A GLIMPSE OF BIKE-N-BUS

An exploratory survey of the United States

A Thesis
Presented to
The Academic Faculty

By

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In partial fulfillment
Of the Requirements for the Degree
Master of Science in Civil Engineering
And
Master of Civil and Regional Planning

Georgia Institute of Technology

May, 2012

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An exploratory survey of the United States

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Date Approved: Friday, March 30, 2012

ACKNOWLEDGEMENTS

I submit this thesis by the support of many people:

- Dr. Meyer, my advisor, has guided me through this process with great patience.
- Dr. Southworth and Dr. Stone have taken the time to review my work.
- My peers have shown me how to persevere in the trials of grad-school.
- My family has supported my education in Atlanta and encouraged me to “get it done.”
- My wife, Danae, helps me turn ideas into sentences when I get stuck.
- The taxpayers of Georgia and the USA have funded my master’s education.

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SUMMARY

Bike-n-Bus includes any number of methods where bicycle serves as the access mode to some form of bus transit. This study examines bike-n-bus operations in the United States based on telephone interviews with transit professionals from 33 transit agencies across the lower 48 states. It reviews past trends in research and gives some history of bike-n-bus in the U.S. and abroad. A brief explanation of methodology is followed by a description of the various facets of U.S. bike-n-bus operations, based on both interviews and the literature, with commentary by survey respondents. The study ends with a long term vision for bike-n-bus based on the characteristics of that mode-couple.

Conclusions are addressed to various audiences: transit agency, community leader/ policy maker, and researcher. Included are suggestions for possible next steps in research and implementation. These findings would be of interest to those studying transit and bicycle travel, developing travel demand models, managing a transit agency, or those with influence over bicycle policy and infrastructure.

Most transit agencies have installed front-mounted bicycle racks on their entire bus fleet, and expressed satisfaction that the amenity accommodates bicyclists. However, agencies have made only moderate efforts to follow-up on this success. Studies suggest that cycling to transit can be competitive with the private automobile in journey-to-work trips and attracts new riders to transit. Better bicycling infrastructure is the most significant way to increase the number of bike-n-bus riders. However, transit agencies seem reluctant to support these improvements.

CHAPTER 1: INTRODUCTION

Bike-n-Bus includes any number of methods where bicycle serves as the access mode to some form of bus transit. This study examines bike-n-bus operations in the United States based on telephone interviews with transit professionals from 33 transit agencies across the lower 48 states.

1.1 Research Question and Hypotheses

What is the maximum potential for bike-n-bus, and how much has this already been achieved?

Because this survey is intended to be exploratory, hypotheses are in terms of what respondents may or may not mention:

- When and how have transit agencies adopted bike-n-bus accommodations?

  Agencies may have installed bike racks in the mid- to late- '90s, during the period when bike-n-bus was receiving national attention, though literature from the American Public Transit Association (APTA) suggests less than one-third of transit agencies installed bike racks during the 1990s (Neff, 2008-2010). Respondents may mention funding retrofits with money available through the Intermodal Surface Transportation Equity Act (ISTEA) or the Transportation Equity Act for the 21st Century.

- Do transit agencies have clear, written policies?

  While one might expect a transit agency to have clear written policies related to their bike-n-bus program, these might take the form of rules bike-n-bus users are required to adhere to. Some of these rules might be related to issuing permits to allow bike-n-bus use.

- How have transit agencies worked with other groups to develop the bike-n-bus program?

  Agencies may have started their bike-n-bus program in response to pressure from bicycling advocacy. Others may have installed FMRs following the example of other agencies. In either case, transit agencies may have needed to collaborate with outside groups in order to promote the program.

- Are agencies aware of which groups have an interest in bike-n-bus?

  Agencies may not be able to tell what sort of riders use bike-load, and assume that transit users are the main stakeholder group.

- Do transit agencies measure the level of bike-n-bus use?

  Agencies may loosely monitor bike-n-bus use, as a means to report on the program's effectiveness. Agencies may have adopted bike-n-bus as a way to increase ridership, but more likely installed racks in response to cyclists wanting greater mobility and easier passage over hills and around bodies of water.

- Can transit professionals comment on what obstacles hinder greater bike-n-bus use?

  Transit professionals may have given casual thought to the obstacles of bike-n-bus use, though transit agencies are not likely to have researched this. According to Replogle, secure bicycle parking may be the greatest need in the U.S. (Replogle, 1984).

- How is it thought that bike-n-bus will evolve?

  Bicycling advocates may have proposed changes to the transit agency's bike program, to better suit their needs. However, transit agencies may find bike-n-ride use too low to warrant further efforts.

1.2 Structure of the Report

The report is structured into five chapters. After the introduction, it covers existing literature, outlines the methodology of the study, and then proceeds into a direct discussion of bike-n-bus. The conclusion answers the research question and highlights key findings.

The second chapter, entitled “Research Context,” includes five sections: the first on terminology, the second highlights key trends in research, the third section looks at international experience, and the fourth hones in on bike-n-bus in the U.S. The final section organizes all of the theoretical benefits to bike-n-bus.

Methodology is discussed in Chapter 3. Agencies were selected to be interviewed based on a number of criteria, so the sample would be representative of the nation as a whole. Respondents were asked to participate in a 10 question telephone survey lasting 10 to 15 minutes, with an email reply offered as an alternative. Along the way, it became apparent that the wording of some questions would need to be changed, to be more neutral. A generalization of the response to each question is given, with results being discussed in more detail in the next section.

