# Designing for Travel

## The inconsistent user experience of riders of public transportation systems

A thesis submitted to the faculty of the School of Design
in partial fulfillment of the requirements for the degree of

**Master of Design** in Communication Planning + Information Design

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Pittsburgh, Pennsylvania
May 2008

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# Acknowledgements

*My aim is to put down on paper what I see and what I feel in the best and simplest way.*
Ernest Hemingway

I'll start by thanking my advisor, Chris Neuwirth, for her patience and encouragement in helping me get what I saw and what I felt down onto paper. Her most frequently used comment was, "This is good. Keep going." That constant push kept me going amidst the vicissitudes of two semesters as a graduate student.

Stacie Rohrbach, my advisor for the thesis project that pairs with this essay, has helped me clarify my thoughts and make connections from an abundance of data. In addition, other professors at Carnegie Mellon, including Dan Boyarski, Karen Moyer, Mark Mentzer, Myrna Rosen and Dave Kaufer, have opened me up to the vast field of design and helped me to set off in a direction that I will enjoy.

I can't give enough credit to my classmates and peers who provided valuable critiques and, when necessary, made sure we all didn't go crazy.

I give thanks to staff members at the 18 public transportation systems that responded to my requests for artifacts, and especially to Francis Fisher at the Massachusetts Bay Transportation Authority (Boston), Neil Greenberg at SMART (Detroit) and Janet Strauss at Valley Metro (Phoenix) for their personal assistance and thoughts. I offer special thanks to Jeff, Matt and Chantel for bringing artifacts to me from across the country and world. David Whipkey and Bob Grove, the current and former directors of media relations for the Port Authority of Allegheny County (Pittsburgh) provided me with complimentary bus passes for my participatory design session and gave me permission to take extensive photographs while riding the bus and light rail.

I am grateful to be honored by the Phi Kappa Phi honor society as a recipient of its 2007 Love of Learning Award, funding my four-day research trip to New York City. Carey Stumm at the Metropolitan Transportation Authority and New York Transit Museum Archives gave me access to many maps from the history of the New York City subway. Alberteen Anderson at the MTA and the staff at the City of New York Mayor's Office of Film, Theatre, and Broadcasting helped me complete the necessary paperwork for permission to take photographs while riding the subway. Kathy and Nicola Bertini graciously shared their home with me, allowing me to stretch my small budget even farther.

Finally, I give thanks to my family and loved ones for supporting me during this long research process. Thank you for listening to crazy stories, for not being too offended when I favored intense observation and note-taking to conversation while riding, for keeping an eye out during your own travels for interesting experiences and for your patience when I was sleep-deprived after one particularly early (3:45 AM) morning of bus and train rides. I couldn't have done this without your support.

# Introduction

I remember as a young child being fascinated with all forms of transportation: from the Walt Disney World monorails and shuttle buses, to *Busy Boats*, my favorite library picture book, to my first train ride, a 20-mile one-way trip on Amtrak that became the subject of my second-grade book fair masterpiece, *The Great Day*. Now, quite a number of years later, that fascination remains, manifesting itself in different ways, like getting excited when I get stopped by a passing train at a railroad crossing or riding the city bus to campus every day.

Being an avid newspaper reader, I followed the long public process in the winter and spring of 2006–2007 as the Port Authority of Allegheny County, the public transit entity in Pittsburgh, identified ways to reduce costs to meet a multi-million dollar budget shortfall. Being a designer, one of the things that struck me was the Port Authority's use of visuals to communicate what routes they proposed for elimination. These diagrams, one of which is shown in Figure 1, left something to be desired. It didn't seem to communicate a clear message amidst all the visual clutter. I spent a few weeks trying out different variations and revisions of the diagram for a class in mapping and diagramming and thought that this area of

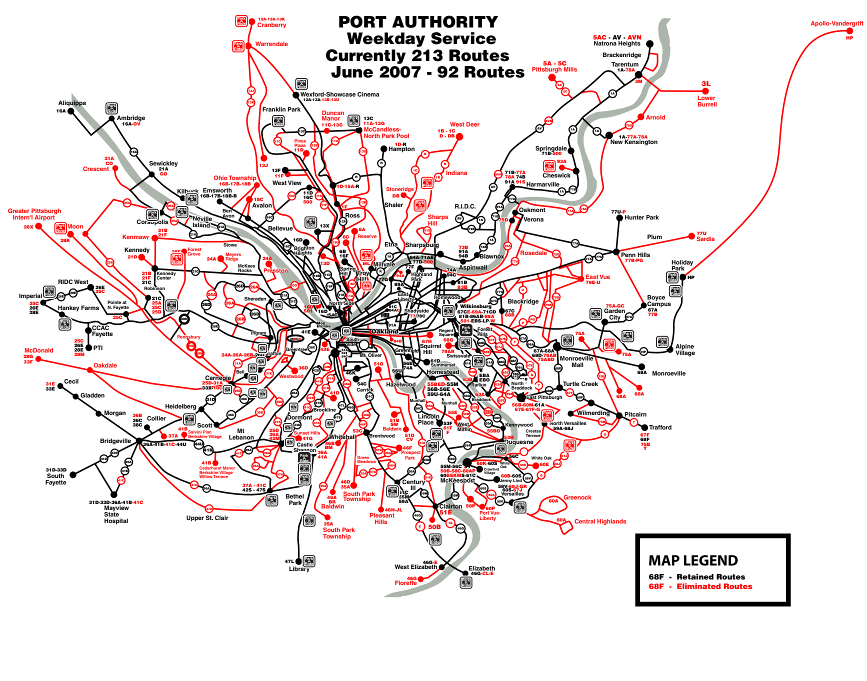



**Figure 1**
Proposed weekday route eliminations by the Port Authority of Allegheny County

design—user experience and complex information systems for transit—would be perfect for further study.

In my preliminary review of current literature, I found studies of specific design improvements, such as a new bus map system in London (Horne, Roberts & Rose, 1986), historical reviews of iconic documents such as the London Underground diagram (Garland, 1994) and surveys of current practices by organizations such as the American Public Transportation Association (2007), an industry trade group, and the Transportation Research Board (1999). However, this research focused primarily on the document or artifact in question and only tangentially on rider information needs from an abstract perspective while ignoring the user experience.

This essay will present the results of my observations and thoughts about the user experience of riders in public transportation systems. I will begin by defining a public transportation system and describing its various components and integration into the city's transportation infrastructure. In the second section, I'll describe users of these transit systems—the riders—and offer a series of categories and characteristics we can use to understand why they use public transportation. I'll discuss how these riders use a public transportation system in section three, by offering a five-part model for a trip. Finally, in section four, I will analyze various aspects of the physical, printed artifacts transit systems distribute to the public to communicate what services they provide.

## Methodology

To develop an understanding of the user experience during a trip on a public transportation system, I documented over 80 trips in Chicago, Denver, New York, Philadelphia and Pittsburgh for close to 24 hours of vehicle riding time alone. I selected a variety of modes of travel and types of routes to get as broad an experience as possible: commuter rail, subway (local and express), light rail and bus (local, limited and express), all at various times during the day (ranging from 4:50 AM to 11:13 PM). During my engagements with the system, I observed driver and rider behaviors, advertising, route and system information, wayfinding devices, and vehicle and station characteristics. I also made generalizations about rider demographic categories.

To supplement these contextual inquiry observations, I interviewed 32 potential or actual transit riders in Pittsburgh and New York, with a mix of interviews while in the system and outside the system. We generally discussed how these people use the system, including how they find an appropriate route to go to a new destination, how they orient and navigate while riding, what trouble or unplanned situations they've found themselves in and how they're affected by changes in service (both structural and operational changes).

Primarily for use in my thesis project, I gathered a group of nine people from Pittsburgh with varying experiences with the local public transportation system for a participatory design session. Over a six-hour period, participants built a shared understanding of the elements of a public transportation system, took three trips on the bus to hypothetical scenarios around Pittsburgh and developed concepts to improve their experiences. Because of its relevance to this essay, some of their observations and comments made during the bus trips are also used here. These interviews, observations and contextual inquiries are described in sections two and three.

I also built a collection of physical artifacts from public transportation systems—things like maps, schedules, brochures and other pamphlets. Some I gathered from my own travels over the past few years, but most I requested by mail. I typically requested a map of the entire system (or multiple maps if there were different versions), and a selection of individual bus, train, and/or subway pamphlets. I sought documents from the Port Authority's self-defined peer transit systems, from major US and Canadian transit systems and from foreign systems that were known to have good design. Totaled together, I requested artifacts from 28 public transportation systems around the world; 18 systems responded, and I added artifacts from 12 systems through other travels, for a total of 30 systems and 410 artifacts, listed in the appendix. This represents a convenience sample with a comprehensive set of Pittsburgh route maps as of March 23, 2007 and September 13, 2007. With the exception of a couple of systems, all of these transit systems operate within a single metropolitan area (as opposed to intercity transportation, for example). These artifacts are analyzed as part of section four.

## Scope and Limitations

This essay is primarily concerned with the information systems used by public transportation systems as they relate to the user experience of riders navigating throughout the system. Though also a part of the overall user experience, I am omitting a detailed discussion of system fare models and communicating to riders how to pay for their travel. I am also just looking at travel within an urban area, not intercity transportation services (except for the handful of intercity system artifacts collected as general reference). I do not intend this essay to serve as an advocate for or against public transit usage, though I do believe a strong pubic transportation system is a vital component of a vibrant urban area. Thus, I am omitting a discussion of the benefits or impacts, including economic and environmental impacts, of public transit over other forms of transportation.

Unless otherwise noted, all photographs are by the author.

# 1 Components

Public transportation systems exist as only one of many modes of traveling from one place to another. Most people have many different travel options, from driving their own cars on public streets and highways, to biking on the street or on dedicated bike paths, to walking, to taking one or more forms of public transportation such as a bus or subway. According to the US Census Bureau (2006), a majority of Americans, 76 percent, drive alone on their commute to work. A much smaller portion took public transportation (4.8%), walked (2.9%), or rode a bicycle (0.5%), among other modes. We only see the impact of public transportation when looking specifically at urban regions large enough to support a well-developed transit system. In 2000, 53% of New York City residents and 25% of residents of the greater New York region used public transportation for their commutes. Other American cities with large public transportation usage rate, though less than New York, were Chicago, San Francisco, Boston, Philadelphia, and Washington, DC (Dunphy, 2004, p. 17).

In contrast, large cities around the world have a much higher usage rate of public transportation for commuting. Even back in the 1990s, the 6.1 million people in Bogota, Columbia used transit for their commutes nearly 75% of the time, with private vehicles accounting for just under 9%. Likewise, Hong Kong, with 5.8 million people, has a transit usage rate of 74% with private vehicles used only 9.1% of the time (Dunphy, 2004, p. 95).

In this section, I will begin by offering a definition of a public transportation system and then will describe the components and organizational structures these systems generally contain.

## Public Transportation Systems Defined

According to the Federal Transit Act, as amended, "public transportation" means "transportation by a conveyance that provides regular and continuing general or special transportation to the public, but does not include schoolbus, charter, or intercity bus transportation or intercity passenger rail transportation provided by the entity described in chapter 243 (or a successor to such entity)"

(49 USC § 5302(a)(10), 2006). The "entity described in chapter 243" is Amtrak, the US passenger rail service (49 USC § 24301(a), 2006). Unpacking this definition, we find the following key phrases:

- *transportation* – public transportation must facilitate the movement of goods and/or people from one place to another.
- *by a conveyance* – public transportation must use some kind of vehicle, though the type of vehicle is unspecified. If we have a vehicle, we naturally need to have something to operate it on such as a road, track or other specialized system.
- *regular and continuing* – The vehicles noted above must follow some form of predictable schedule and route that operates with a repeating pattern. Note that the definition doesn't require vehicles to run continuously (without breaks, i.e. all hours of the day). Instead it uses the word "continuing" meaning "lasting; persistent" according to the Oxford English Dictionary (Continuing, 1989), or running over a period of months and years.
- *general or special transportation* – The system serves the transportation needs of a wide audience (general) or a narrow audience (special) or perhaps both.
- *to the public* – the system must be available for use by all members of the community (city, county, urban region) without regard to race, class, socioeconomic status or ability.
- *schoolbus, charter, or intercity bus transportation or intercity passenger rail transportation provided by the entity described in chapter 243* – public transportation is not focused on transporting children to and from school, nor is it for hire as a charter. However, the definition does not preclude children from using public transportation to get to school, it just means the system doesn't have any school buses. Public transportation is also not Amtrak and the intercity bus and passenger rail transportation services it provides. However, reading closely, the definition does not say that public transportation cannot include intercity bus and passenger rail transportation, just that it does not include those services that Amtrak (or its successor) provides.

To further understand the scope of a public transportation system, we'll need to further explore the phrases "by a conveyance," "regular and continuing," "general or special transportation," and "to the public." Sections 2 and 3 will focus on the final two phrases "general or special transportation" and "to the public" in discussing who the users of public transportation systems are and how they travel on the system. The remainder of this section will discuss the components, design and operation of the system.

## Modes of Travel

The definition of public transportation leaves a lot of leeway in what modes of travel are part of a public transportation system, likely because the systems across the country are responding to different local needs and situations. The general modes of travel, as collected by the American Public Transportation Association (2007), an industry trade group, are as follows. The number following each mode is the number of US providers as of 2005, the most recent data available.

### Road modes

*Bus* (1,500) – the most common form of public transportation, buses operate on streets with other traffic. Some may also make use of fixed guideways (restricted access busways, contraflow lanes, or high occupancy vehicle lanes), designed to avoid the heaviest congestion on normal streets. Buses may operate on several different types of routes including the standard local service with frequent stops, express service with long stretches of no stops designed to speed up long trips, particularly from the city center to outer suburban parking lots, and limited service, a hybrid between local and express service with fewer stops than a local to speed up service. Bus Rapid Transit routes typically use restricted lanes or dedicated streets to speed travel (p. 40).

*Paratransit* (5,960) – though seeming to violate key points of the definition of a public transportation system, paratransit systems are typically limited to serving passengers with disabilities, their attendants or companions, and the elderly. Often known as "demand response" or "dial-a-ride" routes, these smaller vans and minibuses have no fixed routes nor fixed schedules and instead are dispatched where requested (p. 56). Because of their specialized nature, paratransit systems will not be discussed further here.

Other minor road routes include the trolley bus (4), a bus with an electric motor powered by overhead wires, and the vanpool, a service outside the normal bus operating area using 7–15 passenger vans and typically contracted to a third-party service provider (p. 40, p. 80).

**Rail modes**

*Heavy rail* (15) – high-capacity trains, frequently known as subways or metros, operate with their own exclusive system of rails, rights-of-way, signaling and stations enabling high speeds and rapid accelerations. Riders board from high-level platforms at the level of the floor of the car (p. 65). Trains may operate in local service or in express service, servicing a fewer number of stations.

*Light rail* (29) – smaller trains generally of one or two cars that operate on fixed tracks at street level for much of the trip. Light rail vehicles are usually powered with overhead electric wires. Stops may be at high-level platforms or at street level (p. 64).

*Commuter rail* (22) – surface trains that run from a central business district to outlying suburbs for commuters. They are distinguished from light rail trains by their use of multi-trip tickets and more complex station-to-station fares, and service to only one or two stations in the downtown area (p. 63).

Other minor rail modes include automated trains (8), inclines (4, with 2 in Pittsburgh), cable cars (1, in San Francisco), monorails (2) and aerial trains (3) (pp. 65–66).

Ferries (47), the only water based mode, frequently operate between a mainland and outlying islands. All ferries can carry passengers while some can also carry vehicles (p. 52).

Comparing each of these modes, it is surprising how many more transit authorities operate bus service compared with the other modes. This is likely due to a number of factors. First, many western and southern urban regions expanded after World War II when the automobile had already established itself as the default means of personal transportation. Thus, the need for larger capacity transit services was perceived to be limited. Second, because buses can only carry a fraction of the number of people as most of the rail modes, cities need lots of buses to match demand. Coupled with the ability of buses to travel on normal roadways, eliminating the large capital expense of train stations, tracks and other infrastructure, bus service as a whole can have a wide coverage area and is very flexible in responding to changes in demographics or demand. Finally, local bus service is convenient for many riders; because of the large service area, a rider is likely to have a bus stop only a short walk away from his residence (Dunphy, 2004, p. 10).

Light rail transit is currently experiencing rapid growth in the US because of its financial and flexibility advantages over other forms of rail transit. With a larger capacity compared to buses, light rail can generally operate more quickly and more reliably (Dunphy, 2004, p. 11). While the cost of travel using light rail can be up to three times more than the cost of the same trip made by a bus, light rail can be more appealing to many potential riders due to a sense of exclusivity and "coolness" (D. Barrish [Port Authority West Mifflin district director], personal communication, October 5, 2007). For a larger discussion about these social factors, please see section 2). However, high capital costs for infrastructure make expanding a light rail line much more expensive than expanding bus service.

Sitting between local bus service and light rail, bus rapid transit and express bus service offers many of the same advantages of light rail service with the lower operating cost of buses. The dedicated driving lanes of busways and the limited stops both act to increase the average speed of the bus. Pittsburgh's East Busway route from downtown to Wilkinsburg and Swissvale is one of the best examples in the country of active and successful development around an express bus route (Dunphy, 2004, p. 11).

Though each mode of transportation has its own particular characteristics, some elements are common across all of the major modes:

- Vehicles can operate in fixed guideways, generally restricting use to other transit vehicles, or in the street with cars, pedestrians, bicyclists, and other vehicles.
- Vehicles come in different sizes to accommodate different levels of demand.
- Different types of service (local, express, limited) attempt to respond to different levels of passenger need at different points in the day.
- All have fixed routes and fixed schedules, though vehicles may be diverted temporarily because of special circumstances (e.g. construction, congestion, or emergencies).
- Vehicles must be identified with some form of route name or label and an indication of direction of travel.
- Stops or stations must be identified and optionally labeled with a name or location.
- Most require the payment of a fare to ride, though the form of that payment varies widely and will be discussed later in this section.
- Modes generally do not operate in isolation from one another, but with some connection to other modes available in the same system or a connection to

other routes of the same mode. Using multiple modes or multiple routes can be encouraged by offering discounted or free transfer tickets.

- Where multiple modes are present, there may be an overlap in the service coverage for a geographic area.
- Rail stations and some larger bus stops (especially for express buses or bus rapid transit) can encourage commercial and residential development nearby, known as transit oriented development.

## Fare Models

In most cases, transit routes are operated as "revenue routes" where riders are expected to pay for their use of the service. The exceptions include areas of service, such as a downtown area, or a particular route, such as a retail circulator, that are free. There are three primary models of fare structures, with many variations or local changes. In an unlimited travel model, riders pay a fixed fare for any length of trip in the system. New York City's subways and buses use this model. A system using fare zones divides up the transit coverage area into zones, and riders pay a variable fare based on how many zones they travel through. Denver's light rail trains and Pittsburgh's buses and light rail trains use this model. With station to station fares, traditionally used with standard railroads, fares are variable based on specific starting and ending locations. Washington, DC's Metro subway uses this model.

Fares may be collected either on the vehicle (on-vehicle), generally for low-volume modes where boarding time is not critical, or off the vehicle (off-vehicle), used on high-volume modes to decrease boarding time (APA, 2006, p. 267). Nearly all buses use the on-vehicle method either when the rider boards or exits. Subways and other rail modes typically use the off-vehicle method because of their larger volumes. Some light rail vehicles, such as in Pittsburgh, use a hybrid system where riders boarding at a high-level platform pay an attendant at the platform while riders boarding at street-level stops pay the driver on the vehicle. The physical medium of the fare can take many forms. Most buses accept cash payments on-vehicle in addition to various forms of passes or smart cards. Many rail systems require the rider to purchase a ticket (either single- or multiple-use) at a kiosk, booth, or retail store before entering the station.

