployment and formatting requirements may be different. Airports are bigger and busier than even large transit stations and therefore require additional types of content in order to accurately guide people within them.

This thesis has dealt only with rail transit stations and their immediate surroundings; however this may not accurately represent the greatest need for transit wayfinding. Bus systems carry more riders each day and are found in more cities throughout the world than rail transit, and present unique wayfinding challenges that are partially due to their lack of physical infrastructure, like stations. The design of wayfinding for bus systems must be addressed in further detail.

Another area of concern that comes from this thesis includes a range of special situations that are often encountered at transit stations. This includes major transfer points and airport stations that must be addressed in detail, as they present significant additional challenges in jurisdiction and deployment. While this research has defined generalized wayfinding goals for transit stations, these major points often require an additional set of content and deployment requirements. In addition, the maintenance of these systems may or may not be the responsibility of the transit agency. While detailed guidelines are usually developed individually for these types of situations, generalized guidelines and requirements would be helpful for many types of transportation providers.

The final area that will require more research was introduced in the case study of the CTA. There are several possibilities for service changes in the future, and the CTA must develop a plan for identifying each of the lines and the directionality of trains. Some of the possibilities were discussed in Chapter 5 of this thesis, but further investigations into possible operational configurations would allow for the development of a detailed plan that will allow the CTA to move forward towards the standardization of their wayfinding system.

The design of wayfinding systems in transit facilities has the potential to drastically improve the travel experience of many passengers. This thesis has broken this immense problem into tractable pieces that will allow transit agencies to implement wayfinding solutions that are applicable for the full range of potential transit passengers. Although is significant additional work that is necessary in this area, a strong structure and starting point have been provided here. The limited success of both the MBTA and the CTA wayfinding programs indicate that it is possible to design high quality wayfinding systems for public transportation environments. Both agencies have showed renewed interest in wayfinding in the recent past, which hopefully indicates an upward trend in wayfinding design programs across the country.

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