The fourth chapter incorporates these findings, organized by topic, with existing literature. Sections follow a progression from the fundamental issues of accommodating bicycles to answer broader questions about how bike-n-bus is used. It includes the various ways to accommodate bicycles with bus transit, the dynamics of starting a bike-n-bus program, the effort required to publicize the program, and the on-going discussions with other groups concerned with bike-n-bus. It further discusses the hindrances faced by would-be bike-n-bus users, and assesses who is likely to use BnB, as well as identify its other stakeholders.

Conclusions, in Chapter 5, are divided into four sections. Having already portrayed a snapshot of bike-n-bus in the United States (through the end of 2008), the conclusion continues to lay out a vision of what bike-n-bus could be. This is followed with a roadmap for transit professionals seeking to refine their agency's bike-n-bus program. A third section gives tips for policy-makers for how to regard bikes and buses as part of a combined network. Finally, remaining questions are suggested for future research.

1.3 Significance to Transport Policy

This thesis is designed to facilitate the further of development of bike-n-bus. By capturing a snapshot of the current state of practice, and giving a thorough discussion of the different facets of bike-n-bus, it is hoped that future BnB efforts can build upon the collective experience of the U.S. Moreover, by developing a vision of the potential for bike-n-bus, this report seeks to inspire greater innovation by providing a target to reach for. The conclusions of this report are intended to be practical take-aways for each of its three audiences. A framework is provided for the transit professional, so they can assess the structure of the agency's bike-n-bus system. To the decision-maker taking a higher-level view of the transportation system, the conclusion offers some "rules of thumb" for bike-n-bus, by which they can plan. Finally, suggestions are made to the academic on how changes to bike-n-bus programs in various transit agencies can be supported and coordinated through research. Inherent to the survey approach of this study (which asks transit professionals for their opinions) is the acknowledgement that human factors also contribute to the development of bike-n-bus. By examining, along with the mechanics of bike-n-bus, the organizations behind it, both may be found to have room for improvement.

CHAPTER 2: RESEARCH CONTEXT

The research context includes five sections: the first on terminology, the second highlights key trends in research, the third section looks at international experience, and the fourth hones in on bike-n-bus in the U.S. The final section organizes all of the theoretical benefits to bike-n-bus.

Bicycles can be handled in a number of different ways. On Amtrak, they must be partly disassembled and shipped in a special box. On coach buses, such as those used by Greyhound and for express bus services, bikes can be stowed in the undercarriage storage spaces (sometimes in special boxes, bags, or trays). Inside buses and rail vehicles, bikes can be hung vertically from hooks, secured with the wheelchair restraints, leaned against seats or simply held by the rider. Folding bikes can also be used and easily carried aboard. Bikes can be carried outside the bus on a trailer or rear- or front-mounted bike rack (FMR). FMRs are far-and-away the most common form of bike-transit integration. FMR racks are available from a number of vendors in a variety of designs. Normally they can accommodate one, two, or three bikes, but custom racks are seeking to increase this number even more.

When not transported on transit, bikes can be parked at rail stations, bus stops, or transfer centers. The simplest form of bike parking is the “bike rack.” One of the most popular designs for a bike rack is the structure with the “inverted-U” shape, as it allows the owner to lock both wheels and the frame of the bike. Bike rack parking can be upgraded to sheltered parking by placing under an overhang or by constructing an awning over the rack to provide protection from the rain. Bike lockers provide both shelter and enhanced security. A transit rider usually rents a locker space from the transit agency at a station or transfer center. These can be used for day-time parking or for overnight parking for a bike used during the day. Secured bicycle parking

overseen by a staffed supervisor makes sense in locations with hundreds of bicycles. These sorts of facilities can be designed to store bicycles more densely than conventional bike racks.

Additionally, bike-share and bike rental facilities can provide bicycles when they are needed only on the destination end of the transit trip, in addition to serving those who visit the city.

2.1 How to Discuss Bike-n-Bus – A Suggested Lexicon

As a relatively new issue, access to transit is hampered by the lack of a consistent vocabulary. Therefore, the first task of this report is to help establish a lexicon for this discussion. The definitions laid out below seek to establish terms which are concrete, specific and useful. Care has been taken to maintain terms already established through scholarly writing and common use, noting exceptions and highlighting potential confusion.

Bike-n-Bus (BnB) – a simplification of "Bike and Bus." Any combination of bike and bus use. When discussing "bike-n-bus," it may be in one of three ways:

> Accommodation – the physical ability to use bicycles in conjunction with bus. Agencies that accommodate bicycles have means for securing bicycles while the passenger is riding the transit vehicle. Accommodation may be inside the bus, on an exterior rack, or with bicycle parking. Racks are viewed as amenities.
>
> Program – the effort required to maintain a particular quality of service for those who use a bicycle and the bus. This includes the purchase and maintenance of equipment and its impact on transit service. With this view, racks are more than an amenity; they are part of operations.
>
> System – the transportation network that includes all of the options for both transit and bicycle routes. This is the decision context that the bike-n-bus user observes and considers

when he or she makes travel decisions. In this thinking, racks are an investment in a long-term plan.

Bike-on-Bus (BoB) – refers to any method that involves bus transport of a bicycle. This term and its acronym are used in Hagelin's writings (Hagelin, 2005, 2007), but here the letter "O" is lower-case.

Bike-in-Bus (BiB) – where the bike and people travel together inside the transit vehicle. Often this is done to supplement the front-mounted-racks (FMRs). This term was also coined by Hagelin and is consistent with the response of agencies to discuss policies of (not) allowing bikes inside the bus. However, this term may cause confusion when spoken, being only one letter different from "Bike-n-Bus."

Bike-Load (BL) –The method where a bicycle is stored in an external rack on the bus, but not in the bus itself. This study introduces this term for the first time.