## Route Labeling

Early transit routes were often named for the streets near which they operated, either underneath as subways, above as elevated lines, or on top of as traditional surface rail lines. In New York City, the Interborough Rapid Transit Company (IRT) operated routes such as the Ninth Avenue Line, the Broadway Line, and the Fourth Avenue/Lexington Avenue Line beginning in the very early periods of the 20th century (Cudahy, 1979, pp. 56–57). Over time, the three primary transit operators in New York, the IRT, the Brooklyn-Manhattan Transit Corp. (BMT), and the Independent subway (IND), began to identify their various train routes with numbers (IRT) or letters (BMT and IND) as the principle identification method, supplemented with named destinations. Though the individual agencies were eventually all combined into today's Metropolitan Transportation Authority (MTA), this segmented labeling system persists (MTA, 2007).

A 1999 report from the Transit Cooperative Research Program (TCRP) with the Federal Transit Administration suggests that routes be identified with a number, letter, or combination of numbers and a letter, primarily for ease and simplicity of identification and labeling. A sampling of 20 North American systems indicates that this is the most common practice, especially for identifying the numerous bus routes in a system. Frequently, the route number/letter is supplemented with the ending destinations of the line. A subset of systems, such as those in Chicago and London, identify routes by color supplemented by ending destinations. In a nod to redundancy and color blindness, the TCRP report cautions against using colors alone as route labels.

In many cases, route identification is done in a systematic manner, giving route numbers meaning within the context of the city. In Pittsburgh, bus routes are generally organized radially around the downtown area. Bus routes are numbered with a 2-digit number and single letter (e.g. 61C) in a counter-clockwise pattern starting directly north of downtown. While the letters appear arbitrary, an experienced traveler may recognize the general region of a bus route based on the first digit of its route number.

In other areas, a single transit system crosses several municipal boundaries. Buses in New York City are identified by a letter corresponding to the principle borough of operation, followed by a one- to three-digit number. For example, the M101 operates entirely in Manhattan while the Q60 operates primarily in Queens, but also in Manhattan for a few blocks. Express buses are identified with the letter X regardless of borough.

# 2 Riders

Being a service for the entire community, a public transportation system attracts riders from wide demographic groups. As one of my interview subjects said, “You meet all kinds of people on the bus.” Specific demographics naturally tend to vary based on the size of city and coverage of the transportation system in the region. Typically, a larger portion of residents in the largest metropolitan areas use public transportation, especially for trips to work, than in smaller areas because the greater population density makes more modes of transit economical. Census reports indicate that people in the center city areas of cities like New York, Toronto, Montreal, Ottawa, Chicago, San Francisco, Washington, and Boston all had over 30% of work trips taken using public transportation. New York was at the head of the pack with 53% (Dunphy, 2004, p. 17).

Nationally, the American Public Transportation Association, an industry trade group, has collected statistics on general types of riders. Over 55% of all riders are women. There is a fairly even distribution in age range of riders among older teens and adults, with almost 80% of riders nearly equally distributed into four decade-wide brackets for ages 15–54. People describing themselves as White/ Caucasian account for nearly 41% of transit riders, with Black/African American and Hispanic/Latino groups accounting for 31% and 14%, respectively, of riders (Neff & Pham, 2007, pp. 19, 22–23).

## Rider Categories

Using Strauss and Corbin’s (1998) grounded theory approach, I developed the following set of non-exclusive categories of people associated with a transit system to describes riders I observed and interviewed:

- Non-riders
- Occasional riders
- Commuters
- Student riders
- Disabled riders
- Elderly riders
- Low-income riders

### Non-riders

Nationally, there are many more people who do not ride public transportation than who do. According to the Federal Highway Administration's National Household Transportation Survey from 2001, Americans use public transportation for only 1.6% of all trips, while over 86% of all trips are made with a private vehicle (Hu and Reuscher, 2004, p. 19). For most non-riders, public transportation may simply be unavailable within a reasonable distance of their homes, though I haven't seen a comprehensive study on this topic. Many non-riders are unable or unwilling to use public transportation because of constraints placed on their employment. In some cases, especially for workers with non-traditional working hours, public transportation is unavailable when they need to commute. For others, including the majority of non-riders I spoke with, the requirements of their job meant they were either required to travel frequently during the day to other work sites or they had irregular schedules and would not always be in the main office every day. Driving instead of using public transportation was seen as being more flexible and sometimes faster for people who had irregular schedules or wanted to combine errands with their commute. The feeling of personal control over one's own travel played a large part in travel mode decisions.

### Occasional Riders

A small group of people are only occasional riders of the public transportation system, largely based on where and when they are traveling. Most people who fall into this category, according to my interviews, ride public transportation when they're going to an area where parking is either not free or is limited. Nationally, a majority of riders (69.7%) own at least one private vehicle, making them not entirely reliant on public transportation for all of their travel (Neff & Pham, 2007, p. 27). However, only 8.1% of US households do not have a vehicle. The number of people without vehicles is highest in densely populated areas (10,000 or more people per square mile), at 28% in 2001 (Hu and Reuscher, 2004, pp. 32–34).

### Commuters

The largest category of transit users are people commuting to and from work or school, comprising about 70% of the total number of trips nationally on public transportation (Neff & Pham, 2007, p. 35). Considering all the trips a person makes, regardless of mode of travel, a person travels the second-longest distance on trips to and from work (behind social and recreational travel), with an annual average of 6,706 miles. Adding to this amount the average distances traveled on work related business and for school/church, this category becomes the largest at 11,753 miles per year (Hu & Reuscher, 2004, p. 15).

The very nature of commuting implies the same trip done every day of the workweek—once in the morning and once in the evening. As such, commuters who used public transportation knew their usual route well. Instead of knowing when the bus was due to arrive at their particular stop, most commuters I interviewed knew what time they had to leave their home to get to the stop on time. Commuters, then, are more aware of their total trip time rather than specifics for individual connections.

Most regular commuters I spoke with have used public transit for a number of years, either out of choice or out of necessity. This is seen especially with adults who live in the same area as they grew up, where they have been riding for multiple decades. These local observations are confirmed by national statistics: a majority of public transportation riders have used the system for at least two years, with about 37% using it for at least 5 years and almost 19% using it for 10 years (Neff & Pham, 2007, p. 31).

Traveling on the same route every day (and typically at the same time every day), commuters tend to make friends with each other. I observed two women sharing pictures of recent vacations while taking the train to work and others saving seats for friends who would get on at the next stop. Especially in the afternoon, buses, trains and subways were filled with people chatting with one another. This communal activity of commuting is a way for people to bond together. Some commuters develop bonds with the drivers of their buses. In one instance, a bus driver in Pittsburgh with a nearly full bus wouldn't let a group of students get on, but spotted one of his regular afternoon commuters running to the stop and let her board before pulling away from the curb. The students looked on with annoyance, but the commuter was very grateful. Some riders know the 44U bus route in Pittsburgh as the "party bus" because of the close friendships regular riders have formed. Going beyond the boundaries of the bus, a group of riders regularly holds barbecues and other social events for their commuting friends.

### Students

As previously defined, a public transportation system does not include services like school bus routes. However, many middle- and upper-grade students and college students use public transportation systems to go to and from school, or for other types of trips. In many cases, students are given free or reduced-fare passes to use for their travel. For example, students (and faculty and staff) at Carnegie Mellon

University and the University of Pittsburgh can use their school ID cards to travel anywhere in the Port Authority of Allegheny County's system with no additional fare required. Students at Carnegie Mellon are charged a small fee that appears as part of their regular tuition bills ($36 for Spring 2008). Chatham University students can purchase a special semester-long pass for $30 (Chatham University, 2007, Alternative parking and transportation section, para. 1). Either of these options is far less expensive than four three-zone monthly passes (providing the same system coverage), at $440 (Port Authority of Allegheny County, 2008). According to ridership summary documents for September–November 2007 provided by the Port Authority, about 12% of the Port Authority's ridership comes from students at these three universities.

In many cities, students in the upper grades ride public transportation to school, either by choice or by lack of other options. In Albany, NY, for example, middle school and high school students are given free passes for use on the city bus for direct trips between home and school, with restrictions placed on days and times of trips (Albany School District, 2005). New York City offers a program of free fare cards to selected K-12 students depending on how far they have to travel to school (Perez-Pena, 1995; Herszenhorn & Gootman, 2007).

In a bit of age rivalry, adult riders will often blame students for overcrowded buses when going through university areas. In Pittsburgh, one rider was overheard warning his traveling companion, "Uh-oh, CMUs. We'll get crushed!" referring to Carnegie Mellon students boarding at the main university stop. One student who grew up in Pittsburgh separately remarked that she was frustrated that students get blamed for bus crowding problems, but can understand why that happens when the buses are less full during the summer when school is out of session.

### Low-income Riders

Certainly one of the core groups of transit users is people who have no other method of transportation available. Traditionally, these are people who have low incomes. Nationally, approximately 20% of all public transit riders earn less than $15,000, 15% earn from $15,000 to $24,999, and 31% earn from $25,000 to $50,000 (Neff & Pham, 2007, pp. 23–24). Low-income riders are especially noticeable on old-city subway systems where one regularly sees a homeless person sleeping in a train car or station bench, or a panhandler or musician out to collect some money.

### Elderly and Disabled Riders

All public transportation systems offer services specifically directed towards senior citizens and disabled people, such as discounted or free fare passes for regular routes. As part of the Americans with Disabilities Act, a portion of federal funding for public transportation systems is dedicated to the purchase of paratransit vehicles for the disabled and the elderly. The paratransit systems usually operate separately from the other modes of public transportation, often in an on-demand mode instead of continuous service. Across the country, there are nearly four times the number of paratransit service providers than there are regular bus providers (APTA, 2007, pp. 3, 8)

Disabled and elderly users routinely ride regular public transportation routes as well. National surveys indicate that 6.7% of all transit riders are over age 65 (APTA, 2007, p. 13). Ridership data from the Port Authority shows that seniors account for about 9% of all trips in Pittsburgh. Most, if not all buses are equipped with ramps, lifts or other mechanisms to allow a person in a wheelchair to board. Many newer buses are a "low-floor" style where there are no steps to climb to board the bus; many buses can also "kneel down" by releasing pneumatic valves that physically lower the floor of the bus to curb height.

## Transit Mode Demographic Stereotypes

A primary stereotype of public transit riders, at least in the United States, is that only the poor ride the bus while the middle and upper classes drive wherever they need to go (Grava, 2003, pp. 349–350). As we have seen, people with low incomes do make up a disproportionate share of transit riders, but that doesn't mean the stereotype is entirely accurate. There's another social status stereotype at play, one focusing primarily on class differences between different modes of public transportation.

Anecdotal observations in various cities across the country point to a commonly-held belief that buses are used only by those who have no other means of travel, while rail transit is used by those who can afford other means. Grava (2003) observes:

> In Savannah, however, the people clustering at downtown bus stops on major streets during the peak afternoon period tend to be black. In Houston, office workers, mostly white, use the air-conditioned underground pedestrian tunnels to move between their desks and their parking spaces; the people getting in and out of buses on the hot surface

> streets are mostly service workers. In the Southwest, Mexicans are the largest cohort of bus riders. … A middle-class white male regularly commuting on a bus is a rare sight in all but a handful of cities in North America (pp. 349–350).

Grava (2003) cites "large old cities on the East Coast" such as New York, Boston and Philadelphia as the exceptions to this "rule" due to their relatively high proportions of people taking public transportation (p. 349).

According to the National Corridors Initiative (2008), an advocacy group for the development of transportation infrastructure, a section left out of the final report of the National Surface Transportation Policy and Revenue Study Commission specifically advocates for new passenger rail transit projects across the country, noting that "public policy must acknowledge that buses and rail are not fungible. In addition to the obvious advantage of electrification, rail transit, including streetcars, light rail, heavy rail and commuter rail … serve different markets and perform different functions from buses" (The case for public transportation section, para. 10). The apparent excised section later confirms the mode stereotypes presented above, noting:

> Rail transit has repeatedly demonstrated its success in drawing riders from choice, people who have a car and could drive but choose to take transit instead, while buses generally carry only the transit-dependent, those who have no other way to get around. This means that rail transit, but not buses, has a significant potential impact on traffic congestion. For whatever reasons, it is a fact that most Americans like riding trains and streetcars but do not like riding buses (National Corridors Initiative, 2008, Key differences between bus and rail transit section, para. 1).

Rail transit is not immune from negative class stereotypes, however. In the largest cities with large, old railway networks, such as New York, Boston and Philadelphia, the subway is seen as the least common denominator mode of travel. Decades of neglected maintenance contributed to an image of the subways in these old cities as dirty and unfit for the middle and upper classes. Newer subway systems across the country, such as Washington, DC, Atlanta, and the San Francisco Bay Area, do not carry this negative image and are used by a much wider cross-section of the population without hesitation (Grava, 2003, pp. 569–570).

Like these newer subway systems, light rail systems are becoming increasingly popular across the country. Cities such as Denver, Phoenix and Minneapolis recently completed or are currently building/expanding light rail lines to complement existing bus service. Dunphy (2004) explains their attraction:

> Many public officials and transit planners think that light rail has a cachet that buses lack—at least for potential transit users in the Sunbelt. Light rail, it is felt, is needed to attract "by-choice" riders, that is, riders who are not dependent on transit for their travel needs. As a former county supervisor mused during the debate over the rail system in Los Angeles: "The opportunity for riding from Chatsworth to Disneyland on a train far exceeds in excitement and popularity the dismalness of getting on an RTD bus" (p. 11).

## Discrimination in Transit

There are also examples of actual discrimination based on modes of travel. Winner (1980) describes actions taken by Robert Moses, known as the "master builder" of New York City in the mid-1900s, to limit access by minorities and low-income people to his newly-created Long Island parks such as Jones Beach. As he designed and built the Long Island Parkway, he created low (nine-foot) overpasses that prevented the 14-foot-tall city buses from getting to the beach. At the time, wealthier white "upper" and "comfortable middle" class people traveled primarily by car; by limiting access by buses, and later by trains after he killed a project to expand the Long Island Railroad, he was able to control the visitors to the beach (pp. 123–124).

Lawsuits in Los Angeles, San Francisco and other areas allege racial discrimination by transportation systems based on the proportion of their financial allocations favoring rail modes of transit to buses (Moore & Rubin, 2008; Sterngold, 1999; Egelko, 2005). Residents in a new, fairly affluent development in Pittsburgh voiced strong objections to the Port Authority's plan to extend bus service through the development saying, among other reasons, "they fear their streets will become a park-and-ride lot and that other areas of the city need the service more" (Nelson Jones, 2005). Interestingly, residents said they didn't mind if the bus stopped at the entrance to the development, just that they didn't want it entering the development. According to a spokesman for the residents, some people "would like to see some type of service so their baby sitters can come into the area." (Nelson Jones, 2005). The Port Authority resisted their opposition and the 61D bus route currently enters and turns around in the development.

## Perceptions of Speed

Stereotypes about transit are also influenced by perceptions of speed. Two young professional men in Pittsburgh, both lacking another mode of transportation, hesitated to take the bus because they felt it was slow. The time waiting at the stop for the bus to come or waiting partway through your journey for a transfer bus gave a strong feeling of negative progress, especially when compared to a car. One said, “I have it in my head that [the bus is] slow and a waste of time,” so he tends to walk more than ride the bus. With some circuitous logic, one said that yes, he doesn’t have a car, and in reality the bus is faster than walking, but because he perceives it as being slower, he is less likely to take it. In contrast, he would take a subway “in a heartbeat” because he perceives it as being faster than a bus. This perception of speed is likely due, in part, to the fact that there are many more potential bus stops along a given segment of a local bus route than there are stations on a subway line.

When looking at average speeds for different modes, based on data from the Federal Transit Administration and the American Public Transportation Association, there’s not much difference between the three modes, as shown in Table 1. Because trips taken on the subway and light rail are, on average, slightly longer than those taken on a bus, the increased speed only results in a time savings of about 3¼ minutes. Even if these men rode the subway for the same 3.7-mile average trip taken on the bus, they would be traveling for 11:06. After factoring in the additional time needed to descend and ascend to and from the subway platform, the difference in travel time between the subway and bus is negligible.

**Table 1**
Comparison of average travel times on common transit modes

| | Average Speed (mph)† | Average Trip Length (miles)‡ | Average Travel Time (min:sec) |
|---|---|---|---|
| Bus | 12 | 3.7 | 18:30 |
| Light Rail | 16 | 4.5 | 16:53 |
| Subway | 20 | 5.1 | 15:18 |

†Average speed from Dunphy (2004, p. 12). ‡Average trip length from APTA (2007, p. 11).

## Complexity of the Network

The apparent complexity or simplicity of a public transportation system also has a great effect on the types of riders it receives. Because buses run on the existing street network, transit planners have nearly unlimited flexibility in designing bus routes. If the system wishes to minimize the amount of transfers riders must take, routes will develop in an *integrated* manner, with many overlapping segments. Several routes might overlap for some distance before splitting off for separate endpoints. In contrast, if the system wishes to maximize the capacity of the lines, routes will develop in an *independent* manner, where a single high-frequency line serves a particular corridor and passengers then transfer to other local routes where appropriate. Bus systems often take the integrated approach because it's relatively easy to add a new bus route on an existing roadway (in contrast to digging a new subway tunnel, for example). However, as one veteran Pittsburgh bus rider noted, the system becomes "insanely complicated even if you know how" to use it. Vuchic (2005) noted that this complex system "discourages occasional transit users [including visitors and tourists] from considering travel by transit. … The entire role of transit in the city thus deteriorates from the basic mode of travel (which many rail systems maintain) to an auxiliary travel mode used mostly by commuters and captive transit riders" (p. 200).

# 3 Rider Experiences

As we have seen, a wide variety of user groups use public transportation systems to move throughout a city. This section will analyze the experiences of riders as they move through the different phases of a journey. Based on my contextual inquiries, personal experiences and heuristic evaluations of public transportation systems, I developed a five-part model to describe the process of a trip using public transportation (see Figure 2). Riders begin with pre-trip tasks to plan their travel then, upon entering the public transportation system, repeat three phases of orientation (identifying their current location), navigation (making a decision for further movement) and confirmation (evaluating the feedback from the navigation choice). Once they confirm they have reached their final destination on the system, riders then exit the public transportation system and perform post-trip tasks to reach their ultimate destination.

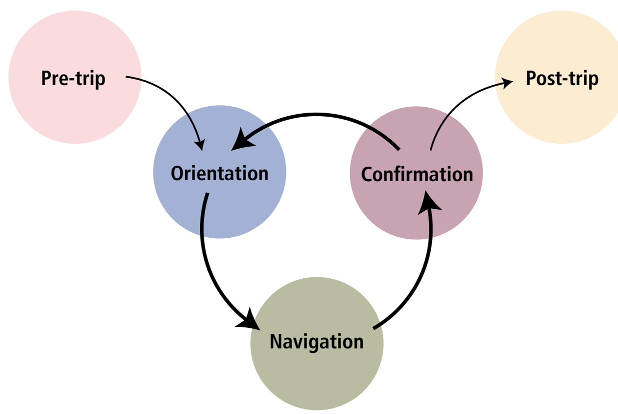



**Figure 2**
Model of steps in the process of riding public transportation.

## Pre-Trip Phase

A journey using public transportation begins with pre-trip activities before riders even enter the public transportation system—tasks such as identifying one or more routes that will get them to their destinations, determining when they need to leave to board the correct route and learning the path to the nearest entrance point to the system. This pre-trip phase is crucial in building an understanding of the operation of the system. For experienced riders, this pre-trip phase is often abbreviated because they already understand how the system works and likely have taken these trips before. They might only need to verify the schedule or check for any detours or other service changes.

Experienced riders taking a new trip must do some research to determine the correct routes and times, but their experiences have already told them where to look for this information. Riders new to the public transportation system in a particular city are at a disadvantage common to new users in any situation. If they have experience with public transportation from another city, they can make educated guesses about where to look for information and how to use the system. Otherwise, they must rely on contextual clues, their observations of other riders, and the friendliness of the driver or other passengers in answering questions.

This pre-trip phase of the journey can take on different characteristics depending on initial rider goals and known information. For a known trip, as noted above, riders spend a minimal amount of time on pre-trip tasks since they have already previously spent the time to decide on his route. Their information-seeking behavior is Marchionini's (1995) recall category because they are trying to refresh their memories with information they found before. Most commuters will fall into this category because most of their travel on the public transportation system is confined to the same trip between home and work.