FMR(s) – "Front-Mounted Rack(s)," for accommodating Bike-on-Bus. This method is by far the most common in the U.S. for accommodating bikes. The term originated in literature with TCRP Synthesis 4 in 1994 (Doolittle & Porter, 1994), but is abbreviated for the first time here.

Bike Stowage – where the bike is carried in cargo bays below a coach bus or on a train.

Bike Hangers – where bikes are secured inside the bus on special racks or hooks in BRT (Bus Rapid Transit) or rail cars.

Bike-to-Transit (B2T) – describes the most common scenario for bike-n-bus, where users will bike from home to transit, but do not need a bike at their destination. This scenario means the bike might be parked at the bus stop or train station of origin and not transported on the transit vehicle. This method is most appropriate when the destination is walkable.

Bike-to-Bus – bike used only on the originating end of the transit trip. Hagelin abbreviates this expression “BTB” (Hagelin, 2005) but here such notation is avoided to prevent confusion about which end of the trip utilizes bicycle. While such an issue may be uncommon in the U.S., it is discussed in the work of Martens in regard to Europe (Martens, 2007).

Bus-to-Bike – where the bike is desired only at the destination. This may require transport of a bicycle on the bus, or might be accommodated through bike sharing, bike rentals, or by parking a private bicycle at the destination stop.

BTB – Bike-to-Bus or Bus-to-Bike; any type of access which uses bicycle on only one trip end. In the Hagelin literature, this usually refers to bike use at the originating trip end, which is more common (Hagelin, 2005).

In these terms, “ride” typically is used to refer to transit in general, whereas “bus” or “rail” is used to indicate a specific mode of transit. (“ride” might be confused by some with the act of driving a bicycle.) In this way, these terms stay consistent with the common terms “Park-n-Ride,” for vehicular access to transit, or “Bike-n-Ride,” for bike access to transit in general. In all of these terms, the ambiguous “roll” is excluded, even though the name “Rack-and-Roll” is occasionally given to a bike-n-bus program.

The term “rack” can refer to either a bus-mounted bike rack or bicycle parking. To clarify, this study refers to the “racks” on the bus as “front-mounted (bike) racks,” or FMRs. These FMRs are sold in 2-bike or 3-bike configurations. A freestanding “rack” will either be referred to directly as a “bike-rack” or under the general term “bike parking.” “Bike-racks” refer to the exposed, freestanding support frames to which a parked bicycle is secured. A bike-rack which is protected from the elements by some sort of an awning is specified as a “bike shelter.” Bike lockers are individual units that completely enclose an individual bike, protecting it from the

elements and vandalism. Often, bike lockers must be rented. “Bicycle parking” could also cover many other advanced methods for secure bicycle storage.

This study also distinguishes between “cyclists” and “bicyclists.” Because cycling is an established sport, it is taken that cyclists are those who choose to ride a bicycle for some sort of recreational purpose. Bicyclists, on the other hand, can be seen as using the bicycle predominately for transportation.

In some cases “bicycle” has been shortened to the vernacular “bike.” This has been done only for readability; it does not indicate a difference in meaning.

Krizek and Stonebraker set forth the acronym “CTU” for “Cycle-transit user” (Krizek & Stonebraker, 2010). This study instead specifies bike-n-ride or bike-n-bus user.

2.2 Evolution of Bike-n-Bus Research

The history of bike-n-bus can generally be divided into three periods. In the first period, from 1984-1992, Michael Replogle advocated for better links between transit and bikes, drawing examples from a few pioneer agencies (Replogle, 1984, 1987, 1992; Replogle & Parcells, 1992). In the second period, during the 1990s, national agencies produced informational materials as agencies across the country began installing FMRs. While most focus has always been on linking bikes to rail transit, in the 2000s bike-n-bus began receiving attention in its own right. This study aligns with that third period in the mid- to late- 2000s and anticipates a fourth period with a renewal of national attention to bike-n-bus, similar to what occurred in the mid 90s (see “5.4 Opportunities for Further Research” in conclusion).

2.2.1 Advocacy by Replogle

The idea of bicycles as an access mode to transit first appears in modern U.S. literature in 1984 with the publishing of the Bicycle Federation's book *Bicycles and Public Transportation: New Links to Suburban Transit Markets*. Michael Replogle worked on this as a researcher for Public Technology, Inc., a technical arm of the National League of Cities (Replogle, 1984). He continued to publicize and advocate for bike-n-bus until he became Director of Transportation at Environmental Defense in 1992 (LinkedIn).

1984 "Role of Bicycles in Public Transportation Access" in TRR 959

This paper in Transportation Research Record 959 briefly described the surge in bicycle access to train station witnessed in Europe and Japan during the 1970s. Replogle frames this within the context of suburbanization and a decline in the dominance of central cities. In the countries he considered, about 10-20% of transit trips involve bike access, with up to 50% of transit riders arriving by bike in some locations.

Replogle found the risk of bicycle theft a major determinant to whether a person would park their bike at a station. He notes that the rate of bicycle theft in the United States was twice as high as in Europe, and five times as high as Japan. This makes secure bicycle parking much more important for the U.S.

Around the time of his writing, about 10% of commuters lived within the ideal range of transit to bike-n-bus (¼-2 miles). Replogle found that transit had infiltrated this market only to a small degree. Nevertheless, a quarter of all transit commuters lived beyond a five-minute walk-shed of transit, making this a substantial market segment that could be served by bicycle amenities.

In his case studies, Replogle found that a substantial segment of riders were from homes with limited access to a personal automobile, emphasizing the importance of bike-n-bus for those with limited mobility.

> "Despite the importance of the automobile in American transportation, one-third of all citizens do not possess a driver's license. Even in suburbia, some 12% of all households lack an automobile… Although not suitable for everyone in these market segments, bike-and-ride travel may offer a strong appeal to many such people." (Replogle, 1984)

Though advocating for bike-n-bus, Replogle concludes by putting it into perspective, recognizing both the value and limitations of bike-n-bus:

> "Bicycle-transit linkage will likely contribute only modestly to the growth or stabilization of U.S. suburban public transportation. However, as suggested in this paper, the greater integration of bicycles with transit opens up new opportunities for transit agencies at low cost in markets that have until now been neglected or penetrated only by relying on the more expensive strategy of park-and-ride services."

1987 "Bicycles on Transit: A Review of International Experience" in TRR 1141

In this study, Replogle claimed that "bicycle egress can open up entirely new markets for public transportation, making transit competitive with the automobile in terms of total travel time for intrasuburban commute trips." As a result of connecting these two modes, "the whole [transportation system] is more than the sum of the parts." The report focused on the history of bike-n-ride in the U.S. since 1897, with some comparisons to Europe, and then goes on to discuss bicycles on rail transit. The final part of the study discussed some early case studies on bike-n-bus and their associated costs. He concluded from successful trials that bike-n-bus is able to divert automobile trips and can make transit more competitive in suburban markets (Replogle, 1987).

1992 "Bicycle Access to Public Transportation: Learning From Abroad"

This article was widely distributed among transportation professionals, appearing in the December issue of the Institute of Transportation Engineers Journal. Replogle began with the

premise that “American communities need to consider new more cost-effective strategies to expand transit use and reduce automobile dependence.” To this end, he declared that “bicycle access to transit may be the most promising but neglected low-cost strategy to enhance air quality.” He cited a Chicago study showing that bicycle parking was substantially more cost-efficient than other methods to reduce emissions. The problem with park-and-ride, he explained, is that it involves “cold start” vehicle trips. For the few minutes after a car starts, it consumes a greater amount of fuel and produces more pollutants per gallon than during the rest of the trip (Replogle, 1992).

Replogle contrasted the Dutch and Japanese efforts to improve bicycle access to (rail) transit with the U.S. focus on building park-and-rides for cars. He criticized this focus on automobile access, as it actually makes transit less competitive in the increasingly important suburb-to-suburb market. Moreover, it makes suburb-to-city transit less cost-effective:

> “The several billion dollar investment American communities have made in park-and-ride transit access systems has not been accompanied by balanced investment in pedestrian and bicycle access to transit. Indeed, in many cases, transit services have been reoriented to serve isolated parking lots rather than existing or potential centers of development, eliminating opportunities to cluster more jobs and housing within walking distance of transit. Park-and-ride systems have stimulated peak-period, peak-direction ridership, worsening directional imbalances in ridership flows and reducing transit seat-mile productivity.” (Replogle, 1992)

2.2.2 National Attention

The advent of ISTEA in 1991, with the new focus on federal spending for bicycle improvements, caused bike-n-ride to shift from a matter of advocacy to a national interest. While Federal money for bike-n-ride had been available since the mid-80s, few had taken advantage of this funding source ("Case Study No. 9," 1992; Replogle & Parcells, 1992). The Transportation Research Board focused their fourth Synthesis on Transit Practice, published in 1994, on the “Integration of Bicycles and Transit.” During this decade USDOT put out a number of publications about bike-transit integration. Most of these publications presented similar

information and seem to be geared toward the many transit agencies that were starting bike-n-bus programs during this time.

1992 National Bicycling and Walking Study, Case Study No. 9: "Linking Bicycle/Pedestrian Facilities with Transit"

Authored by Replogle and Parcells, this study was included in a compilation by the Federal Highway Administration (FHWA) the same year as their other work by the same name, "Linking Bicycle/Pedestrian Facilities with Transit" (the original being produced by the National Association of Railroad Passengers). The document is largely a re-presentation of Replogle's other work on bike-transit integration, though in some places it does elaborate more. Nevertheless, "Case Study No. 9" marks the beginning of national-level publications on bike access to transit.

The first two sections of the study are mostly background describing transit-access issues in the U.S. The third section gives some case examples of bike-n-bus programs and provides a comprehensive summary table of the earliest bike-n-bus programs. For a copy of this table, see the section of this study called "2.4 History of Bike-n-Ride in the United States." Replogle and Parcel's section drawing on experience from Europe and Japan gives a good historical snapshot. However, their case studies dealt mostly with bike parking at rail stations – a subject which has continued to develop since their study was published two decades ago.

The authors present a fairly complete discussion of the concept and implications of expanding transit's catchment areas. The study talks about the challenges of missing links in the transportation network and cites some case studies that looked at the impact of increasing the distance people travel to reach transit. It does not draw any conclusions about how much biking could expand the catchment area of a transit stop, but it cites some literature that provided distances for various access modes. A hypothetical study from Melbourne, Australia suggests

that doubling the catchment area of rail stations from 1 to 2 km could increase transit use by 33% for that region ("Case Study No. 9," 1992; Replogle & Parcells, 1992). Of course, the impact of higher access distances would be unique for each region; it would depend on the distribution of population and the layout of the street network and transit system. Service area analysis is not a perfect approximation of the how much ridership may increase through encouraging bike access. It assumes that biking is as easy as walking and that the only hindrance a would-be transit rider must overcome is access distance. It also must assume particular values for the median walking and biking distance. However, this type of analysis does provide a picture of bike-n-ride's maximum potential.

In their argument, Replogle and Parcells state that the greatest benefit of bike-n-bus is in reducing emissions – switching short-distance park-n-ride auto trips to bike trips. Replogle and Parcells estimated that each transit rider that switches from car to bike would save about 150 gallons of gasoline per year.