A slight variation to this behavior is a rider who already knows the route that will get him from his origin to his destination, but does not know what time it will be arriving. Many regular riders, especially bus riders where service is not constant, will carry one or more timetable schedules with them at all times, or will keep a pile of schedules at home and at the office, their two most-used locations. Riders value these timetables as ways of understanding the system. One woman pointed to the bus schedule in her backpack pocket, mentioned that she had a stack of them at home, and declared, "I wouldn't move without those." Some riders create a customized timetable of their own frequently used routes when the information supplied by the public transportation system is deemed to be inefficient or ineffective. Several people that I interviewed created combined timetables from all the individual routes that went by their house, especially if the routes overlapped. One person created an activity-centered timetable of routes he could take to and from the downtown Cultural District with just the times before and after theater shows so he could avoid carrying four different schedules.

Knowing at what time to expect the vehicle to arrive helps riders to better plan their travel around their other activities. This is especially important when a rider is relying on a particular route that has long wait times between trips, and when a rider must wait outside (e.g. for a bus) instead of inside (e.g. for a subway). Here, the rider has an additional physical comfort goal of staying as warm and dry as possible in cold or wet weather, and of staying as cool as possible in hot weather. Thus, minimizing the amount of time waiting to board the vehicle is desired.

Riders who must choose a new route to complete a particular trip can fall into a few different categories depending on the number of constraints they place on themselves. A rider with the most constraints, who knows his specific origin and destination points and who has defined time constraints, practices a known-item search (Rosenfeld & Morville, 2002, pp. 31–32). Based on the people that I interviewed, riders are most likely to use an electronic interface, such as an online trip planner, to determine a route or combination of routes that meet their constraints, when it is available. These systems are ideal for known-item searches because they often rely on physical street addresses as inputs. If riders don't want to use this type of system, or where it isn't available, the people I interviewed rely on other people for the information, frequently asking friends or other riders.

In other situations, riders don't have enough information to perform a known-item search. For example, a person moving to a new city may want to know what general areas are well-served by public transportation before buying a house. Or, a person may want to explore the system or the architecture of different stations or neighborhoods. One student in Pittsburgh said she tries to expand her knowledge and familiarity of the bus system by taking a random route and trying to connect it geographically to her knowledge of the city's geography. A man in New York City would take a different subway ride every Sunday afternoon for the first several years he lived in the city, just to look at the artwork and architecture of the stations. Planning these types of exploratory trips requires knowledge about what route options are available in the system and a general idea of where they go. Riders don't necessarily need to know exactly what streets a bus will follow, for example, only that it goes to a particular area. Rosenfeld and Morville (2002) described this behavior as an exploratory search.

These two types of behavior (the known-item and exploratory searches) correspond to Boorstin's (1976) differentiation between *exploring* and *discovering*:

> The crucial distinction between these two roles we can see in the origins of our English words. The etymology of the word "discover" is obvious. Its primary meaning is to uncover, or to disclose to view. The discoverer, then, is a *finder*. He shows us what he already knew was there. The word "explore" has quite different connotations. Appropriately, too, it has

> a disputed etymology. Some say … it comes from *ex* (out) and *plorare* (from *pluere*, to flow). Either etymology reminds us that the explorer is one who surprises (and so makes people cry out) or one who makes new knowledge flow out" (p. 6, emphasis original).

Extending Boorstin's reasoning, a discoverer uses the known-item search to look for something that he already knows exists. In contrast, the explorer is looking for some new understanding or new knowledge about the system, and uses the exploratory search methods to select a route.

Based on my interviews, this initial planning step to find an appropriate route is often the most daunting, especially for people in Pittsburgh. Because Pittsburgh lacks a complete system-wide map either in print form or online through the Port Authority's web site, riders essentially must already know what routes go to their destination to see if they really go to their destination. In the extreme case, one rider took a relaxed approach by avoiding all pre-trip planning and waiting at a bus stop for a bus to come along that had the name of his destination neighborhood on its sign. Most riders, however, relied on online services to plan their trips, with varying degrees of success. Some were able to use the Port Authority web site successfully, but others told stories of the site not being "user friendly" and randomly crashing his web browser. The growth in alternative transportation planning services such as Google Transit, buskarma.com, and hopstop.com, is evidence of the perceived need of these types of services.

### Entering the system

Once a rider has selected a route, he needs to get to an entry point for the public transportation system: a bus stop or train station, for example. None of the people I spoke with mentioned having any trouble with this step, likely because these structures are unique in their appearance. Once a person knows what a bus shelter is or knows what a subway station entrance looks like, he is able to apply that general model to recognize any number of variations.

The bus stop and train station, as entry points to the system, require a high level of visual identification in the larger built environment, usually in the form of signage. We will look at the steps of recognition for a bus stop in particular, remembering that these steps are largely similar for other entry points (subway stations, light-rail stations, etc) as well. A person must first be able to recognize that a particular location is a bus stop. This is most often accomplished through the use of a sign noting the public transportation system that operates the stop and is often supplemented with additional visual cues: benches, a covered shelter or information about bus routes stopping there, for example. These features create a sense of place and identify that place as one of importance with a special function.

Then, one must be able to identify that particular bus stop based on its street location. Here, a combination of signage, information displays and standard street signage play a role. Most bus stops are associated with street intersections or a street address, so looking at the surrounding street signs, if visible, can provide this identification and naming information. Often, especially if the stop has a shelter or other structure, this identification and naming information is repeated as a sign on the structure, further reinforcing the name. It is crucial that the name of the stop remain consistent regardless of where it is presented. By naming the stop with respect to the adjacent streets, the rider is able to tie together the public transportation system with the general street system. Other names are possible, such as those of nearby landmarks, but could possibly create more confusion among riders especially if the landmarks are large enough to have entrances on multiple streets.

Once the identity of the stop is established, the routes serving that stop need to be identified. The most common method uses the bus stop sign to list the corresponding route numbers. This can be reinforced by providing additional information about those routes, such as schedules or maps. Based on my interviews, riders craved this type of route information at each stop, but it was all too frequently absent. Some stops (especially large transfer stations) have display screens that show the next few upcoming routes and their expected arrival times. Riders of all types appreciated these information aids because, as one rider put it, "you can pace your wait."

As the most commonly-used identification element, the sign (sometimes in conjunction with a structure or architectural feature) is used to establish the location of the station or stop. Urban and transportation planners note that signs "may be just as important to wayfinding as street names [and] addresses" (Mace, 2001, p. 9). Three primary factors affect how well a sign functions in an environment: its conspicuity (visibility), its legibility, and its recognition (readability) (Mace, 2001, p. 9).

A sign's conspicuity is a measure of how easily it can be spotted in the surrounding environment. Hughes and Cole (1984) distinguish between *attention conspicuity*—how well a sign is able to capture the observer's attention when focused on something else—and *cognitive conspicuity*—how well an observer asked to specifically look for a particular sign can find it. In the situation of a person looking for the nearest bus stop or subway station, cognitive conspicuity is at play because the person is actively searching for the sign. Mace (2001) identifies several variables that can be used to enhance a particular sign's conspicuity: graphic content, border, color, shape and size. With regards to graphic content, he writes, "it may be possible to increase the conspicuity and/or recognition of signs by adding icons to the text. When the graphics used are not familiar and are not likely to become familiar through frequent encounters, the legibility of text may still have to be relied on" (p. 28). In this case, adding the logo of the public transportation system or an icon of the particular mode (e.g. a bus icon) may increase the conspicuity of the sign as these are likely to be familiar images. A border and color used to increase the contrast on the sign— a light border around a dark sign background, or light text against a dark background as two examples—helps to improve conspicuity. A unique shape or size to the sign can improve conspicuity by drawing attention to that sign from the others nearby.

Though my sample size is quite small, some public transportation systems seem to taking these principles into consideration when designing their signs for bus stops, subway entrances and other locations while other systems do not. A survey in 1996 of 21 representative transportation systems (various sizes, modes of transportation, and regions) across the US and Canada indicated the most common type of bus stop sign was a metal rectangular sign 12 inches wide and between 18 and 36 inches long (Dobies, 1996, p. 10). This still seems to be the case in many areas across the country, as my travels to Denver; Albany, NY; Philadelphia; and Pittsburgh confirm. The survey also noted many agencies use an icon of a bus on the sign instead of, or in addition to, a label such as "Bus Stop." This has advantages in reducing the physical space on the sign required for identification of the sign's purpose and in providing accommodations for people who do not speak English (Dobies, 1996, p. 11).

As some of my interview subjects pointed out, this standard type of bus stop sign looks too much like a standard-sized No Parking sign in shape, size and height on the pole, making it hard to distinguish in the visual clutter of the urban environment, especially seen in Figure 3.

Some notable examples (see Figure 4) are the newer bus stop signs in central London that, in addition to their relatively large size and tall poles, have internal lighting powered by a solar panel on top of the signpost (Transport for London, 2006, p. 15). New York City began a program to replace its bus stop signs in 1996 with a distinct round sign with a bus icon atop a 12-foot pole (Pierre-Pierre, 1996).


**Figure 3**
While the white on blue bus stop sign used in Pittsburgh provides a high amount of internal contrast, its location on the same pole as four other signs dramatically reduces its conspicuity, rendering it effectively hidden.


**Figure 4**
Both the London solar-powered illuminated bus stop sign (left) and the New York City tall pole bus stop sign (right) show an icon, the name/location of the stop, and the routes that service the stop. [Left image from Transport for London, 2006, p. 15]

Both of these examples prominently display the location of the stop and the routes stopping there.

However, some efforts at distinctive signage can have a negative effect. Times Square in New York City, an international landmark, is known for its abundance of bright digital animated signs and advertisements. Apparently trying to follow this visual environment, the signs for the subway station at Times Square are large, bright and attached to buildings adjacent to the entrances (see Figure 5).

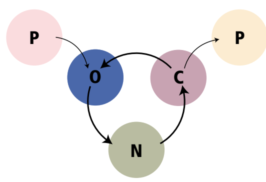

**Figure 5**
Subway signs in New York City's Times Square are too similar to the surrounding visual environment and tend to get lost due to their low conspicuity.


**Figure 6**
The Lorimer Street subway station entrance is an example of a typical subway station entrance in New York City.

Not only does this signage not fit the rest of the system signage (see a more typical station entrance in Figure 6), but because it is in the same style as the surrounding environment, it loses its conspicuity.

Mace (2001)'s other factors for sign design, legibility and readability, refer to the content on the sign. Legibility is defined as "the ability of the eye to clearly distinguish individual characters and numbers in an alphanumeric message" while readability, or recognition, is "the ability of an observer to understand the meaning of an alphanumeric or graphic message" (p. 28). These two factors have been heavily studied by sign researchers to determine optimal sets of characteristics for a given situation (Garvey, Thompson-Kuhn & Pietrucha, 1996). Legibility is most affected by the eyesight of the observer and the typeface and size of the text on the sign. Additional graphic design considerations, such as spacing (kerning and leading), color, uppercase/lowercase letters and text orientation, play a smaller role in the legibility of the sign (Mace, 2001, p. 29).

When looking at readability, we need to look at the sign in context to determine if a person is able to understand where the bus stop or train station entrance is located. Because a bus stop sign will always be located next to a road, and usually next to an intersection, the context helps to improve the readability of the sign itself. A subway station sign will usually be associated with a set of stairs to go underground, or with an above-ground station platform where the tracks are visible. In these cases, the small amount of text or graphics on the sign itself, combined with other necessary infrastructure elements, is likely not to negatively impact readability.




## Orientation Phase

Once riders have located their entry point into the transportation system, they start a circular process of orientation, navigation and confirmation as they travel through the system. In the orientation phase, riders use their five senses to determine where they are in the system. The specificity of this orientation information, however, varies based on a rider's current position in the trip and the mode of travel.

After initially entering the system, riders must have very specific knowledge of their current location to ensure their current position matches the plan for the trip they created before leaving. The result of the orientation phase in this case would be a station name or a bus stop location (usually an intersection of one or more roads). More the case with a bus than with any rail transportation, riders need to translate their actual physical location, perhaps something like "On Forbes Avenue, 40 yards after the intersection with Murray Avenue," to a system-centered location: "Forbes Avenue and Murray Avenue." The system is often highly specific—some might say cryptic—in naming the bus stops, using cardinal directions or other abbreviations to pinpoint the stop's location. Continuing with this example, the Port Authority refers to the Forbes Avenue and Murray Avenue stop as "FORBES AVE & MURRAY FS" in its online route-planning system. The "FS" likely stands for "far side," because the bus stop is after the intersection in the direction of travel, though this explanation is not present in any informational literature. This specificity is often needed in the system because at a typical 4-way intersection, there are eight likely locations for a bus stop that all could be named with those two street names, but is not told to riders. One person I talked with waited for a bus at the appropriate intersection, but at the wrong position at the intersection and nearly missed the bus as a result.

Once riders have boarded a vehicle, they indicated they needed less specific information in the middle periods of their trips, but needed more specific information towards the end, in the few stops preceding the stop where the needed to exit. One rider said, "[it's] ok to know that this section of town is not where I am getting off, but when I get close [to my destination, I] need to know every street." In this middle period, general geographic features were the most desired; riders liked to know when they were crossing boundaries such as neighborhood lines, major streets, or bodies of water. Interestingly, riders used architectural features to identify when they had entered downtown by noting that the "buildings were all tall." These general geographic cues helped them to monitor their progress on their trip.

In a slightly different way, however, new riders felt like they needed detailed orientation information at all times. One rider mentioned the difficulty in knowing when to transition from this middle period of low specificity to the end period of high specificity: "If I was just new here, I wouldn't know when to start looking for cross streets." Another rider captured the emotional aspect of a new trip: "People have a constant fear of being lost. Sense of direction and comfort are definitely related. However, we knew we were headed in the right direction, so we had faith." I observed a rider new to the Pittsburgh area traveling to downtown from the airport constantly comparing the printed bus route map with what she could see out the bus windows to identify her current locations. Because the particular map for that route was not very detailed and the route went on a restricted busway instead of a normally named or numbered road, the rider never felt at ease that she was going in the right direction and asked the bus driver several times to confirm what she needed to do to reach her hotel.

When nearing the end of a trip, riders again required detailed orientation information so they know when and where the need to leave the vehicle (bus, subway car, etc.). This information was gathered using a variety of senses, depending on the mode of travel. Because of its location underground, riders on a subway have far fewer external observation opportunities—they can't see very much out the windows in a darkened subway tunnel. Thus, they rely more on information present inside the subway car such as a map of the system, spoken announcements and visual signs or progress meters. Subway riders will often keep a count of the stations they pass, measuring their progress in a linear fashion, and will look for a sign on the station platform with the name of that station. One rider also received secondary orientation information by watching the number of people entering and exiting the vehicle, noting that an indicator of a popular location is when more people get off.

Bus riders and riders on above-ground rail modes can often look out the windows of the vehicle to determine their location in the urban environment, creating a different orientation experience. Here, riders can orient themselves to well-known landmarks such as particular buildings, intersections, parks, monuments or other features. The nearly limitless array of features to watch for, however, can serve to overwhelm riders who may have a hard time limiting their sensory perception. Even when the vehicle travels above ground, however, there is no guarantee that riders will be able to see the landmarks and other physical features they're watching for out the windows. Outdoor environmental conditions can severely limit external visibility, as can things like fog or graffiti on the window itself.

Some of my interview subjects mentioned how much easier it was to see things inside the bus than outside the bus. Though they appreciated the ability to watch for street signs and other physical features, they often had a hard time identifying an upcoming sign with enough time to signal the driver to stop the bus. They nearly universally preferred the buses in the system that had electronic displays showing the upcoming bus stop, as there were fewer variables involved that could restrict their visibility of this in-vehicle device. One rider said that vehicles without these electronic displays made travel "more nerve-wracking" because she needed to pay more attention to the announcer and what was happening outside the windows of the vehicle.

While riders preferred these visual in-vehicle orientation devices, many expressed regret that when the bus got crowded, it became harder and harder to see the display. This phenomenon holds true across transportation modes as well—in my experiences in a crowded subway during rush hour in New York, when I stood in the middle of the car, I couldn't see out the windows on either side and could barely make out part of the electronic display showing upcoming stops. One subway commuter in New York said she watches out the windows as best she can to note changes in station architecture and to catch a glimpse of a "2" at the Second Avenue station, one stop before she gets off. She finds it difficult to see the station signs from inside the train because the little signs on platform support poles are often covered by people standing or leaning against them and the large signs hanging from the ceiling are at an awkward angle to see while seated in the car. But, she always tries to catch a glimpse of those signs so she has time to put away her magazine, put her coat back on and gather the rest of her belongings. To continue to provide effective orientation information when the vehicles are crowded, orientation devices must be redundant, offering information to riders using multiple senses to prevent complete obstruction of the message.

Riders who were new to the system wanted to avoid looking at printed information (hand-held maps and schedules or wall-mounted maps) as much as they could so they would not appear to be tourists, a label that left them feeling vulnerable. Two teenage girls visiting New York City commented, "they have maps credit card size so you don't look like a tourist." The small size of these maps was a comfort to them because they wouldn't have to deal with unfolding and refolding a large map or with looking at the printed map mounted on the wall of the subway car. Technology also helps people avoid the tourist label: many third-party services, such as isubwaymaps.com, have converted the official system maps (usually subway maps) for use on cellphones, iPods and other personal electronic devices, and devices with Internet access can make use of various online trip planners. For all the riders traveling without these devices, however, orientation information provided inside the vehicle itself was critical.

Most riders appreciated the combination of a visual system and an auditory system showing and announcing current and upcoming stops. With this combination system, riders could sneak a glance at the display or listen for the announcement without making overt actions that would label them as tourists or as unfamiliar with the system. A stop-by-stop approach to providing route information does not fully inform riders of where they are in the system, however. Complete system maps or route maps are needed for this function. On buses, often the hand-held route maps and schedules are made available for riders, ideally in addition to the electronic systems mentioned above. However, some systems do a poor job of making sure the correct set of maps appears on the correct vehicles. Over a several-week period of regular bus-riding in Pittsburgh, only 33% of the vehicles I rode had at least one map of the correct route on board among the 3-6 map holders on the bus. Though I recognize that buses are often used for multiple routes throughout the day, there was no apparent effort to make sure there were materials aboard for the various routes the bus travels.

Riders disagreed, however, on the specific style of spoken announcement. Some preferred standard pre-recorded announcements to live announcements from the driver because they were assured they could understand what was being spoken. In a noisy environment such as on a bus or train, not only did riders find it difficult to hear messages (legibility), but they also found it difficult to understand the content of the message (readability). These pre-recorded announcements were much preferred by first-time riders, who were already feeling slightly overwhelmed with the amount of information they had to process to complete their trip, because they were carefully crafted to avoid problems with the legibility of the message, allowing riders to focus on understanding the message's content. Pre-recorded messages are generally spoken slower than a live announcement, use consistent language throughout the system and are certain to include the same information each time.

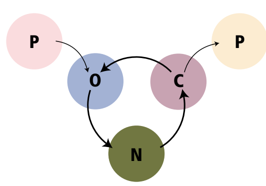
Since the pre-recorded messages were always the same, however, one rider mentioned that once he grew accustomed to them, he automatically ignored the pre-recorded messages. This finding is consistent with observations made by a New York Times columnist about celebrities pre-recording safety and informational messages for the Metropolitan Transportation Authority. Susan Dominus (2008) reported:

> Officials at the Long Island Rail Road enlisted [CNBC Anchor] Ms. Bartiromo's help in the hope that a celebrity voice could cut through the background noise competing for commuters' attention, and Metro-North embraced the idea.
> On Friday, Al Roker took over the job, with his messages regularly broadcasting at Penn Station and throughout Long Island, with Grand Central expected to follow.
> On Friday afternoon in Penn Station, however, a police officer who'd been standing in the terminal for an hour and a half said he had yet to hear Mr. Roker's message even once. The message was, in fact, playing every 15 minutes, as scheduled.

Though these repeating general informational messages are of a slightly different character than the station information messages being proposed here, the principle is similar: people tend to ignore things that are repeated and predictable. In addition, pre-recorded messages are more difficult to use in abnormal situations: to give emergency instructions or to explain delays or rerouting.