Replogle and Parcells insisted that "It is important that State and locally sponsored pilot projects related to bicycle-transit linkage include an evaluation to ensure that maximum learning occurs regardless of project success or failure." ("Case Study No. 9," 1992). While most bike-n-bus efforts today are not groundbreaking pilot projects, their call for careful research may still be applicable. They also saw a need for agencies to share the results of their research with others. The two recommended the creation of a "Non-motorized Transit Access Clearinghouse" to assemble "information on the best types of bicycle lockers and racks, costs of various options, experience of other cities in implementing bike-on-rail, bike-on-bus services and in creating more pedestrian- and bicycle-friendly environments, and the successful experience of other countries," consolidating the research that each agency must do when developing their bike-n-

ride program. This would largely take the form of case studies. They also encouraged university programs to emphasize transit access through special courses devoted to the subject.

1994 TCRP Synthesis of Transit Practice 4: "Integration of Bicycles and Transit."

This study covers bicycle access to bus, rail, and ferries. It also has a brief section devoted to bike parking. The study was oriented toward transit agencies wishing to incorporate bike-n-ride and gives a good deal of information to that end. It discussed how to gather community input, staffing needs, training bus operators, how to gain funding, and how to market and evaluate the service once in place. The document also lists the areas that might be targeted for bike-n-ride: low density areas with excess transit capacity, active bicycle programs, safety for pedestrians (and thus, bikes), strong bicycling advocacy, colleges and universities, recreational or tourist attractions, air-quality non-attainment areas, along corridors that are difficult to traverse by bike, and where a pro-bike leader can oversee the program. The study also describes some of the challenges with early rack designs – long load times, headlight interference, and maintenance complications – challenges which are largely addressed in modern FMR designs.

The study lays out a methodology when adding bike-n-ride amenities (see section 4.2 Program Creation.") The recommendation for factory installation of bike racks seems to have been heeded. However, some of their recommendations for further research are still merited, particularly:

- Methods for program evaluation to quantify benefits and costs, measures of use.
- Methods for removing institutional barriers that stand in the way of multi-jurisdictional and comprehensive bicycle transportation planning and project implementation.
- Determination of the potential for full-range bicycle access to significantly displace SOV [single-occupancy vehicle] use, and how best to achieve that potential.

  (Doolittle & Porter, 1994)

Doolittle & Porter briefly explored the impact of weather on biking ridership, not finding any direct relationship. They found that while weather may affect ridership, it will not preclude success.

> "In Phoenix, racks continue to be used during summer's 100+ degree days, although the number of users is somewhat lower than during cooler months. There is extensive bicycle use in rainy Seattle and cold Madison, Wisconsin. Several agencies without bicycle programs, however, cite weather conditions as a reason for not adding the service." (Doolittle & Porter, 1994).

The document discusses the pros and cons of requiring permits for passengers with bikes, an issue of great debate at the time. However, today this question has largely been resolved; this research found that in 2009 that only one of the 33 responding agencies requires a permit to transport a bike.

TCRP Synthesis 4 also addresses the problem of bikes delaying the bus. However, it found that a clear bike policy does much to resolve this concern:

> "Non-bicycle passengers of Roaring Fork services have complained about loading and unloading time delays, but mostly over delays caused by disputes over how to handle bicycles that could not fit onto racks already filled to capacity." (Doolittle & Porter, 1994).

Finally, their study acknowledged that the greatest determinants of how many people bike-n-ride are those factors that are beyond the control of transit agencies:

> "Current use rates may not be a fair measure of market potential and public interest because of barriers that are beyond the control of the transit agency. Access improvements such as signage and bicycle lane and path improvements are facilities cited as important in encouraging bicycle use, but for the most part are not the direct responsibility of transit agencies." (Doolittle & Porter, 1994).

This finding emphasizes the role of state and local DOTs in planning for bicycle access.

Other resources

The FTA published a 12 page pamphlet in 1999 entitled "Bicycles & Transit: A Partnership that Works". It gave highlights from various bike-n-ride case studies and suggested how to pursue

federal money under “TEA-21” legislation. It pointed out those projects linking bicycles with transit were eligible for more money than a conventional transit project - a 95% federal match instead of just 80% ("Bicycles & Transit," 1999).

Lesson 9 of the FHWA Course on Bicycle and Pedestrian Transportation, entitled “Bicycle and Pedestrian Connections to Transit,” is a brief summary of Case Study 9. It is part of a larger lesson plan developed to teach students of various ages how to consider bicycles and pedestrians; perhaps an attempt to carry out Replogle’s recommendation from the end of Case Study 9. It is available for free online (Toole, Pietrucha, & Davis, 1999). This document was re-published in 2006 as Lesson 18 in the Course on Bicycle and Pedestrian Transportation. It is also available on the web ("Bicycle and Pedestrian Connections to Transit," 2006).

2.2.3 Bike-n-Bus Studies – Martens and Hagelin

In the 2000s, as the prevalence of bike-load increased, research was published from new sources. Karl Martens brought new insights from Europe and, particularly, the Netherlands. (Europe, like the U.S., had also developed bike-transit linkages during the 90’s (Martens, 2004, 2007)). Christopher Hagelin, working for the National Center for Transit Research and Center for Urban Transportation Research at the University of South Florida, wrote specifically on bike-n-bus – its value and potential. However, not all research in this decade has been from academia. A second TCRP Synthesis published in 2005 was a major effort to survey the state of practice nationwide. It saw the need for better data collection and compilation of knowledge from across the country.

Martens’s 2004 “The Bicycle as a Feedering Mode: Experiences from three European countries”

Martens surveyed literature from across Europe, drawing case study results from the Netherlands, Germany, and the United Kingdom. He selected these countries to represent the

various attitudes and levels of investment in bike infrastructure. His analysis looks at bike access to all modes of transit, rail and subway, as well as bus.

By studying what was similar about bike-n-ride in different contexts, Martens was able to identify some common characteristics about the mode-combination. Particularly, he found that faster transit modes make bike-n-ride more desirable. More people are willing to bike longer distances to reach faster modes of transit. For example, while bus travel typically attracts fewer bikers than train, the express buses in the UK saw a higher level of bike-n-bus access because of its quick connection from suburbs to city. It is transit speed, not mode, that influences ridership.

In Europe, “The majority of bike-and-ride users travel between 2 and 5 km to a public transport stop, with longer access distances studied for faster modes of public transport.” This varies by country and transit mode, but Figure 1 clearly shows few access trips longer than 4 km (2.5 miles) (Martens, 2004). This data suggests that the median bike-n-bus traveler rides a little more than 2 km (1.2 miles).

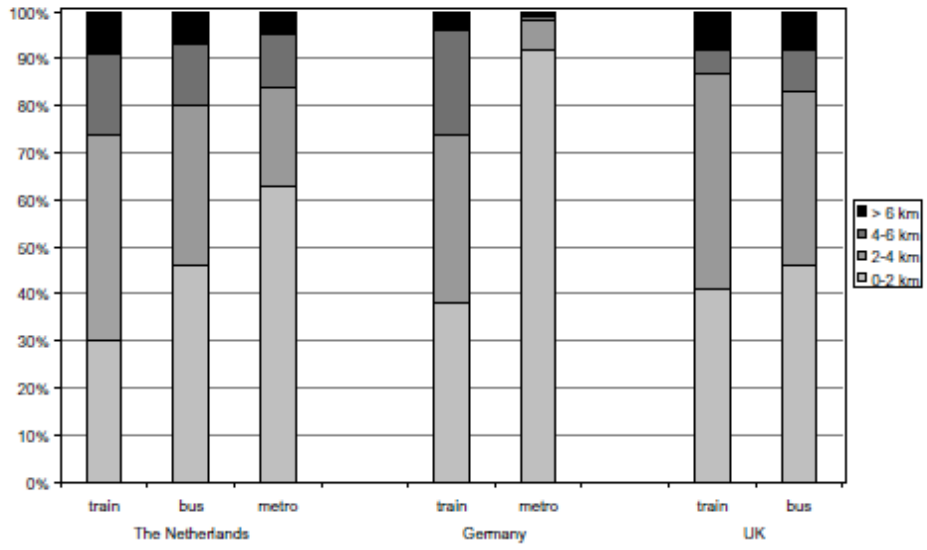

Fig. 1. Distribution of bike-and-ride trips over distance categories (access trips). Note: The data refer to the national average for the Netherlands, to the Grafing train station and Kiefergarten metro station for Germany, and to five selected train stations and three P&R bus stations for the UK. Sources: Van Goeverden and Egeter (1993) for the Netherlands; Bickelbacher (2001) for Germany; Taylor (1996) for the UK.

Figure 1 – European bike access trip distances (Martens, 2004)

Martens compared three countries having high, medium, and low levels of bike riding popularity, and found that in each country the percentage of transit users who use a bike as their access mode is approximately equal to the percentage of trips made by bike in country as a whole. However, this correlation is weaker for bicycle access to a bus. Instead, auto-ownership and bikeability seemed to be the determining factors.

Martens found the share of passengers who bike to the bus varied greatly from town to town and stop to stop. This suggests that locational variables at the sub-town level (like bike network and route structure) are important to determining the attractiveness of bike-n-bus. Moreover, it emphasizes the need to study bike-n-bus at a stop-by-stop level and tailor programs to the needs of each particular case.

With regard to the utility of combining bikes and transit, Martens theorizes:

> "The attractiveness of bike-and-ride lies in its potential to solve one of the key problems of public transport: the accessibility of stations and stops. As a feedering mode, the bicycle is substantially faster than walking and more flexible than public transport. The combined use of bicycle and public transport could thus be a relatively competitive alternative to the private car." (Martens, 2004).

The primary use for bike-n-ride was found to be commuting to work or school, with shopping as a notable third. Bike-n-bus seemed to be most appealing to students and those without access to personal automobiles.

> "Bike-and-ride offers a number of environmental and societal benefits over the use of the private car. The environmental benefits include reduction in energy use, air and noise pollution." (Martens, 2004).

Yet even in a bike-oriented culture like the Netherlands, bike-n-ride only accounts for a small percent of travel. For this reason, he argues bike-n-ride will never directly lead to substantial reductions in air emissions. Nevertheless, he finds four other ways that bike-n-bus can make an impact: (1) enabling a car-free lifestyle, (2) providing equity for those who cannot drive, (3) helping to alleviate congestion at peak times and in key junctures, and (4) increasing the competitiveness of transit.

*Martens's 2007 "*Promoting Bike-and-Ride: The Dutch Experience"

A national effort to improve bike-n-ride in the Netherlands began in 1992, at the same time a similar movement was taking shape in the United States. The Bicycle Master Plan (BMP) for the Netherlands featured 24 (out of 112) bike-n-ride demonstration projects. From these bike-n-bus case studies Martens focuses on six case studies dealing directly with bike-n-bus (rural bus stops in Brabant, villages around Leeuwarden, bike parking in central Utrecht, a bike-oriented service in the Enschede-Oldenzaal corridor, and two unsuccessful trials on express routes).