Other riders, primarily regular commuters, preferred live announcements made by the driver or conductor. One person commented on the "personal touch" that a live announcement provided, noting that he never knew what kind of person he would be hearing from. This element of surprise was something to look forward to on a commute that was more or less the same every day of the working week. Angelos (2007) reported on Jason Lewis, a subway conductor in New York known for supplementing the official announcement script with friendly greetings, jokes or other personal messages to his riders, noting that Lewis "accomplished what may be a remarkable feat: He made a few rush-hour riders—at 8:30 a.m. no less—smile." A major drawback to the live messages, however, is their legibility. Variables such as the driver's accent, rate of speech and use of an amplification device can all have negative effects on the legibility of the message. Subway riders complained of driver announcements that were "quick and easy to misunderstand" while bus riders often couldn't even hear the driver, especially when he or she didn't use the microphone and PA system. This left riders confused and, at times, afraid because they didn't know what was happening.

In either case of a pre-recorded or live announcement at each stop, the content of the announcement (and ideally, the content of the visual display as well), should provide enough information for riders to completely orient themselves with respect to the system, and with respect to the larger city if possible. This includes the route number of the vehicle, the direction in which it is traveling, the current or approaching stop, the stop after that, and any routes riders can transfer to at either of those stops. The Chicago Transit Authority goes one step further and includes a sentence in their pre-recorded subway/el messages telling riders on what side of the car the doors will open. All of this information helps riders to orient themselves in the system and, by informing them of the upcoming stop, helps them to prepare for their departure.




## Navigation Phase

The next phase in the travel process is the navigation phase, where riders use the information gathered from the orientation phase to make a decision about continuing their travel. This decision can take many forms depending on the rider's current location: "Do I get on this bus?" if waiting at a bus stop, "Do I stay on or get off?" at a particular stop or "Will this route still go where I need to go?" if a detour has been announced, for example. If the system is running smoothly and the rider has thoroughly completed the pre-trip phase, the navigation phase simply consists of selecting the correct options from his or her travel plan. However, if elements of the system are not functioning as scheduled or if the rider's travel plan is inadequate, the navigation phase can become a frustrating experience for the rider who has to adjust his or her plan to meet the challenges of the current context.

### Identifying the vehicle

Beginning with the first question identified above, riders waiting at a bus stop or a station platform must decide if they should board a particular vehicle that approaches the stop. Factors affecting this decision include what territory a route covers, the direction on the route that particular vehicle is heading and the presence of multiple routes stopping at that location. Riders who create thorough travel plans during the pre-trip phase will know what routes they should board and where those routes travel. However, riders who skipped this phase will look for information at the stop or on the vehicle itself to decide what route they need to take. One Pittsburgh bus rider looking to go to the South Side neighborhood waited at a popular bus stop until he saw a bus that said "South Side" on the side. He boarded, without knowing if it would take him to where he wanted to go in the neighborhood.

The vehicle itself is one important source of information. It is essential for vehicles to display the name or number of their current route, ideally on multiple locations on the vehicle. Riders preferred electronic displays showing route identification information to interchangeable signs because of the greater amount of information they could display in a compact area and because they were more visible under various lighting conditions. Riders especially liked LED-based signboards because they provided the most contrast between the letters and the background in non-optimal lighting conditions. Other methods, such as backlit translucent printed signs or a matrix flip-dot display, suffer from reduced visibility at night. Some riders wished that the glass panel covering the route signboard had a non-glare coating so it would be easier to see the sign at dawn and dusk.

Formal studies of bus display signs roughly correspond to these observations. The United Kingdom's Department for Transport sponsored research in 2004 on bus route and destination displays, concluding that none of the three current options is best all-around. The LED display could be read from the furthest distance away, though participants wanted the text to be clearer when viewed up close (meaning smaller LEDs for a greater resolution) (Cook & Lawton, 2003, p. 19). Study participants most expressed desire for the largest text possible, both on the route number and final destination. Text size was seen as the most important factor in making the displays easy to read (Cook & Lawton, 2003, p. 35–36).

The most important piece of information for a vehicle is the route number—riders first want to know what route is approaching (Cook & Lawton, 2003, p. 36–37). The route number should thus be the largest piece of information displayed on the vehicle. One rider laughed when I asked how she identified buses coming down the road and demonstrated what she's termed the "bus stop squint" that she's seen countless riders perform over the years: leaning slightly forward, the waiting rider squints slightly and gazes up the street to try to make out the route number on a bus that just came into view. Viewing a vehicle head-on is the most common orientation, so the route number should be largest on the front of the vehicle. In addition, signs on the other three sides of the vehicle with the same route information help to identify it from other positions.

Researchers in the British study determined that after the route number, the next most important piece of information is the final destination of the vehicle (Cook & Lawton, 2003, p. 36–37). The final destination is an established convention for showing the direction the vehicle is traveling on the route, though it doesn't always prevent people from getting on a vehicle going in the opposite direction from their intended path. However, to their credit, the riders usually quickly realized they were going the wrong way and got off at the next convenient place and found their way to the routes traveling in the other direction. Some riders ignored the final destinations present on the route signs because the names of the end-line towns were unfamiliar to them and instead determined the direction they wanted based on their understanding of the streets and general geographical landmarks.

Many vehicles, buses especially, also display intermediate destinations on route identification signs to identify the many different neighborhoods the vehicle might pass through on its way to the final destination. While this practice helped the rider going to the South Side mentioned above, it has been shown to severely increase the time needed to read the information (Cook & Lawton, 2003, p. 30). In a crowded urban environment, when riders can identify an approaching vehicle more quickly, they have more time to decide if it's the vehicle they need and, if yes, they have more time to prepare to board.

### Making transfers

In many cases, one route will not get a rider from his or her origin all the way to his or her destination. In these cases, the rider must transfer to a different route (sometimes multiple times) to complete the journey. Transfers are common both from one mode of travel to another (e.g. from a bus to the subway) or between two routes on the same mode (e.g. between two buses). Surveys by the American Public Transportation Association suggest that 40% of all trips involve one or more transfers, with a majority of that amount (about 30% of all trips) with just one transfer (Neff & Pham, 2007, p. 33–34). In most cases, these transfers are available at no additional cost; only about 19% of public transportation systems in the US add a surcharge for transfers beyond the base fare (APTA, 2007, 38).

Most of the people I interviewed didn't like to transfer between bus lines because it usually involved an unpredictable wait for the second bus. Riders saw transfers as one more variable that could keep them from getting to their destination on time. In cities such as New York with extensive bus and rail systems, many people thought of the subway as the "primary" mode of transportation and might need to take a bus to reach the subway station. The local term "two-fare zone" categorizes these areas that are a bit too far for people to walk to the nearest subway station, requiring them to take a bus and transfer to the subway.

Transfer locations present their own information requirements during the navigation phase. With just a single transfer, riders double the amount of route and schedule information they need to be aware of. Signage and wayfinding systems at transfer points must cater not only to normal behavior (people exiting to the street system) but also to other connecting routes. Where this is done well, many riders notice: at the Jay St subway station in New York, for example, one rider appreciated that the transfer from the A to the F continuing away from Manhattan could be done all on the same platform. As noted earlier, announcements of upcoming transfer routes should be made inside the vehicle to remind riders of the options available.

### Service changes

Perhaps the most frustrating factor in traveling on a public transportation system is dealing with changes in the regularly-scheduled service. Like any large and complex system, a public transportation system is constantly changing, responding to maintenance requests, accidents, delays, special events and even expansion construction. Service changes can be divided into two categories: structural changes such as large-scale capital projects and operational changes such as routine delays or maintenance.

Public transportation systems are responsive to changes in the population patterns of a region, meaning that over time, a system will expand and contract based on demands of residents and available finances. Structural changes include long-term capital projects that will shape the system for many years into the future. Current and recent projects include a light rail tunnel under the Allegheny River in Pittsburgh, a new subway line under Second Avenue in New York and a new light rail line in Phoenix. Structural changes are not always about expansion, however. When funding is tight, structural changes are often centered around reductions in service or changes to existing routes for more efficient service, as in Pittsburgh's June 2007 15% service cuts (Grata, 2007). Many systems also periodically make more minor changes to route schedules or the routes themselves at specific times during the year that can also be considered structural changes.

Because of their large impact, structural changes require considerable planning time and are presented to the public in a series of public hearings before they take effect. The news media is likely to report on the changes extensively, so the public generally understands what the proposals are. That is not to say that everyone agrees with the plans, but they generally know what is going to happen. These structural changes are often associated with extensive public information campaigns by the system itself, with advertisements through the local media and often with special flyers or signs in stations and vehicles.

Because of the advanced notice, riders are given the opportunity for input into these projects, with many naturally protesting service cutbacks or fare hikes. However, because of their familiarity with the system, many long-time riders understand why some changes are necessary. In talking to Pittsburgh bus riders about the large service cutbacks put in place in June 2007, riders were naturally unhappy with cutbacks, but generally understood that they were necessary. One woman, while lamenting that her preferred bus now "runs every two hours" after the cutbacks, realized their necessity because only two or three people used to be aboard. She modified her errands to accommodate the new schedule—finish her laundry at the Laundromat and then do other errands in town before returning home. Other riders, too, were forced to adjust their personal schedules to fit the new bus schedules, but most did so without too much grumbling. Many noted that cutbacks on Saturdays were the most difficult, likely because their activities were more varied compared to during the workweek.

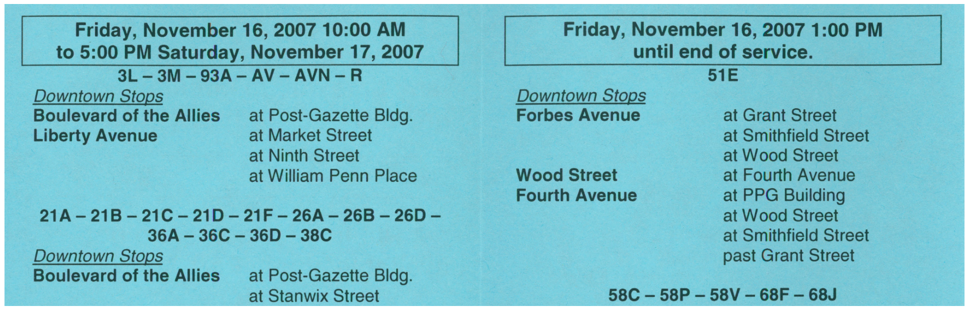
The more common type of service change is the operational change. These are the daily disruptions to the service from activities like routine maintenance on tracks or roads, congestion, weather or even parades or other events that close city streets. In these situations, riders are typically at the mercy of the system and must wait out any delays because they have little control over the situation. In some extreme cases, however, riders have been known to grow impatient with the length of delays and, ignoring crew instructions, exited subway cars and walked down the tracks to the nearest exit (Garcia & Ahmed, 2008).

The user experience during these operational changes is one of general confusion and lack of information leading to frustration. Riders waiting for a bus or train get tired of waiting with no idea of what is causing delays. Frustration builds as the wait time increases: one student got to the bus stop 10 minutes early to make sure he wouldn't miss it, but the bus was half an hour late, leaving him with 40 minutes of waiting time. Another noted one of his regular routes is chronically late or never shows up at all. He'll just "curse and wait" for the next one, which may entail a wait of 45 minutes. Sometimes he'll wander off hoping to do something productive with his time, only for the bus to return "when I'm on the other side of the street" with no way to cross back over in time.

One rider noted an apparent paradox: she could be fired for getting to work late, but what could she do if the bus she relied on was late and she had no way of knowing? Even if the bus were on time, if it's already full and just passes by without stopping, "there's not much you can do except call and say 'I'm going to be late.'" Some riders have the ability to use a vacation or sick day in these circumstances, but staying home because you couldn't get to work on time wasn't anyone's idea of a good time.

In some cases, riders identify more than one route that could take them to their destinations, though one might be more direct or involve less walking. With imperfect information while waiting, riders play a game of probability in calculating whether they think their preferred route will come before a less-optimal alternative. When they make the "wrong" decision (in this case, opting to wait for their delayed preferred route instead of taking the earlier option), their frustration turns inward to a degree, blaming themselves for choosing the optimal solution instead of satisficing. One Pittsburgh bus rider waited over an hour for a preferred route and watched two sub-optimal routes pass by on the other side of the street. "They don't follow their own schedule. Why should they tell the public to get one?" he complained, "I could've been at my destination by now!" if he had taken the other route and walked a few additional blocks at the end.

Sometimes operational service changes are known in advance, as in the case of regular maintenance or community events. However, knowing an event will be happening does not necessarily lead to advanced warning of how it will affect the public transportation system. In my own experience, my trip to New York City overlapped with the marathon race in November 2007, and I had to switch to using the subway during the race instead of the bus for a day. The race went down one of the main streets in Greenpoint, Brooklyn, so the bus route I wanted to ride was obviously not running on that street like it usually did. However, I could find no information either at the nearby subway station or any of the bus stops about



Friday, November 16, 2007 10:00 AM
to 5:00 PM Saturday, November 17, 2007

3L – 3M – 93A – AV – AVN – R

Downtown Stops

Boulevard of the Allies at Post-Gazette Bldg.

Liberty Avenue at Market Street

at Ninth Street

at William Penn Place

21A – 21B – 21C – 21D – 21F – 26A – 26B – 26D –
36A – 36C – 36D – 38C

Downtown Stops

Boulevard of the Allies at Post-Gazette Bldg.

at Stanwix Street

Friday, November 16, 2007 1:00 PM
until end of service.

51E

Downtown Stops

Forbes Avenue at Grant Street

at Smithfield Street

at Wood Street

Wood Street at Fourth Avenue

Fourth Avenue at PPG Building

at Wood Street

at Smithfield Street

past Grant Street

58C – 58P – 58V – 68F – 68J

**Figure 7**
Pittsburgh's Light Up Night service changes brochure suffers from multiple organization flaws, including overlapping main time periouds.

alternative options or whether the bus was still running on a parallel street, for example.

In the cases where notices are available for operational service changes, they frequently use language familiar only to people intimately familiar with an area, presenting great difficulty for new riders. Figure 7 shows a portion of a brochure attempting to explain how bus routes would be detoured for Pittsburgh's Light Up Night in November 2007. Explanatory text on the front panel describes how difficult it will be for a rider to accurately predict where his or her bus will be:

> There are different detours for different time periods and days. Routes may be listed in more than one time period and may have different stops during the different periods. / Detour beginning and end times shown are approximate or may change as directed by Pittsburgh Police.

The brochure is organized at the top level into five time periods, with four of the five overlapping in some way: Friday, November 16, 2007 10:00 AM to 5:00 PM Saturday, November 17, 2007; Friday, November 16, 2007 1:00 PM until end of service; Friday, November 16, 2007 From 6:00 PM until 9:00 PM; and Friday, November 16, 2007 From 6:00 PM until 9:30 PM (all text appears as in original). Within each time period, groups of bus routes (1–12 individual routes) are listed as a title, with their available downtown stops listed below.

One of the problems with this brochure, and indeed a problem with many types of public transportation system communications, is the use of language only familiar to a rider intimately familiar with the area. Without a map of the downtown area (a feature present on every individual bus route map and schedule for routes going downtown), riders see these streets as seemingly random points and will likely have difficulty navigating to the new stop. As I discussed earlier in this section, the naming of the stops can also cause confusion. For example, the 81A is listed to stop at "Liberty Avenue opposite Ninth Street." There is no indication of how this situation is different from saying "Liberty Avenue at Ninth Street" like most of the other listings.

Another problem with the brochure, due to the overlapping time period organization, is that some groups of routes are listed twice with different stops. For example, the various 61 and 71 routes are listed under the two different time periods as follows:

| **Friday, November 16, 2007<br>1:00 PM until end of service** | | **Friday, November 16, 2007<br>From 6:00 PM until 9:30 PM** | |
|---|---|---|---|
| Forbes Avenue | at Grant Street | Forbes Avenue | at Grant Street |
| | at Smithfield Street | | at Smithfield Street |
| | at Wood Street | | at Wood Street |
| Wood Street | at Fourth Avenue | Wood Street | at Fourth Avenue |
| Stanwix Street | at Forbes Avenue | Fourth Avenue | at PPG Building |
| Fifth Avenue | at Market Street | | at Wood Street |
| | at Wood Street | | at Smithfield Street |
| | at Smithfield Street | | past Grant Street |
| | at Ross Street | Forbes Avenue | at Manor Building |

Applying principles of hierarchy and organization will likely greatly improve this brochure, shifting from organization based on time periods to organization based on route numbers, like all other materials for the system are organized. Instead of the text-based listing of various stops, printing a single map to show the normal and temporary stops could benefit many riders.

Operational service change announcements can also fall into the trap of information overload, a term coined by Alvin Toffler (1970), in this case referring to an abundance of information of varying qualities, so riders need to spend a considerable effort to filter irrelevant messages. The New York City subway system had distinctive posters posted around stations noting operational service changes on a particular line that stopped at that station. Though the posters suffered from the same problem plaguing the text-heavy Pittsburgh Light Up Night brochure, they also offered specific details on how the changes would affect riders with sections labeled "How will this affect my trip?" and "Why is service being changed?” The latter heading attempts to build some rider understanding of the necessity of the repairs (and thus, the change to service), but on a survey of a dozen or more posters, the text was nearly always a variation of a standard, information-lacking sentence: “We are making track repairs to ensure that trains continue to operate safely along the N line.”

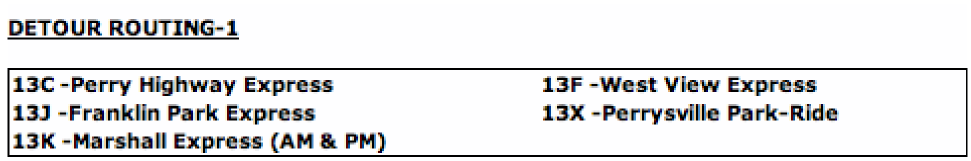
Specific details about the design of the posters helps riders to quickly determine if any apply to their trip: a top banner noting the operating period the work will occur (“Late Night” or “Weekend” for example), a large graphic symbol showing the number/letter of the subway route next to specific dates and times, and large text with a succinct message noting the change. Unfortunately, these details compete for attention when 18 signs are placed on the wall of one popular station, as I observed at Union Square station on the evening of November 3, 2007 (see Figure 8). The signs were arranged with no apparent order, often with multiple signs applying to each line for different periods of time. There are six separate posters showing changes affecting the #6 subway line, for example.

Known detours should be shown wherever route information is available, including on transit agency web sites. Pittsburgh’s Port Authority does a decent job of informing potential riders that detours exist for a particular route when they search for general or specific route information. However, the web site doesn’t go so far to tell riders what the detour is, only that it exists. Riders are presented with a screen similar to that seen in Figure 9, where the detour is labeled with a number and the affected routes are listed.

Many systems will also send press releases to local media outlets (especially newspapers) announcing detours. However, because they are typically short, they


**Figure 8**
Eighteen separate service changes posters on the wall of the Union Square subway station in New York can serve more harm than good due to their lack of organization.

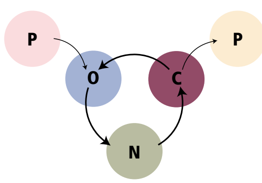
**Figure 9**
Riders are informed that detours exist for several Pittsburgh bus routes in this web site screenshot, but are not told what they actually are. [Image from Port Authority of Allegheny County, 2008]


**DETOUR ROUTING-1**

| | |
|---|---|
| 13C -Perry Highway Express | 13F -West View Express |
| 13J -Franklin Park Express | 13X -Perrysville Park-Ride |
| 13K -Marshall Express (AM & PM) | |

often get buried in the paper with lots of other short articles and announcements where many people might miss them.

When the transit systems themselves have failed to adequately serve rider needs with information about the status of the system, enterprising riders have begun to fill in the gaps, like the Clever Commute system in the greater New York area (Belson, 2007). Using their cell phones, riders can send announcements of delays, detours or other service changes they're experiencing to other subscribers. This instant peer-to-peer system is described as being "hyper-local," filling in for official announcements from the transit system that "can be too generic and occasionally arrive after problems have been resolved." In addition, riders with questions can poll the group looking for specific information about a particular route or stop. Similar to how text messaging has been used to organize demonstrators in the chaotic environment of political rallies, these types of services can offer much more useful information tailored to a person's travels.