Much of the study gives background information that might be interesting to one unacquainted with that context. The Netherlands has a highly-developed rail network and has the highest

levels of bike use worldwide (27% of all trips), so bike-n-ride is an established topic of transportation research in that country. Even before the BMP, 25% of all transit trips were accessed by bicycle, though bike-to-rail was much more common (29.3% of access trips) than bike-n-bus (6%). Bicycles were used six times more often for accessing transit than at the end of the trip (Martens, 2007).

Successful experiments saw the total of number riders increase because of bike-n-bus, with an even more drastic increase in the percent biking to the stop. Some of the increase in ridership can be attributed to transit riders who rode more often as a result of bike-n-bus. Many transit riders switched their access mode to bike. Nevertheless, Martens still observes "a limited switch from car to bike-and-ride" (Martens, 2007).

> "The success of the Dutch experiments even seems to suggest that the barriers for changing travel behavior in access trips may be substantially lower than those that prevent overall mode change, perhaps because public transport users are confronted everyday with the relative inconvenience of access trips. In addition, the 'conformity and peer' effect may be at work here." (Martens, 2007).

Martens found that in areas where there is sufficient bike infrastructure, small investments may be able to increase bike access to transit.

> "Cities and towns with [a basic level] of bicycle ridership could also promote bike-and-ride by simply improving bicycle parking facilities at key stations and stops." (Martens, 2007)

Improving stop amenities may not be enough to create a large shift to bike and bus in all locations. Certain environments are more suited for bike-n-bus access:

> "The most potential seems to lie in high quality bus lines that connect residential areas and employment areas and/or educational facilities, especially in cases of large distances between subsequent stations." (Martens, 2007).

The study also discussed experiments with subscription bike sharing and rentals for use by bike-n-ride passengers at the destination end of their trip (egress). These early bike sharing programs of the mid 1990s were not as successful as modern bike-share/rental programs. Pilot

projects were unable to solve the "egress problem," participants finding the pilot bike programs too difficult to use. Martens states that any solutions to provide bicycle accessibility on the destination end of the trip will have to be "simple and flexible," as people do not want to make huge commitments (Martens, 2007). New developments in bike-share/rental technology may now address this need for major cities.

Hagelin's 2005 "A Return on Investment Analysis of Bikes-on-Bus Programs"

Hagelin began with the goal of creating a quantitative benefit/cost ratio for bike-n-bus operations, hoping to ascertain the value of maintaining or expanding the programs. While he was not able to ascribe numbers to all categories (in part because of poor usage statistics), he gave a complete accounting of what costs and benefits such research should consider. An abbreviated table of these costs and benefits is given in Table 1. Nevertheless, Hagelin showed that BoB programs easily pay for themselves:

> "Transit agencies generally view the initial investment and operational costs of BOB programs to be minimal [average of $465 per rack in agencies he surveyed] compared to the return on the investment. The BOB user survey results showed that BOB programs attract new patrons, encourage increased use of transit, and expand the transit service area." (Hagelin, 2005).

While many transit agencies do not track BoB usage (6/15), 11 of the 15 agencies Hagelin interviewed claimed rack capacity as a limitation: "As bikes-on-bus (BOB) programs become popular and demand increases, the typical rack capacity of only two bicycles per bus can limit the integration of bicycles and transit." While some agencies have tried 3-bike FMRs and bike-in-bus, Hagelin believes increasing bike-n-bus ridership would have to involve bicycle parking at bus stops:

> "BOB users tend to bicycle a greater distance from their residence to the bus stop than from the bus to their work location. Therefore, this strategy is centered on the provision of bicycle parking at bus stops and transfer centers to accommodate BOB users that need their bicycle on only one side of their transit trip. Bicycle parking at bus stops,

specifically in residential areas, can ease the impact of rack capacity limitations and maximize the potential of the bicycle as a means to access transit." (Hagelin, 2005).

Hagelin found that two-thirds of BnB users bike more than a mile to the bus stop, but more than half are within a ¼ mile walk of their destination after disembarking. Of the BnB users surveyed, 22% of said they would definitely use bike parking at their initial bus stop instead of loading it on the bus. An additional 21% said they would make use of bus stop bike parking if there was not room on the FMRs.

The BoB user survey also indicated that bike-n-bus draws some new riders and encourages more-frequent transit use. A majority of bike-n-bus riders were commuters who take transit more than 4 days per week. For details, see the section 4.6.2 Bike-n-Bus Users."

"A Return on Investment Analysis of Bikes-on-Bus Programs" could be a useful resource for transit agencies considering investments in bike amenities, either for starting a bike-n-bus program, or in coping with limited FMR capacity. Hagelin's conclusions are based on a survey of 15 transit agencies (11 of them from Florida) and a survey of 220 BoB users.

Table 1 – Costs and Benefits of Bike-n-Bus (Hagelin, 2005)

Table ES.1: Possible BOB Costs and Benefits

BOB Investments or Costs	BOB Returns or Benefits
Capital cost of purchasing racks	BOB ridership/boardings
Maintenance cost of repairing/replacing racks	Expansion of transit service area
Administrative cost of day-to-day operations	Attraction of new transit riders
Marketing costs of program	More frequent use of transit
Insurance claims and incidents	Bicycle locker rental fees
Permitting process and training	Improved bicycle safety
Funding of bicycle facilities to access transit	Reduction in traffic congestion
Provision of bicycle parking	Improved air quality
Bicycles abandoned on racks	Promotion of healthy lifestyle
Route delay and increased dwell time	Improved transit agency image
Impact of rack capacity limitations	Increased mobility

Hagelin's 2007 "Integrating Bicycles and Transit through Bike-to-Bus Strategy"

Hagelin's second paper followed up on the user survey mentioned in the first paper. It focused on the finding that "BOB programs attract new patrons, encourage increased use of transit, and expand the transit service area." (Hagelin, 2007).