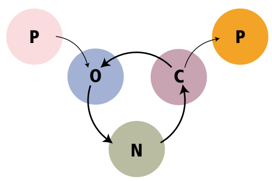



## Confirmation Phase

In the confirmation phase of the travel process, riders compare their pre-trip itineraries with the decisions they made in the navigation phase to make sure they're still following their plans to arrive at their destinations. In addition, riders unfamiliar with an area will often try to confirm that their travel plan will get them to their destinations.

A common task during the confirmation phase is determining the current status at the bus stop or on the subway platform when first approaching. A rider might see a bus leave the stop before he or she arrives, but not be able to tell what route it is, for example. Especially if they're running slightly behind schedule, riders want to know if they've missed the bus or train they were hoping to board. To this end, many buses and trains display the route number in a panel on the back of the vehicle in addition to the front and sides. While this helped people when they were fairly close to the vehicle, the sign on the back of the vehicle is frequently smaller than the sign on the front, reducing the legibility distance. If you're looking at the back of a bus, the bus is necessarily moving away from you, so the route number will be getting smaller as the distance increases. Bus riders wished that the route number on the back were even larger than on the front so they could read it for a longer period of time. This would help them decide more quickly if they should chase after a bus that just pulled away from the stop or wait for the next one, hoping that it wouldn't take too long to arrive.

Many of the same devices and information needs that apply to the orientation and navigation phases are also useful during the confirmation phase. Riders can compare consecutive stops listed on an electronic display or announced over the PA system with a map or diagram of the route or entire system to verify that they're heading in the correct direction.




## Post-Trip Phase

During the post-trip phase, riders leave the transit system and move back into the city environment. This transition occurs in a liminal, or threshold, space that is fraught with confusion and unease. Problems successfully making this transition and reorienting oneself to the city environment are especially prevalent with subway riders because of their lack of street visibility when underground. My own observations and interviews with subway riders support reports in the popular media of subway riders walking up the stairs to exit the station, walking halfway down the block in one direction, and turning around because they realized they were going the wrong way (Barron, 2007). This disorientation is especially problematic with subway stations that have multiple exits coming up on all four corners of an intersection and affects visitors and local residents alike.

To help bring order to this liminal space, riders require information about how the stop or station fits in to the local neighborhood. This could take the form of neighborhood maps, signs showing nearby streets or directions to frequent/important places (hospitals, grocery stores, parks, etc.). Some systems have taken steps to help with this transition. New York is experimenting with sidewalk decals outside of a few exits from Grand Central Station that show the streets in each cardinal direction (Barron, 2007). Other New York subway stations often have neighborhood maps showing the subway station and the surrounding few blocks. While helpful, one rider said she would've preferred these maps to be located closer to the actual exits (stairs to the street) than near the turnstiles in the middle of the mezzanine. Paris mounts these neighborhood maps on the sidewalks outside the station exits, right where they're most needed.

One reader reacting to the Grand Central Station decals on the New York Times web site lauds Hong Kong's subway system (the MTR). She wrote:

> All exits at an MTR stop are identified by a letter, and there are signs right down by the tracks—and periodically as you work your way up to the street—that tell you what's at each exit. As you get closer to the exit, the signs get more specific, to the point that you know exactly what key locations are at each exit (Mary, 2007).

Using signs or other devices at eye-level certainly offers an advantage to something on the ground that could get lost in crowded environments, but something is generally better than nothing.

For bus riders, re-orientation is slightly easier as they have remained on the surface in the city's street system. Even so, bus riders mentioned difficulties seeing the street signs at the next block to determine how they were oriented. Some bus shelters in the Center City District of Philadelphia help to solve this problem as part of a pilot signage program extending the city's pedestrian wayfinding system. The shelters have neighborhood maps giving riders quick visual clues on their current orientation and to other bus routes in the area (see Figure 10). These types of neighborhood maps are also useful during the orientation and navigation phases in helping riders determine where they are and what alternate transportation options are available nearby.

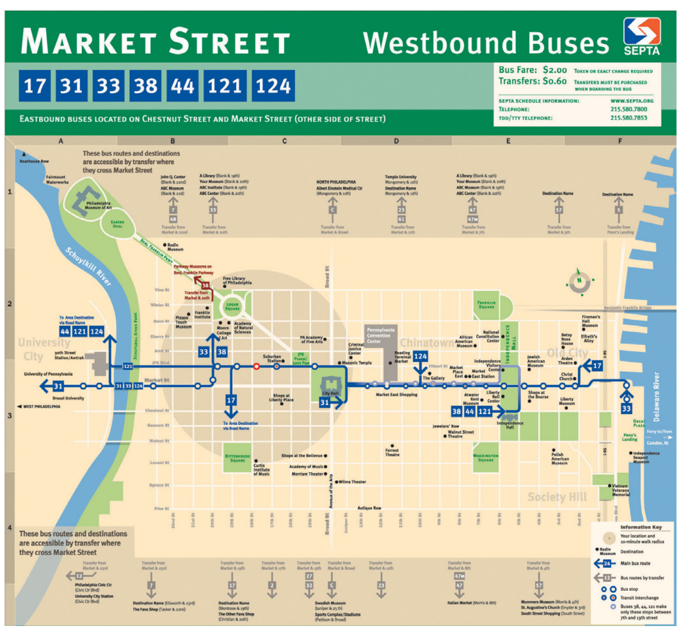



**Figure 10**
Maps at bus shelters of the surrounding area, including major attractions and other transportation routes, can help riders orient themselves, as in this pilot program in Philadelphia.
[Design 2005 by Joel Katz Design Associates (Designers: William Bardel & Joel Katz)]

# 4 Printed Artifacts

## Artifact Categories

The 410 printed artifacts I collected can be grouped into eight categories: system maps, pocket maps, individual or combined route maps and schedules, area maps, system-wide timetable books, announcements for service changes, special events services, and general informational brochures. Each of these artifact categories attempts to solve particular information needs, though some do it more successfully than others. This section will describe these artifacts, analyze some of their physical characteristics and show how they assist or hinder a rider attempting to make sense of the system or the city.

### System Map

The artifact that is most common to all systems is the system map, showing a general overview of all the routes in the system and the territory they cover. All systems except for the Port Authority of Allegheny County in Pittsburgh had system maps available. The level of detail in these maps generally depends on the type of system, with subway system maps generally having fewer details in a more abstract form than bus system maps, which usually show additional surface roads and features.

The system map answers the question, “Where can I go?” for riders. Riders can learn what areas of the region are not accessible by public transportation. For people new to an area or those considering moving into a new area, the system map can help orient them to the city. For people without other means of transportation, access to public transit can be a key factor in a housing decision.

The system map also begins to answer the question “How do I get there?” for riders who have a specific destination. Because the system map shows all the routes in the system, a rider can identify all the possible routes he or she might be able to take on a trip. Knowing about alternative routes can greatly assist riders if they have to adjust their trip because of service changes, detours and delays that are a normal part of any complex system. Once a rider has identified a route or combination of routes that will get him to his destination, he can move to the more detailed route maps and schedules to determine the specific logistics of his travel. Because system maps are generally quite large, they can be cumbersome to use during a trip, however.

### Pocket Map

A pocket map is, in most cases, a specialized version of the system map. In essence, it shows the entire system in a pocket-sized format instead of a large fold-out map. It is generally only seen in subway or other rail systems because of trade-offs between physical size and level of detail. In addition to the system map, pocket maps typically have listings of the closest stations to major tourist attractions. In this way, the pocket map is designed to be used during travel, with extra support for riders unfamiliar with the city and the system.

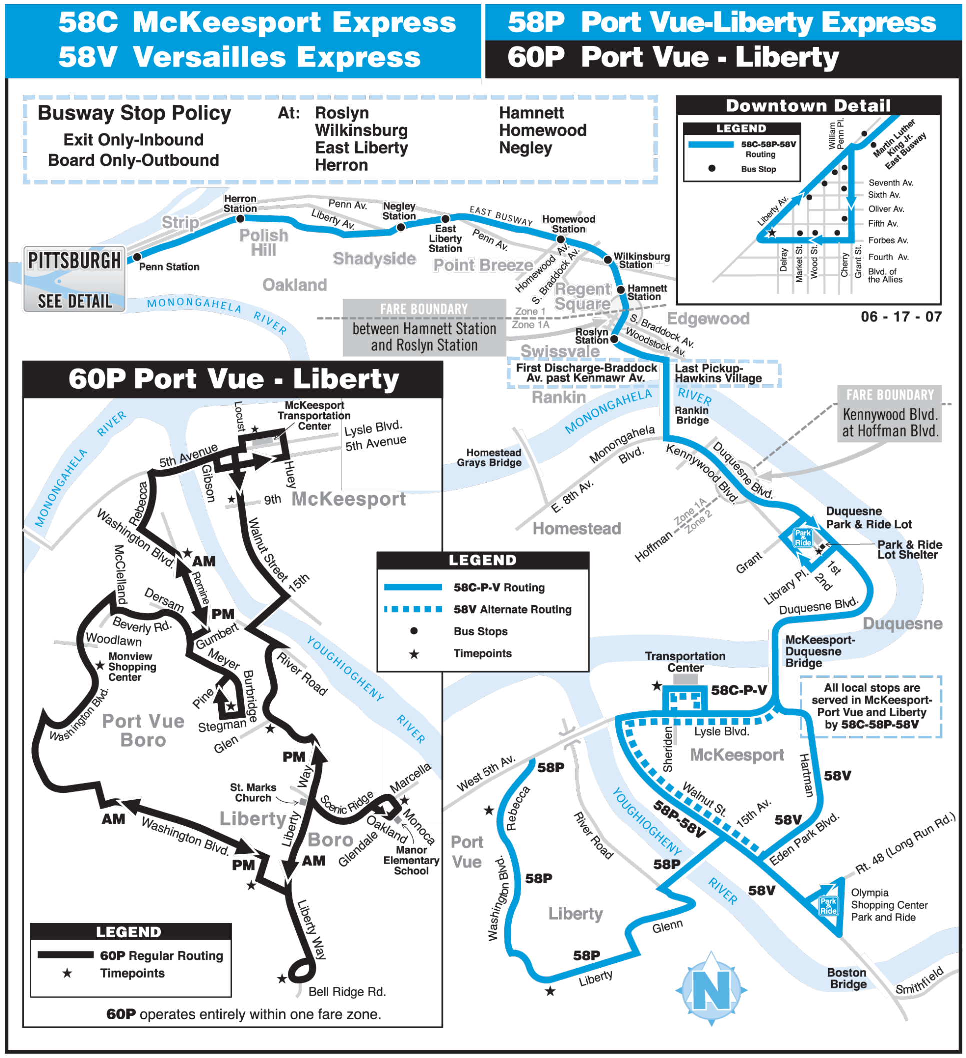
### Route map and schedule

Next to the system map, route maps and timetables are the most commonly available information documents. Route maps and timetables can each take two forms: the maps most commonly show a single route, but some systems combine multiple routes serving similar areas in a single map pamphlet; the schedule can show absolute departure times from certain way-points along the route (e.g. 2:36 PM), or it can show relative departure times for all stops along the route (e.g. every 7 minutes). Hybrid forms of the schedule show absolute times for certain periods of the day (primarily non-rush hour) and relative times for the remaining periods. The map can complement a schedule showing relative departure times by marking the average elapsed time for different segments of the route.

Route maps show more detail for an individual route than the system map, generally showing exactly which streets a bus travels on, for example. For non-local routes, where there are long stretches with no stopping, the transition between local service and non-local service is noted with text or line styles, or individual stops will be marked in a different manner. Route maps also have more flexibility to show detail for certain areas where stops need to be clearly defined, such as in large shopping mall parking lots or in downtown areas.

Combined route maps show multiple routes on one map, typically routes serving the same general geographic area. These maps are typically only seen in bus systems and can be useful ways of conserving paper and reducing the number of pamphlets needed to be kept in stock. However, when too many routes are too loosely combined into one document, the differences in their geographical

**Figure 11**
This Pittsburgh route schedule pamphlet has information about 6 different bus routes, including three separate maps juxtaposed on top of each other with different, though omitted, scales.



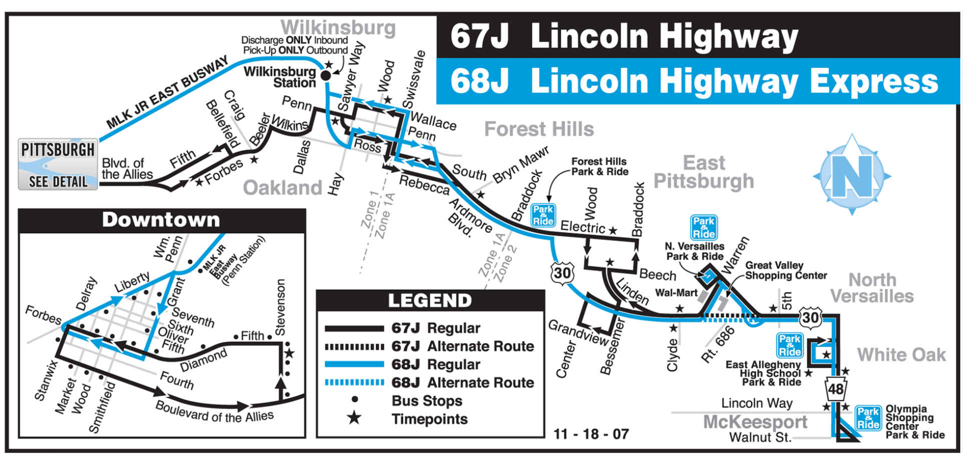
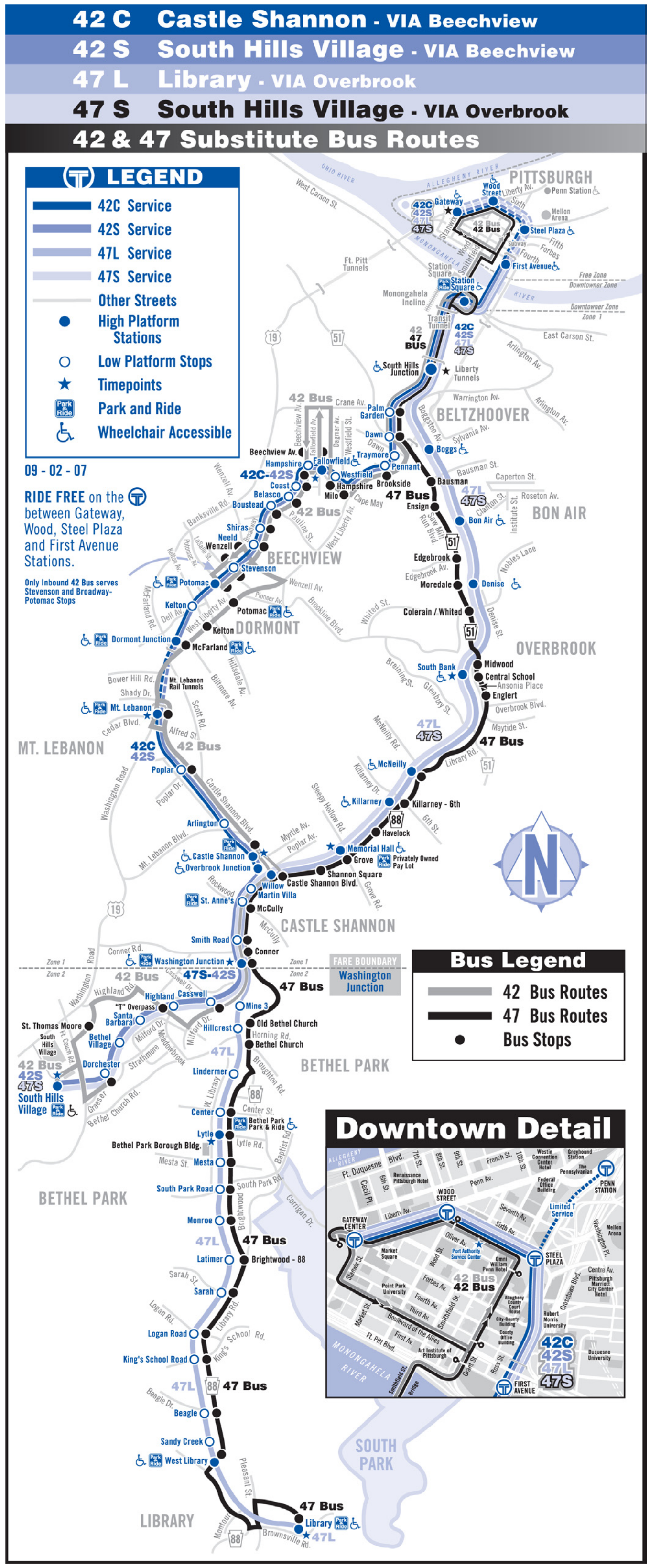



**Figure 12**
The Port Authority of Allegheny County pamphlets for 42C, 42S, 47L and 47S routes and "42 & 47 Substitute bus routes" shows routes on the map that do not have corresponding scheules in the pamphlet. The map is further complicated by the close color tints needed to distinguish the four light rail routes.



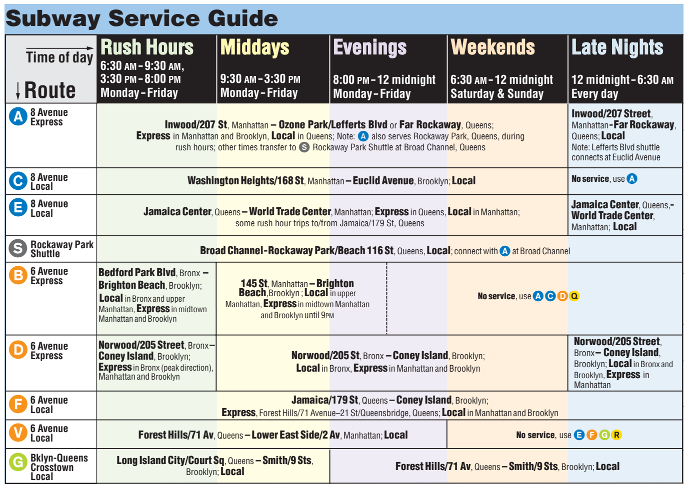
coverage often necessitate the need for separate maps within the same document because of problems with scale. For example, the Port Authority of Allegheny County's combined map for routes 58C, 58P, 58V, 60P, 67J, and 68J contains three separate maps to cover the six routes (see Figure 11). Along with differences in scale, the separate maps are also juxtaposed next to or inside each other, creating a very confusing visual image. In addition, for this specific example, the 60P route is identified in two locations on the left-hand panel: once on the inset where its actual route map is and once on the larger map where it is not shown at all.

Another example of a potentially problematic combined route map is with the Port Authority's maps for its light rail routes: 42C, 42S, 47L, and 47S (see Figure 12). The four light rail routes are split up into 2 map pamphlets: the 42C with the 42S, and the 47L with the 47S. However, both pamphlets contain the same map showing all four routes. In addition, the 42 and 47 substitute bus routes are shown on the same map, though there is no explanation of what these routes are, nor is there another pamphlet just for these buses. While the argument could be made that the same map is used here because the four light rail routes are unique in the system and riders might want to know all of their options since the routes cover similar areas, a more powerful argument could be made that you shouldn't show a map of a route that doesn't have a corresponding schedule in that pamphlet. If all the light rail routes should be combined on one map, then their schedules should all appear there too. Because five routes are being shown on a single map printed with two inks, four different tints of blue are used to distinguish the light rail routes, resulting in only slight differences between the four routes.

Shifting our focus to the schedules in these pamphlets, most routes operate with at least three different schedules: weekday (Monday–Friday) service, Saturday service, and Sunday service. The Sunday schedule is frequently used for holiday service as well. Some routes, such as the subways in New York City, operate with different schedules based on both day and time of day (see Figure 13). Weekdays have rush hour, midday, and evening service schedules, Saturday and Sunday times in those three time periods are grouped together in a weekend schedule, and every day shares the same late night schedule.

For routes with frequent service, a table of departure times from various points along the route can quickly become overwhelming, especially when considering how many different schedules might be required for opposite directions and multiple time periods. When the data require too much space to display as regular times, some systems convert to showing the frequency of service for different

**Figure 13**
New York City Subway Service Guide divides the week into distinct periods allowing for different service based on demand



**Subway Service Guide**

| Time of day → / ↓ Route | Rush Hours 6:30 AM–9:30 AM, 3:30 PM–8:00 PM Monday–Friday | Middays 9:30 AM–3:30 PM Monday–Friday | Evenings 8:00 PM–12 midnight Monday–Friday | Weekends 6:30 AM–12 midnight Saturday & Sunday | Late Nights 12 midnight–6:30 AM Every day |
|---|---|---|---|---|---|
| A 8 Avenue Express | **Inwood/207 St**, Manhattan – **Ozone Park/Lefferts Blvd** or **Far Rockaway**, Queens; **Express** in Manhattan and Brooklyn, **Local** in Queens; Note: A also serves Rockaway Park, Queens, during rush hours; other times transfer to S Rockaway Park Shuttle at Broad Channel, Queens | | | | **Inwood/207 Street**, Manhattan–**Far Rockaway**, Queens; **Local** Note: Lefferts Blvd shuttle connects at Euclid Avenue |
| C 8 Avenue Local | **Washington Heights/168 St**, Manhattan – **Euclid Avenue**, Brooklyn; **Local** | | | | **No service**, use A |
| E 8 Avenue Local | **Jamaica Center**, Queens – **World Trade Center**, Manhattan; **Express** in Queens, **Local** in Manhattan; some rush hour trips to/from Jamaica/179 St, Queens | | | | **Jamaica Center**, Queens,- **World Trade Center**, Manhattan; **Local** |
| S Rockaway Park Shuttle | **Broad Channel-Rockaway Park/Beach 116 St**, Queens, **Local**; connect with A at Broad Channel | | | | |
| B 6 Avenue Express | **Bedford Park Blvd**, Bronx – **Brighton Beach**, Brooklyn; **Local** in Bronx and upper Manhattan, **Express** in midtown Manhattan and Brooklyn | **145 St**, Manhattan – **Brighton Beach**, Brooklyn; **Local** in upper Manhattan, **Express** in midtown Manhattan and Brooklyn until 9PM | | **No service**, use A C D Q | |
| D 6 Avenue Express | **Norwood/205 Street**, Bronx– **Coney Island**, Brooklyn; **Express** in Bronx (peak direction), Manhattan and Brooklyn | **Norwood/205 St**, Bronx – **Coney Island**, Brooklyn; **Local** in Bronx, **Express** in Manhattan and Brooklyn | | | **Norwood/205 Street**, Bronx– **Coney Island**, Brooklyn; **Local** in Bronx and Brooklyn, **Express** in Manhattan |
| F 6 Avenue Local | **Jamaica/179 St**, Queens – **Coney Island**, Brooklyn; **Express**, Forest Hills/71 Avenue–21 St/Queensbridge, Queens; **Local** in Manhattan and Brooklyn | | | | |
| V 6 Avenue Local | **Forest Hills/71 Av**, Queens – **Lower East Side/2 Av**, Manhattan; **Local** | | | **No service**, use E F G R | |
| G Bklyn-Queens Crosstown Local | **Long Island City/Court Sq**, Queens – **Smith/9 Sts**, Brooklyn; **Local** | | **Forest Hills/71 Av**, Queens – **Smith/9 Sts**, Brooklyn; **Local** | | |

periods in the day. The large reduction in page area needed to just show service frequencies allows the pamphlet and schedule to use a smaller paper size. An additional feature to some frequency of service schedules are elapsed time markers on the map, showing how long it takes to go from station to station. These elapsed time markers help make up for the information riders can calculate from absolute time schedules, but that is missing from the relative schedules. A few systems include a table showing elapsed time from any station on the route to any other station on the route.

The schedule can get complicated quickly when multiple routes from a combined map are shown in the same table of absolute times. Here, additional information and coding is required to differentiate the different lines. In the example from Washington, DC in Figure 14, each line is prefaced with a route number, shown in bold type. Since not all routes travel to the same stations at the eastern end of the routes, many spaces in the table are left blank. A rider looking for a bus at a particular time would have to find the stop location at the top, follow down to find the desired time, and then follow to the left to determine what route would be arriving, a cumbersome three-step process. Riders in Pittsburgh using a similar schedule reported getting frustrated when they were traveling from one of the stops served by all routes to one of the outlying areas served by a single route. One rider said she would "get excited" when she saw a nearby time listed for the stop where she would board the bus, but then was "let down" when she discovered it wasn't the route she wanted, meaning she would have to wait longer.

Figure 14 also shows an example of the necessary coding in a schedule to identify non-standard trips along the route. The square and circle are defined later on the

**Figure 14**
Showing multiple routes on the same schedule, as in this example from Washington, DC, requires riders to complete an additional step to determine when their bus will arrive.

## Weekday Eastbound —
### Entre semana con dirección al este

| Route Number | Friend-ship Heights M | Wiscon-sin Ave. & Albe-marle St. NW (Tenley-town-AU) M | Wiscon-sin & Cathe-dral Aves. NW (Massa-chusetts Ave.) | M St. & Wiscon-sin Ave. NW (George-town) | H St. & Jackson Pl. NW (Lafay-ette Square) | Pennsyl-vania Ave. & 7th St. NW (AR-CHIVES-Navy Mem'l-Penn Quarter) M | Pennsyl-vania Ave. & 8th St. SE (Eastern Market) M | Pennsyl-vania & Potomac Aves. SE (Potomac Ave) M | Naylor Rd. & Alabama Ave. SE | Pennsyl-vania & Branch Aves. SE | 31st & Gaines-ville Sts. SE (Hill-crest) | NAYLOR ROAD M | SOUTH-ERN AVE M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AM Service — Servicio matutino** | | | | | | | | | | | | | |
| **30/** | - | ■8:52 | 9:01 | 9:13 | 9:25 | 9:34 | - | - | - | - | - | - | - |
| **30/** | 8:48 | 8:56 | 9:05 | 9:17 | 9:29 | 9:38 | - | - | - | - | - | - | - |
| **34** | 8:53 | 9:01 | 9:10 | 9:22 | 9:34 | 9:43 | 9:56 | 9:59 | 10:08 | - | - | 10:15 | - |
| **30/** | - | ●9:03 | 9:12 | 9:24 | 9:36 | 9:45 | - | - | - | - | - | - | - |
| **32** | 8:59 | 9:07 | 9:16 | 9:28 | 9:40 | 9:49 | 10:02 | 10:05 | 10:14 | - | - | - | 10:24 |
| **30/** | 9:05 | 9:13 | 9:22 | 9:34 | 9:46 | 9:55 | - | - | - | - | - | - | - |
| **35** | 9:11 | 9:19 | 9:28 | 9:41 | 9:53 | 10:04 | 10:14 | 10:17 | - | 10:26 | - | 10:35 | - |
| **34** | 9:18 | 9:26 | 9:35 | 9:48 | 10:00 | 10:11 | 10:21 | 10:24 | 10:33 | - | - | 10:40 | - |
| **32** | 9:25 | 9:33 | 9:42 | 9:55 | 10:07 | 10:18 | 10:28 | 10:31 | 10:40 | - | - | - | 10:51 |
| **35** | 9:34 | 9:42 | 9:51 | 10:04 | 10:16 | 10:27 | 10:37 | 10:40 | - | 10:49 | - | 10:58 | - |
| **34** | 9:43 | 9:51 | 10:00 | 10:13 | 10:25 | 10:36 | 10:46 | 10:49 | 10:58 | - | - | 11:05 | - |
| **32** | 9:52 | 10:00 | 10:09 | 10:22 | 10:34 | 10:45 | 10:55 | 10:58 | 11:07 | - | - | - | 11:18 |
| **35** | 10:01 | 10:09 | 10:18 | 10:31 | 10:43 | 10:54 | 11:04 | 11:07 | - | 11:16 | - | 11:25 | - |
| **34** | 10:10 | 10:18 | 10:27 | 10:40 | 10:52 | 11:03 | 11:13 | 11:16 | 11:25 | - | - | 11:32 | - |
| **32** | 10:18 | 10:26 | 10:35 | 10:48 | 11:00 | 11:11 | 11:21 | 11:24 | 11:33 | - | - | - | 11:44 |
| **35** | 10:27 | 10:35 | 10:44 | 10:57 | 11:09 | 11:20 | 11:30 | 11:33 | - | 11:42 | - | 11:51 | - |
| **34** | 10:36 | 10:44 | 10:53 | 11:06 | 11:18 | 11:29 | 11:39 | 11:42 | 11:51 | - | - | 11:58 | - |
| **32** | 10:45 | 10:53 | 11:02 | 11:15 | 11:27 | 11:38 | 11:48 | 11:51 | 12:00 | - | - | - | 12:11 |
| **36** | 10:54 | 11:02 | 11:11 | 11:24 | 11:36 | 11:47 | 11:57 | 12:00 | - | 12:09 | 12:15 | 12:19 | - |
| **34** | 11:03 | 11:11 | 11:20 | 11:33 | 11:45 | 11:56 | 12:06 | 12:09 | 12:18 | - | - | 12:25 | - |
| **32** | 11:11 | 11:19 | 11:28 | 11:41 | 11:53 | 12:04 | 12:14 | 12:17 | 12:26 | - | - | - | 12:37 |
| **36** | 11:20 | 11:28 | 11:37 | 11:50 | 12:02 | 12:13 | 12:23 | 12:26 | - | 12:35 | 12:41 | 12:45 | - |
| **34** | 11:29 | 11:37 | 11:46 | 11:59 | 12:11 | 12:22 | 12:32 | 12:35 | 12:44 | - | - | 12:51 | - |
| **32** | 11:37 | 11:45 | 11:54 | 12:07 | 12:19 | 12:30 | 12:40 | 12:43 | 12:52 | - | - | - | 1:03 |
| **36** | 11:46 | 11:54 | 12:03 | 12:16 | 12:28 | 12:39 | 12:49 | 12:52 | - | 1:01 | 1:07 | 1:11 | - |
| **34** | 11:55 | 12:03 | 12:12 | 12:25 | 12:37 | 12:48 | 12:58 | 1:01 | 1:10 | - | - | 1:17 | - |

■ — *Trip originates at Fort Dr. & Albermarle St. NW(Tenleytown-AU Station) one minute prior to time shown and operates only when public school is open.*
*El recorrido comienza en las calles Fort Dr. y Albermarle St. NW (estación Tenleytown-AU) un minuto antes de la hora indicada y se realiza solamente cuando están abiertas las escuelas públicas.*

● — *Trip originates at Fort Dr. & Albemarle St. NW (Tenleytown-AU Station) one minute prior to time shown.*
*El recorrido comienza en las calles Fort Dr. y Albemarle St. NW (estación Tenleytown-AU) un minuto antes de la hora indicada.*

page to identify special starting points for those trips, leaving one minute prior to the first time shown.

### Area map

An area map is used to show all routes passing through a particular area. Though relatively uncommon, it can be useful in consolidating information about routes with very different end destinations that all pass through the same territory at some point. Area maps are also useful where there is a convergence of many routes, such as in a downtown area, with each route taking a slightly different path through the area. They are more often seen in stations or at bus shelters than they are as printed pamphlets. Since these maps are in the minority, they will not be further considered in this paper.

### Timetable book

Two systems in my sample, Valley Metro in Phoenix and HART in Tampa, used combined timetable books instead of (or possibly in addition to) individual route maps. These books contained route maps and schedules for all bus routes in the system. These books can be very helpful when planning a trip, as you don't need to unfold multiple individual schedules or make sure you brought the right schedule. In addition, having a single publication with every route eliminates the need to keep individual maps stocked at information kiosks. The drawbacks are a likely greater cost of production per unit and larger and heavier physical size than a single route pamphlet. But in the form of a book, it might be treated differently (with more care) than a map would. A specific comparison study of the effectiveness of the book versus the individual schedule would help to verify some of these claims. Since these books are a minority in the collection, they will not be further considered in this paper.

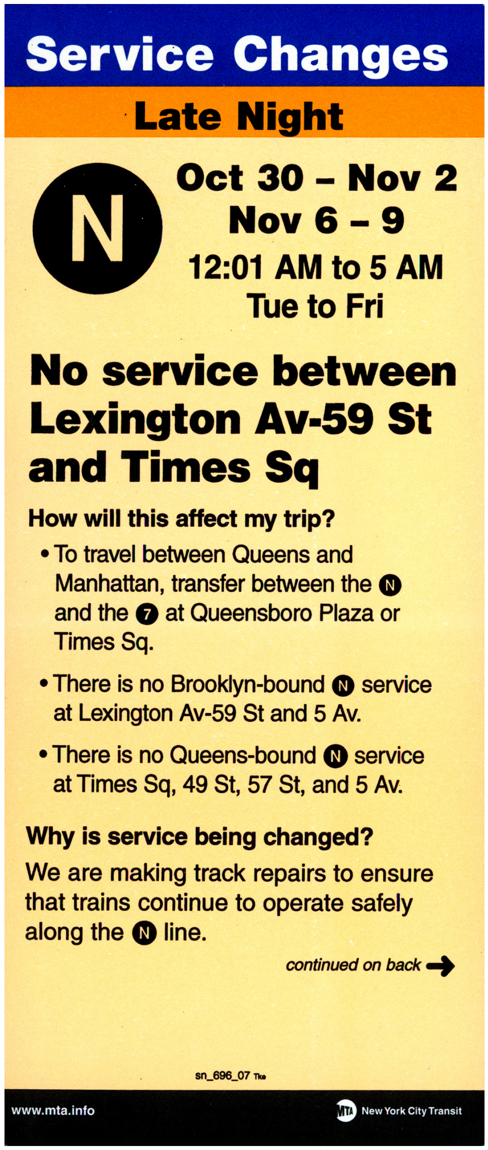
### Service changes

Most systems also provide some form of notification about future disruptions or changes to the service. These could take the form of posters at stops, shelters, or stations, or pamphlets distributed with the other maps and schedules. They include detours due to city events like parades that close streets to buses, stop closures or rerouting due to construction or line maintenance, or advanced notice of upcoming major service reductions with more long-term implications. These documents are generally only available in person, so I am limited to examples from Chicago, Denver, New York, Philadelphia and Pittsburgh. But because of their importance to a successful trip, they will be included as part of the overall passenger information system. Figure 15 shows an example of a brochure service changes notice provided in the New York City subway.

### Special event service

Cities with professional sports teams will frequently run special routes right to the station on game days. These routes typically have a similar route pamphlet to regular bus routes, often with the team's logo or other sporting image on the front cover. Only two examples were found, in Denver and in Pittsburgh at the time of the study. With such a small sample, these documents will not be further discussed.

**Figure 15**
This New York City service changes brochure describes a service outage along the N subway line. The back of the brochure (not pictured) offers detour options for specific destinations.




### General information brochure

All systems publish various documents intended to help riders become familiar with the system. Geared towards first-time riders, these booklets often describe the rules for riders, the proper method of payment, the procedure for signaling for a stop, and the various accommodations for people with disabilities. Other pamphlets are intended for commuters to the workplace and describe various incentive programs the systems may have to provide discounts or special programs for regular transit commuters. While these documents are important, especially for first-time riders, they are beyond the scope of this study.

## Physical Analysis

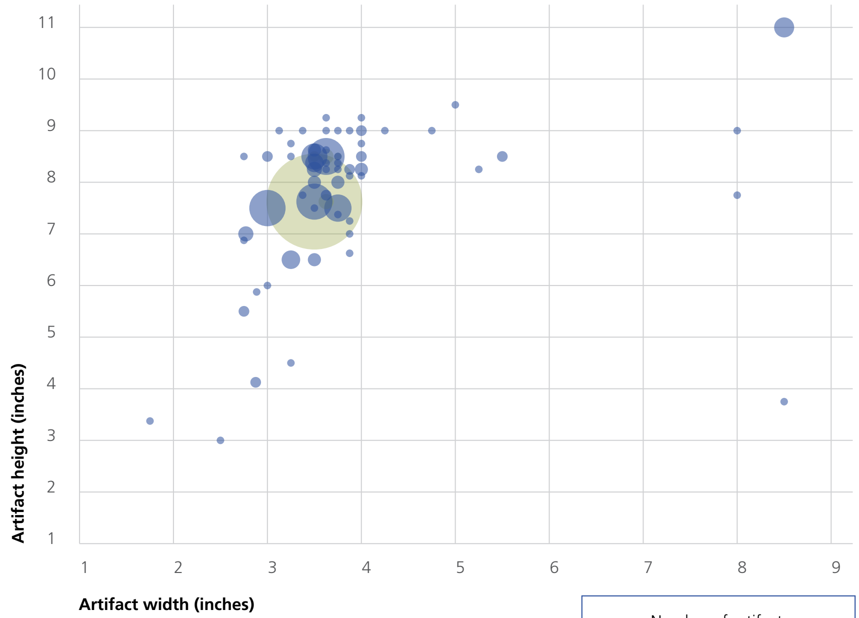
Artifacts such as these maps and schedules were created and distributed by public transportation systems so passengers would use them to understand the transit system. To gauge their effectiveness, I will evaluate them with respect to their physical characteristics, content, and design. For this evaluation, a subset of 363 artifacts was used, omitting artifacts that provided more general information (such as "How to ride the bus") in favor of artifacts providing specific information like the above-mentioned maps and schedules. As mentioned earlier, this is a convenience sample of artifacts with a comprehensive set of Pittsburgh route maps. The Pittsburgh data is shown in the graphs in a contrasting color. Unless the Pittsburgh data had a large impact, all statistics include the entire set of artifacts.

The physical characteristics of these artifacts are important because they are physical documents that get used in a variety of different contexts. A four-foot wide system map would be much easier to use when laid out over a kitchen table at home, preparing for your trip, than it would be in a crowded subway car. A map with a shiny surface would reflect glare in the summer sunlight much more than one with a plain surface. A map printed in full process colors is likely to be much more expensive than a simpler black and white map would be, but could also be more usable because of an added dimension (color) to distinguish different types of information. For these artifacts, I will examine: physical size when folded and when open, number of panels, folding patterns, paper selection, and printing technique with respect to the number of colors used.

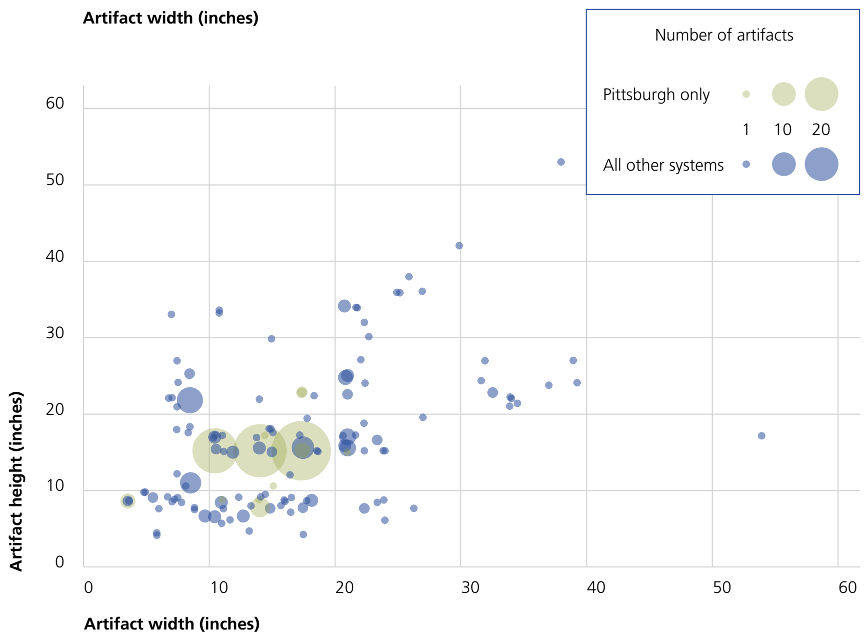
### Physical Size

Beginning the physical analysis with the size of the artifact when it is fully folded (see Figure 16, top), we can see that most documents fold to between three and four inches wide and between seven and nine inches tall. A few outliers on the right are letter-sized paper either tri-folded or not folded at all. With two exceptions, all of the artifacts smaller than 6″ × 4″ are pocket system maps. A large number of documents are 8½″ tall (a standard US paper size) or just slightly smaller after taking trimming into account. With only one exception, all artifacts are taller than they are wide. The weighted average size for the collection is 7.79″ × 3.64″. At these sizes, the artifacts are small enough to be carried fairly easily in pockets, purses, notebooks and backpacks and fit easily in standard pamphlet holders.

**Figure 16**
Physical size of artifacts when folded.

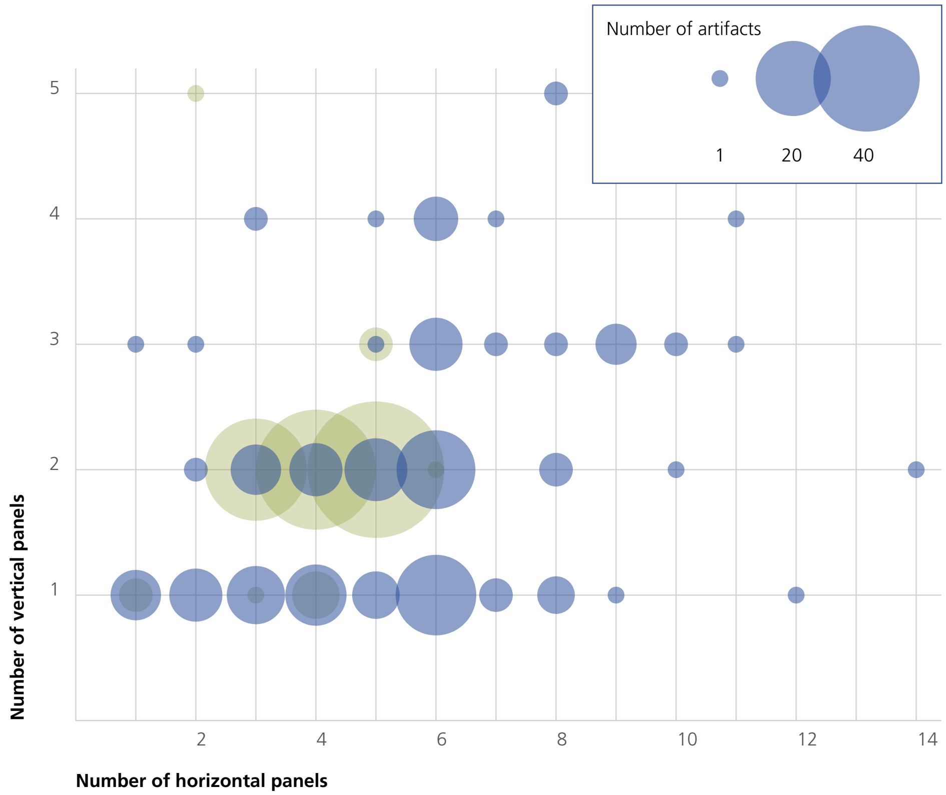



Physical size of artifacts when unfolded.




The field becomes much more varied when we unfold these artifacts (see Figure 16, bottom). A large majority of the objects, 88% (78% without Pittsburgh), are less than two feet square. A larger percentage is less than two feet in a single direction (90% in height, 94% in width). At these sizes, the document is small enough that it generally does not exceed a person's body width, making it fairly easy to use in semi-confined spaces. There is only a slight difference in the distribution between vertical and horizontal orientation, at 55% and 44% (51% and 49% without Pittsburgh), respectively (the remainder are square).

**Figure 17**
Horizontal and vertical panel arrangement of artifacts. The green circles distinguish the route maps from Pittsburgh from the rest of the artifacts.




## Folding

The more interesting discussion related to these sizes is how the artifacts are folded, as shown in Figure 17. On average, the artifacts contain 4.7 horizontal panels (counted based on the direction of orientation of the artifact when folded) and 1.9 vertical panels. While almost all (96%) of the artifacts have multiple horizontal panels, only 72% have multiple vertical panels.

The artifacts use a variety of folding styles depending on the number of panels, with these folding styles greatly affecting the ease with which the document can be opened. Multiple folds on a sheet can be parallel or at right angles to each other. Artifacts with panels only in one direction (typically only horizontal panels) have the simplest folding patterns with just parallel folds. Artifacts with three panels are typically folded like a brochure, with the two outer panels folded across the center panel. With four panels, the artifact is typically folded in half twice, along the same axis. Once past four panels in one direction, the most common fold is the accordion fold, which can accommodate any number of panels because they just keep stacking on top of each other. This stacking behavior is beneficial for users because they can only open that part of the map that they need to use at any particular time. Visual examples of these folds are shown in Figure 18.

**Figure 18**
The folding pattern of an artifact can make it easy or more difficult to use. From left, the pamphlet, nested, accordion and double-nested folds.

**Figure 19**
Complicated folds make some artifacts difficult to use. MARTA rail maps (left) use a triple-nested folding pattern with parallel folds. The Chicago Route 19 bus map (right) has one panel folded in the opposite direction to form a cover.

When the artifact expands with panels in two dimensions, the folding typically becomes slightly more complex, with two sets of folds at right angles to each other. For most artifacts where this applies, the secondary fold (the direction with fewer panels) is just a single fold or a pamphlet fold for two or three panels, respectively. Based on the number of panels, the primary fold (the direction with more panels) is typically a nested, double-nested, or accordion fold.

Most of the more unusual folding arrangements involving several layers of nesting or tucking panels in a particular order were needlessly complex and I found that they hindered my ability to effectively use the document. For example, the two rail lines maps from the Metropolitan Atlanta Rapid Transit Authority (MARTA) both had 8 horizontal panels. Most artifacts of this arrangement use an accordion fold, allowing the document to be opened with one motion. These maps use a complicated triple-nested folding pattern that requires three separate unfolding actions to view the entire map (see Figure 19).

A route map by Miami-Dade Transit for the Little Havana Circulator Route 208 only has 6 × 2 panels, but with three groups of right-angle folds, it is needlessly complicated to unfold. First, the user unfolds a three-panel horizontal pamphlet fold, revealing an area of 3 panels across. Then, the user flips up the top half, giving an area of 3 × 2 panels showing. Finally, the user can unfold the single three-panel nested fold revealing the full 6 × 2 panel area.

Finally, the Route 19 bus map from the Chicago Transit Authority (CTA), at only five panels across, doesn't sound too daunting. However, instead of being folded in a straight accordion pattern that would be the easiest to use, the map has four panels folded in the accordion pattern with the fifth in the opposite direction, forming a cover for the booklet (see Figure 19).

A relatively new innovation in map folding could help eliminate the problems with refolding the map the correct way. Drawn from research in the deployment of large solar sails and antennas, the developable double corrugation surface, known commonly as *Miura-ori* folding, can be unfolded and folded automatically by pulling on opposite corners of the map. Instead of folds on regular right angles, folds in *Miura-ori* are about 2–6° off from right angles, limiting their movement to a single prescribed direction. Thus, the folds can't be accidently turned inside out and are less likely to tear than conventional right angled folds. This folding method has been known in traditional origami areas for a number of years, but mass production for commercial interests just recently became feasible (Miura, 2002).

### Colors

One of the primary expenses in printing is the number and type of inks used. For many systems looking to reduce costs, reducing the number of inks on their maps and schedules is viewed as an acceptable cost-cutting area. Table 2 shows the distribution of the number of colors (inks) within the artifacts. These figures are likely highly biased from the overwhelming number of artifacts from Pittsburgh that are printed with two colors. Removing these, the distribution between CMYK, 1 and 2 colors is more even, at 38%, 23%, and 32%, respectively. The most popular single colors are black and blue. When two colors are used, typically black is added with another color such as blue or red.

Breaking these numbers down to analyze the documents by type (see Table 3), we can see that one- and two-color artifacts are primarily route maps (19% and 26% of the total, respectively), with most of the full-color going to system maps (18%). None of the system maps are printed in less than four colors, most likely because the designers needed to use color to distinguish the many different routes from one another.

**Table 2**
Distribution of artifacts by their number of colors

| Number of colors | Percent of artifacts |
|---|---|
| CMYK | 21 |
| 1 | 13 |
| 2 | 63 |
| 3+ (not including CMYK) | 3 |

**Table 3**
Number of artifacts in each color category, by artifact type.

| | CMYK | 1 color | 2 colors | 3+ colors |
|---|---|---|---|---|
| System map | 35 | | | 4 |
| Pocket map | 8 | | | |
| Route map | 17 | 39 | 212 | 7 |
| Special area map | 12 | 1 | 4 | |
| Timetable | | 1 | 11 | |
| Service changes flyer | | 6 | | 3 |
| Other | 3 | | | |

Problems can arise on combined route maps using a limited color palette when all (or many) of the routes described in the document are shown on a single map. Looking back at Figure 12 showing light rail routes in Pittsburgh, two ink colors attempted to distinguish between six different routes, primarily using four different tints of blue for the rail routes and showing the two bus routes with two tints of black. The four blue tints quickly become difficult to distinguish in low lighting conditions, with the lightest tint used on the 47S route fading almost to white and requiring a different text color than the others.

### Paper Type

The type of paper used to print the artifact is also a key factor in how it is used. As with reducing the number of colors, reducing the quality of the paper can also save costs at the expense of longevity and ease of use of the artifact. Paper grade and quality were estimated based on experience and comparison to known paper types. The most common type of paper used was standard 20 lb. bond paper, used in about 71% of the artifacts (including most of the artifacts from Pittsburgh). Complete results are listed in Table 4.

The bond paper has the advantage of lower reflectivity, making it easier to read in various lighting conditions. However, the glossy paper gives a feel of greater professionalism and often is more accurate when reproducing color. When comparing paper type to color usage, the glossy paper was only used for full color artifacts (mostly the system maps), though full color was used on all the major paper types.

The folding pattern also should be considered when selecting a paper type. A complex folding pattern with multiple right-angle folds should not use a

**Table 4**
Distribution of artifacts by paper type and weight.

| Paper type and weight | Percent of artifacts |
|---|---|
| 12–16 lb. bond | 6.1 |
| 20 lb. bond | 70.5 |
| 24 lb. bond | 9.1 |
| Other bond | 0.5 |
| Glossy writing | 3.0 |
| Glossy text | 6.6 |
| Glossy other weight | 1.7 |
| Cardstock | 1.7 |
| Newsprint | 0.8 |

lightweight paper that will tear easily during folding. Likewise, larger artifacts should have a heavier paper that will maintain its structural integrity.

## Content Analysis

Architect and urban planner Kevin Lynch (1960) proposed in his book *The Image of the City*, written nearly fifty years ago that every city has a unique image, which people, both residents and visitors alike, create and internalize as they move throughout the natural and built environment. This image becomes a mental map created by each traveler projecting his or her own meaning of the space back onto the environment.

The difficulty of this image-making process can be determined to some degree by what Lynch (1960) calls the "legibility" of the city:

> By this we mean the ease with which its parts can be recognized and can be organized into a coherent pattern. Just as this printed page, if it is legible, can be visually grasped as a related pattern of recognizable symbols, so a legible city would be one whose districts or landmarks or pathways are easily identifiable and are easily grouped into an over-all pattern (pp. 2–3).

A legible city, according to Lynch (1960), gives people positive feedback through emotional satisfaction due to an underlying organizational framework in the built environment (p. 5). To be legible to the observer, five elements comprising the city's image should be prominent: paths, edges, districts, nodes, and landmarks.

### Path

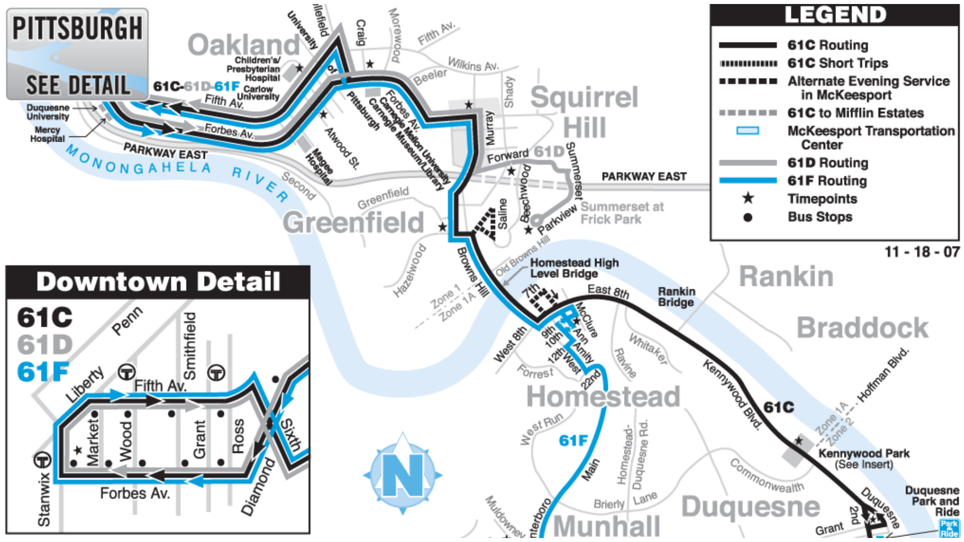
Lynch (1960) defines a path as a channel of movement through the city (p. 47). This broad definition includes the infrastructure for all modes of transportation: sidewalks, streets, highways, subway lines, railroad tracks, or bike paths. Paths dominate our mental images of the city because they allow us to move through and observe it.

The US Federal Highway Administration ([FHA], 1989) groups roads into four categories based on their function and capacity. Principal arterial roads, typically controlled-access interstates or other highways, are designed for continuous travel between and within urban centers at high speeds. They become the primary routes for people entering and leaving the urban center and for people looking to bypass the center en route to another destination. Minor arterial roads compose the backbone of the street network because of their hybrid nature: connecting to both the high-volume principle arterial roads and the neighborhood collector streets. They are typically numbered routes (either a US Highway or a state route), continuous through the urban area to provide connections to large commercial and industrial areas. Collector streets begin to connect to individual neighborhoods to move travelers from the larger arterials to the local roads they likely live on and vice versa. They share duties of *land access*, bringing people to the area, and *traffic circulation*, moving people around in the area. At the bottom of the hierarchy are the local streets, composing nearly 90% of the road mileage in the street network, but only about 10% of the travel. These are typically local neighborhood streets with low speed limits and frequent traffic signals, discouraging through traffic (American Planning Association [APA], 2006, p. 226). This hierarchy of roads is directly reflected in our image of a city: the principal arterial roads are physically the largest roads and carry the most traffic, and thus are the most visible.

Paths are a vital component of any public transportation information system—riders need to know where the route goes. However, this information is often conveyed in varying amounts of detail. The paths shown on a bus route map are frequently detailed with the bus route drawn over a map of all the surrounding streets. In contrast, a subway map is often less connected to the surface, with paths there representing only connections between stations. Since riders cannot exit the system between stations, the representation of the actual path traveled can be less accurate and more abstract.

Seeing just the path of the route does not provide enough information for the rider, however. He needs to understand how to get from where he is to where

**Figure 20**
This bus map from Pittsburgh shows the paths of the three bus routes and additional related paths in the area. However, it uses the local term "Parkway East" instead of an interstate number, adding difficulty for new residents.




the route is. Thus, most maps, especially bus maps, will show and label other important paths in the area that help orient the traveler to the larger space of the city. In Figure 20, the paths of the three bus routes using this map are identified with thick lines, one color or shade for each route. In most instances, the streets that the routes follow are labeled with their names in mixed-case text. Important intersecting streets are also often labeled in the same manner, giving the rider further information to help him orient himself.

In addition, streets that have no relation to these particular routes, but that are important parts of the city's image are shown, identified and labeled, such as the "Parkway East." In most cases, this inclusion of important unrelated paths is a benefit to the traveler, providing additional orientation information. In this example, the Parkway East is shown with a different line style to differentiate this controlled-access interstate highway from normal ground-level streets. However, its label is problematic. The term "Parkway East" is the colloquial term for this particular section of highway, known by the locals but not by visitors or new residents. That particular name is not shown on any street signage, leading to confusion. The official route designations for the Parkway East of Interstate 376 and US Routes 22 and 30 are not shown anywhere on this map, forcing new users to play mental gymnastics to confirm the name of the road.


**Figure 21**
The early 1926 diagram of the London Underground (left) doesn't show the River Thames, while Beck's 1933 diagram (left) shows the Thames (curiously unlabeled) as a striped blue line. [Images from Garland, 1994]

### Edge

The second element composing the image of a city is the edge, or a linear boundary element that either permits or forbids passage. The best edges for a city's image are highly visible, continuous over a long distance and impenetrable (Lynch, 1960, p. 62). An edge doesn't necessarily have to be present on the same plane as the traveler—a large overhead power line or an elevated rail line could both serve as edges because they are linear elements seen by people on the ground. Prime examples of edges are bodies of water adjacent to a city or traveling through it, such as lakes, bays, oceans and rivers. Bodies of water are nearly always depicted on transportation maps because of their orientation abilities.

A historical example of the edge is the Thames River running through London (see Figure 21). Early diagrams of the London Underground system left the river out, choosing to focus only on the rail lines. The river was added beginning in mid-1926, twenty years after the first diagram was produced. Harry Beck kept the river as the only surface-level detail in his historic schematic-like redesign in 1933 and it has been present ever since. Because the river was the only feature from the surface shown on the diagram, its importance becomes magnified. Without exception, an informal survey of riders found that it was very useful in helping them to orient themselves to the city and to navigate through it (Garland, 1994, pp. 11, 18).

### District

A district, according to Lynch, is an area within the city of a common character that is externally identifiable. It could be an area with similar types of architecture or similar businesses or industries, similar styles of lampposts or demographicallysimilar residents, or any other theme or characteristic (Lynch, 1960, pp. 66–67). The term *neighborhood* is often associated with districts. By breaking the larger city down into smaller regions, orientation and navigation become easier. Travelers use their powers of observation to generalize features in the district, ignoring those details that don't fit the image.

Districts are often hard for newcomers to understand because they have not had enough time to experience different areas of the city to observe differences. In addition, because of their amorphous nature, exact district boundaries, if they can even be defined, are rarely shown on road maps. Long-time users also move away from navigating by districts, choosing instead to focus on smaller details like individual intersections or buildings.

One particular district is nearly always shown on a transportation system map: the central business district, or "downtown." Because the density of buildings, stops, routes and people is generally much greater in the downtown area, this district is frequently shown on bus maps in an inset at a larger scale for additional detail. Instead of using an inset, subway diagrams frequently change the scale within the diagram itself, a liberty that can be taken because of their more typical schematic and abstract form. The downtown inset must function in two ways: its primary purpose is to show the downtown area in detail, but it must also show some connection to the larger form of the map and the city. Thus, the graphic elements used to link the district inset itself with its normal location on the larger map become crucial.

The Twin Cities Metropolitan Area Transit System, serving the Minneapolis/St. Paul metro area in Minnesota, uses two insets to show the Minneapolis and St. Paul downtown areas (see Figure 22). One of the strong elements here is the use of a large black area in the shape of the downtown district to denote the area covered by the inset on the opposite side of the map. The borders of the shape help users to understand the boundaries and form of the district and help to place it into context with the larger system.

Seattle's King County Metro Transit system uses semi-transparent overlays to define the boundaries for the district inset and a separate color for the downtown area (see Figure 23). In this way, the downtown inset is immediately placed into context with the surrounding territory and all the routes are still visible through the district, though not necessarily legible. The yellow color defines the boundaries of the district apart from the rest of the city shown in tan.

**Figure 22**
The Twin Cities Metropolitan Area Transit System uses black areas to identify the downtown district. Though the filled shape hide details within the district, they preserve the general outline of the district, helping with orientation.

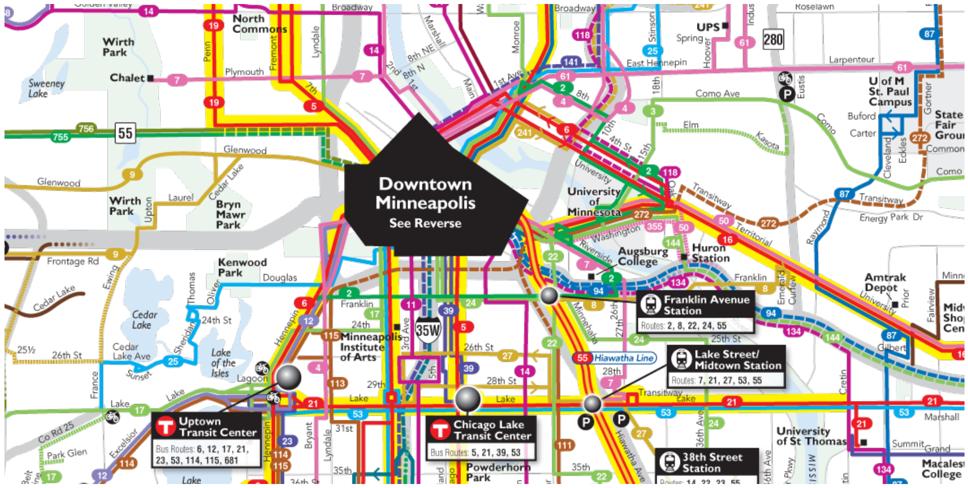



**Figure 23**
The King County Metro Transit System in Seattle uses a transparent overlay to mark the downtown district, preserving the underlying structure, density, and major routes.

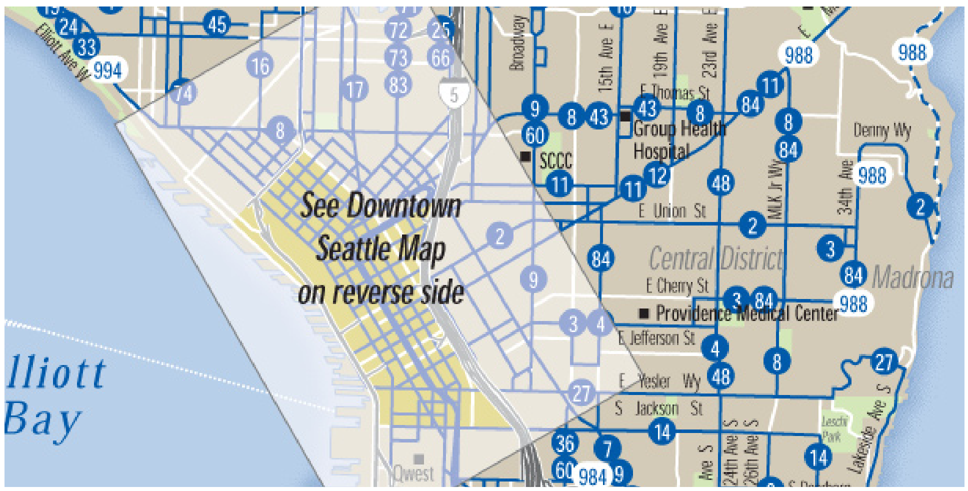
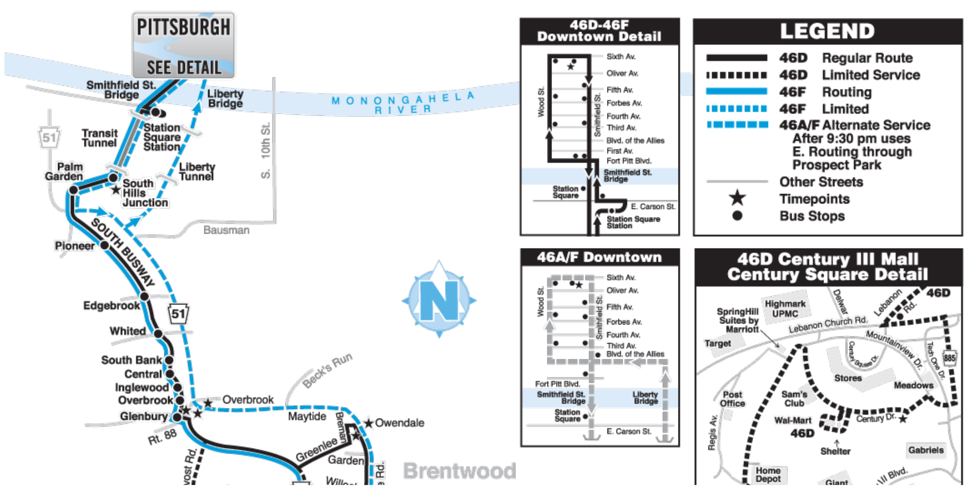



**Figure 24**
The Port Authority of Allegheny County (Pittsburgh) obscures the downtown area with a rectangular graphic, removing all orientation information of the two rivers , bridges, and roads.



In contrast to these examples, the Port Authority in Pittsburgh uses a large stylized graphic icon to show where the inset should be placed (see Figure 24). This icon, drawn with a gray gradient inconsistent with the rest of the map, hides the underlying structure of the downtown area as a triangular region at the confluence of two rivers. The icon does show two rivers merging into one, but doesn't show where the downtown region is in relation to this. Furthermore, only the southern river, the Monongahela, is shown in the normal map, though the Allegheny River to the north would normally appear in this visible region.

The Pittsburgh example also demonstrates disconnects between the label of the detail area and the magnified view. The graphic icon is labeled "PITTSBURGH SEE DETAIL" and appears on a map showing five bus routes or route alternatives. This single indicator then must correspond to two separate magnified views, one for routes 46D and 46F and the other for 46A/F. These magnified views are labeled "Downtown Detail" or simply "Downtown," different indicators than the graphic label suggests. It is also unclear why the routes are separated into two different views when they follow almost essentially the same route. Differences also appear in the graphic language of each magnified view. The 46D-46F inset uses a thick black line to show the routing that, according to the legend, applies only to the 46D Regular Route. As a further disconnect, the gray dashed line shown in the 46A/F inset does not appear in the legend at all. Finally, in addition to the visual language and labeling disconnects, there is also a physical disconnect between the graphic icon and the magnified views. The detail views are placed in a convenient location next to other similar-looking boxes, on the opposite side of the map from the graphic icon. There is no graphic element, such as a simple line, that connects the detail views to each other or to the icon.

### Node

Lynch's (1960) fourth element of a city's image is the node, a strategic focal point in the city where travel decisions are often made. Thus, they are frequently junctions of several paths where travelers naturally pay closer attention to the environment to make the correct decision to continue their journeys (pp. 72–73). Public transportation stations are prime examples of nodes because of their role in a rider's trip and visibility both inside and outside of the system.

Riders using public transportation must begin their journeys by transferring from one mode of transportation (on foot, by car) to another (by bus or subway) at a station; the reverse action occurs when they leave the system to return to the city environment. Because of this key transfer, the rider's beginning and ending stations function as personal nodes for that individual. The individualized nature of beginning and ending nodes makes it difficult to specifically highlight starting and ending points on a mass-produced system or route map. However, maps accompanying directions from an online route-planning system where the rider is able to get personalized directions do highlight the beginning and ending nodes because the rider's particular trip is known.

Points in the city where large numbers of public transportation routes converge are also nodes. These often take the form of large stations or transfer hubs where riders change routes. Often, the largest stations are multi-modal or multi-system, allowing transfers from subway to commuter rail, for example. New York City's subway system has many of these large stations, including Times Square, the busiest subway station in the system. On the subway system map, shown in Figure 30, the Times Square station, at the convergence of the 1, 2, 3, 7, S, N, Q, R, and W lines, is shown with the largest open circle, signifying the importance of the node. Less important nodes, the stations servicing both express and local trains, are shown with smaller open circles. Local stations are shown with closed circles. The hierarchy developed with these three symbols helps a traveler understand the importance of various points in his trip. A node's importance is further identified with a callout box that lists bus routes stopping at or near that station. The value of displaying key details for multiple modes of public transportation together, especially where riders can transfer from one to the other, cannot be overstated.


Figure 25
A hierarchy of three levels of nodes in the form of subway stations are shown on this map of New York City's subway system around Times Square.


**Figure 26**
Landmark buildings are shown as icons on the Washington, DC Metro map. The names of many stations also indicate the locations of many secondary landmarks.

## Landmark

The final element making up a city's image, according to Lynch (1960), is the landmark—a feature unique to a particular location in the city that immediately establishes a place. The best landmarks, he states, have a clear form and contrast significantly from the background around them. This contrast and form gives them excellent external visibility, often from a wide area. Landmarks can vary in scale from a significant building to a street clock (pp. 78–79).

Washington, DC, a city known for dozens of monuments, memorials, and internationally-recognized government buildings, includes icons of some of the most well-known landmarks on its Metro subway map (see Figure 26). These landmarks are extremely helpful for tourists and first-time visitors who are likely to want to visit each one. The landmarks are depicted as outlines of the major geographical features of five buildings: the White House, the Capitol and the Washington, Jefferson and Lincoln Memorials. Their depiction as outlines contrasts with the language on the rest of the map, helping to highlight their importance. However, they are not labeled with the names of the landmark. That may be acceptable in this example because these five buildings are generally very widely known, but it may not hold true for landmarks depicted in other cities. We also note that these landmarks appear only in a green area on the map that is not defined in any sort of legend. The green field here is used to connect to our sense of a park or other natural area. Secondary landmarks are also shown on the map in the form of station names. Riders can rightly assume that the Smithsonian station on the blue and orange lines will bring them very close to the Smithsonian Museum, for example.

## Strengthening or Weakening a City's Image

The visual form of a system map that uses Lynch's various image elements can strengthen or weaken the underlying image of the city. To illustrate these two circumstances, we'll look at Harry Beck's London Underground diagram and Massimo Vignelli's New York City Subway diagram.

### Strengthening London's Image

London grew very organically over hundreds of years without any formal master plan. Thus, the city had no overarching structure for its paths, edges and landmarks. Local residents had no central focal point (landmark) to use to develop an image of the city (Garland, 1994, p. 7). With little overarching structure, images of the city were as varied as the residents living there.

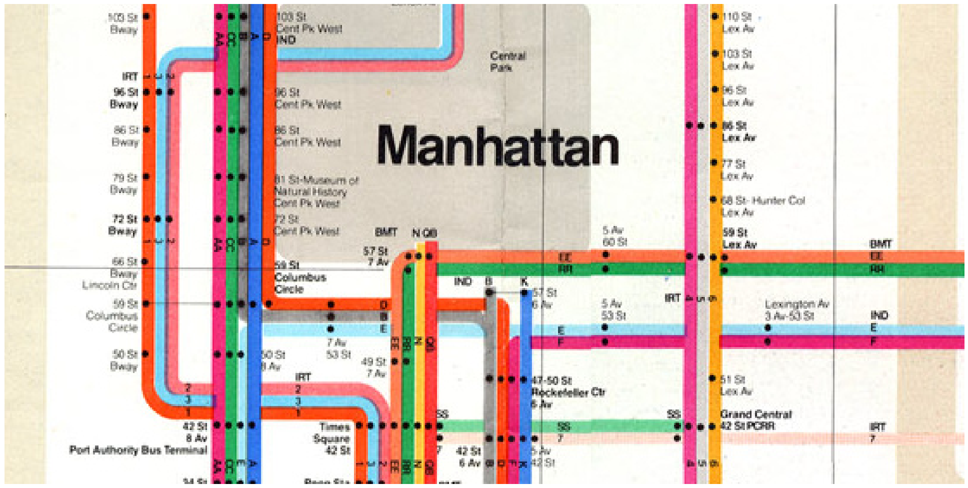
Harry Beck's iconic London Underground diagram, shown previously in Figure 21 and in Figure 27, was a radical departure from previous system maps as the strict rules governing its form resulted in drastic distortions of proportion and scale from the actual geography, eliminating the chaotic nature of the actual streets for a refined, simple image. Garland (1994) noted that Beck's diagram was highly successful in encouraging residents to build a unified image of the city:

> Above any consideration of the Diagram as a navigation aid was the optimistic vision it offered of a city that was not chaotic, in spite of appearances to the contrary, that knew what it was about and wanted its visitors to know it, too. Its bright, clean and colourful design exuded confidence in every line. Get the hang of this, it said, and the great metropolis is your oyster (pp. 7–8).

The diagram was incredibly successful and well-received by the public because, as Garland (1994) notes, it was "so obviously useful" (p. 19). After an initial printing in January 1933 of 750,000 copies, a second printing of 100,000 additional copies was ordered just a month later (Garland, 1994, p. 19). This total is roughly 10% of Greater London's population at that time (London Population, 2008).


**Figure 27**
Beck's London Underground diagram brought order and structure to the disjointed London city image. [Image from Garland, 1994]

**Figure 28**
Vignelli's 1972 New York City subway diagram conflicted with the image of the city held by most residents, leading to its quick abandonment. [Image from 1972 System Map, 2005]




## Weakening New York's Image

In contrast to London, most of New York City follows an established plan of development with a rectangular grid and numbered streets dating back to 1811 (Bridges, 1811). This rectangular arrangement makes it relatively easy for people to navigate throughout the city. In 1972, Massimo Vignelli introduced a simplified system diagram for the Metropolitan Transportation Authority that built on his previous work developing a signage system for the subway stations and platforms (see Figure 28). Drawing from Beck's original design, the Vignelli map limits subway lines to 90- and 45-degree angles and each subway line is given a different color, with stations represented by a single dot in the middle of the line. The map is classified, like Beck's, as a diagram because of the various distortions taken to make it work graphically. It also omits most surface detail, with the exceptions of major parks and rivers, to focus just on the connections between different subway lines. Graphic designers hail the map as "a design solution of extraordinary beauty" (Bierut, 2004).

However, the map was a commercial failure because of the conflict between the image of the city presented on the map and the image of the city people had developed over time through their own experiences. Three subsequent versions were printed (1974, 1976 and 1978), but all were eventually replaced in 1979 with a more geographically-accurate version (Metropolitan Transportation Authority Archives, personal communication, November 5, 2007; Haberman, 2004). The primary flaw, noted by Bierut (2004) and others, is the obvious distortion of the shape of Central Park. Though represented on the map as nearly a square, in reality the park is much more elongated. New Yorkers easily picked up on this abnormality and then were quick to notice other areas where Vignelli's graphical system conflicted with the actual street pattern and city plan. Bierut (2004) provides an illustrative example:

> [B]ecause of the simplicity of the Manhattan street grid, every New Yorker knows that the 28th Street number 6 train stops exactly six blocks south and four blocks east of Penn Station. As a result, the geographical liberties that Vignelli took with the streets of New York were immediately noticable [sic], and commuters without a taste for graphic poetry cried foul.

Designers and subway enthusiasts are understandably saddened at the demise of this map, but riders have come to appreciate the more geographically-accurate versions that provide more contextual information linking the subway system to the regular street system above.

# Conclusion

The user experience of riders on public transportation systems is one of great complexity often filled with a degree of stress or anxiety. Riders frequently rush to meet their expected train or bus, worried that it will leave without them. Riders often have just enough information to navigate to their destinations under perfect conditions and must scramble to find alternative options when the system changes unpredictably. By and large, riders feel somewhat helpless because they turn over control for their transportation to a faceless entity.

As riders adjust to these unpredictable travel conditions, they look to printed and online sources to give them information to plan their journeys. In most cases, these components of an information system are irregularly or poorly designed, with little consistency between different types of documents or different mediums of communication. These sources frequently appear to have been designed without consideration for their contexts of use, leaving riders with useful information trapped in impractical physical forms. Riders then must redesign the information to suit their own needs.

This research on the user experience and information needs of riders in public transportation systems begins to look at these systems from a service design perspective. The travel process model offered in section 3 of pre-trip, orientation, navigation, confirmation and post-trip phases, can be used as a baseline for further design innovations in this area. To get a complete picture of the complexity of the user experience, both from the rider's and from the system's point of view, an exercise in service blueprinting would be appropriate.

As public transit systems across the country look to build their ridership to balance ever larger budget deficits, an analysis of the barriers of entry to riding public transportation would be timely and appropriate. As an extension of this paper, research involving non-riders and infrequent riders could look for connections between elements of the user experience (or perceived user experience) and transit service capacity planning. As specific design innovations are identified, studies for practical feasibility including cost considerations will be necessary. An additional research task would be to identify reasons why a majority of systems have not adopted elements of rider-focused information systems that have been in place in some areas for 20–30 years (such as schedules at each bus stop).

Riders build their familiarity with the public transportation system every time they travel on a bus, subway or train. Like other aspects of our lives, when things become familiar to us, we begin to develop regular patterns in our usage and start to see things from a different perspective. One regular bus rider had a preferred seat he called *The Perch*, the seat just behind the rear door, raised about three steps from the seats in the front of the bus. From this vantage point, he felt protected from the congested area in front of him because of the railings and plastic walls on either side of the rear door. This place of perceived power gave him a nearly unobstructed view to the front of the bus, ensuring that he could see the LED screen showing each stop. He sought The Perch for its visibility—to gain information he could use for orientation, navigation and confirmation. Riders of all types are constantly looking for relevant information during their trips. To become a service that people want to use instead of one they have to use, public transportation systems need to focus on increasing the amount and improving the relevancy of information they provide to their riders.

# Appendix

The table below identifies the public transportation systems from which I received artifacts in response to my request, or from which I collected artifacts during the course of my own travels. Systems listed below without any artifacts were systems that did not respond to my request. In some cases (Denver, Philadelphia and San Francisco), the system didn't respond to my request, but I was able to collect some artifacts using other means. This is a convenience sample of artifacts with a comprehensive set of Pittsburgh route maps as of March 23, 2007 and September 13, 2007.

| | | Number of artifacts | |
|---|---|---|---|
| **Name** | **Location** | **Received** | **Collected** |
| Capital District Transportation Authority | Albany, NY | | 1 |
| Metropolitan Atlanta Rapid Transit Authority | Atlanta, GA | 5 | |
| Maryland Transit Administration | Baltimore, MD | | |
| Berliner Verkehrsbetriebe | Berlin, Germany | 10 | |
| Deutsche Bahn | Berlin, Germany | | 1 |
| SBB, The Swiss Railway | Berne, Switzerland | | 1 |
| Massachusetts Bay Transportation Authority | Boston, MA | 8 | |
| Niagara Frontier Transportation Authority | Buffalo, NY | | 1 |
| Chicago Transit Authority | Chicago, IL | | 4 |
| Southwest Ohio Regional Transit Authority | Cincinnati, OH | | |
| Greater Cleveland Regional Transit Authority | Cleveland, OH | | |
| Dallas Area Rapid Transit | Dallas, TX | 4 | |
| Regional Transportation District | Denver, CO | | 19 |
| Suburban Mobility Authority for Regional Transportation | Detroit, MI | 33 | |
| Metropolitan Transit Authority | Houston, TX | 10 | |
| Transport for London | London, England | 2 | |

| Name | Location | Number of artifacts | |
|---|---|---|---|
| | | Received | Collected |
| Los Angeles County Metropolitan Transportation Authority | Los Angeles, CA | | |
| Miami-Dade Transit | Miami, FL | 12 | |
| Milwaukee County Transit System | Milwaukee, WI | 4 | |
| Metro Transit | Minneapolis, MN | 13 | |
| Société de transport de Montréal | Montréal, Canada | 7 | |
| Metropolitan Transportation Authority | New York, NY | 39 | |
| Port Authority of NY & NJ | New York, NY | | 2 |
| OC Transpo | Ottawa, Canada | 11 | |
| Régie Autonome des Transports Parisiens | Paris, France | | 2 |
| Southeastern Pennsylvania Transportation Authority | Philadelphia, PA | | 10 |
| Valley Metro | Phoenix, AZ | 4 | |
| Port Authority of Allegheny County | Pittsburgh, PA | | 177 |
| Tri-County Metropolitan Transportation District of Oregon | Portland, OR | | |
| San Francisco Municipal Transportation Agency | San Francisco, CA | | 1 |
| Metro Transit | Seattle, WA | 3 | |
| Metro | St. Louis, MO | | |
| Hillsborough Area Regional Transit | Tampa, FL | 6 | |
| Toronto Transit Commission | Toronto, Canada | 1 | |
| Eurail | Utrecht, Holland | | 2 |
| Greater Vancouver Transportation Authority | Vancouver, Canada | | |
| Washington Metropolitan Area Transit Authority | Washington, DC | 17 | |
| | **Total** | **189** | **221** |
| | **Grand Total** | | **410** |

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