Hagelin found that one in four bike-n-bus riders were not regular transit riders until they could bring their bike. Of the BnB users surveyed, 72% used it for commuting, with 65% traveling four days per week or more. Nine out of ten users had been biking to the bus for more than six months, and 69% had been using the program for more than a year or more. Bike-n-bus proved a valuable travel option for those 35% of users who do not hold a drivers license (Hagelin, 2005).

The study also considered how far patrons will bike to access the bus. Hagelin found that 37% travel less than a mile to access the bus, 34% travel between one and two miles, with 27% traveling more than two miles (Hagelin, 2007). This suggests that the median user travels about 1.5 miles to the bus. While a bike ride of that length may take only 10 minutes, it would take nearly half an hour on foot.

Table 2 gives a detailed breakdown of access distances.

Finally, Hagelin advocates for bicycle parking at bus stops to overcome rack capacity limitations. He observed that most passengers need their bike only on access to the bus, but are relatively close to their destinations upon disembarking. He found that two thirds of BnB riders would use bike parking at their stop, and nearly a quarter of BnB would use this regularly (Hagelin, 2007).

Table 2 – Distance Biked to and from the Bus (Hagelin, 2005)

TABLE 3 Trip Length of BOB Commuters

TRIP DIST.	HART N=55		MDT N=60		PSTA N=47		TOTAL N=162	
	To stop	To work	To stop	To work	To stop	To work	To stop	To work
< ¼ mi.	5.5%	14.5%	6.7%	18.3%	3.6%	20.0%	5.6%	18.5%
¼ mile	7.3%	30.9%	10.0%	30.0%	5.5%	27.3%	8.0%	30.9%
½ mile	14.5%	32.7%	26.7%	31.7%	18.2%	18.2%	21.0%	29.0%
¾ mile	1.8%	1.8%	1.7%	1.7%	1.8%	0.0%	1.9%	1.2%
1 mile	38.2%	10.9%	16.7%	6.7%	41.8%	10.9%	33.3%	9.9%
2 miles	23.6%	7.3%	18.3%	5.0%	12.7%	7.3%	19.1%	6.8%
3 miles	5.5%	1.8%	5.0%	0.0%	1.8%	1.8%	4.3%	1.2%
4 miles	1.8%	0.0%	3.3%	0.0%	0.0%	0.0%	1.9%	0.0%
5 miles	1.8%	0.0%	1.7%	0.0%	0.0%	0.0%	1.2%	0.0%
>5 mi.	0.0%	0.0%	3.3%	0.0%	0.0%	0.0%	1.2%	0.0%
Refused/ NA	0.0%	0.0%	6.7%	6.7%	0.0%	0.0%	2.5%	2.5%

2005 TCRP Synthesis 62 "Integration of Bicycles and Transit"

This study asserts the need for more research to better understand bike-n-bus users.

> "Transit administrators, engineers, and researchers often face problems for which information already exists… in undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution." (Schneider, 2005).

TCRP Synthesis 62 follows up on the findings of the 1994 TCRP Synthesis of Transit Practice 4, also entitled "Integration of Bicycles and Transit." This study found that in the 11 year time period between TCRP reports, 80% of 56 transit agencies surveyed had begun some form of service for bicycles. While most of this "significant growth" comes in the form of bike-on-bus facilitated by FMRs, the study lists some complementary services, namely: bike racks for vanpools, hanging bicycle storage in rail cars, and providing bicycle parking at transit hubs. Also included as new services are upgrading to higher-capacity FMRs and developing bike stations to serve bicyclists' unique needs (Schneider, 2005).

Synthesis 62 confirms that a large number of agencies believe accommodating bicycles will attract significant numbers of recreational bicyclists at off-peak hours. However, the report also found that few agencies have studied their bicycling users.

> "Systems with more comprehensive bicycle and transit integration services tend to have the most success attracting bicycling customers." (Schneider, 2005)

The study suggests some data a transit agency should collect, given enough resources: number of bicyclists during peak- and off-peak hours, the number of turn-aways, origin-destination (O-D) travel data, rider characteristics, trip purposes, when the rider is traveling, and which alternative modes a rider also considers (Schneider, 2005). All this data could be used to develop a travel demand model for bike-n-bus.

2010 Krizek & Stonebraker's "Bicycling and Transit—a Marriage Unrealized"

Krizek & Stonebraker find that limited capacity is a pervasive problem for bike-n-ride, and one which is not seriously addressed by transit agencies.

They argue that the power of bike-n-ride to increase transit ridership is by enabling better access at the destination end. They find that one of the big hindrances to transit use is that it does not bring riders close enough to their destination. Theoretically then, bicycling as an egress mode holds considerable potential. For this reason, they set forward bicycle sharing/rental as a way to overcome limited capacity for bikes on transit (Krizek & Stonebraker, 2010).

This conclusion is inconsistent with the previous findings of Hagelin, who found that 50% of all bike and bus riders disembark only about a quarter mile from their destination, and traveled much farther to reach the bus to begin with (Hagelin, 2007). Nor does it make sense with Martens, who found bicycle access projects more successful than programs aimed at solving the egress problem (Martens, 2007). Indeed, transit users' sensitivity to egress distance might

be a reason why some choose to bike-n-ride. But if people are only willing to use transit when it takes them near their destination, simply providing a bicycle may not bridge this gap. The current use of bike-load already provides the flexibility to use a bike for egress, but this is not how it is primarily used (Hagelin, 2007).

The authors advocate against funding for bike-n-bus, saying that scarce funding for bicycle integration is better spent on modes with high returns on investment. They judge regional transit services like express bus, commuter rail, and ferries to have the best return on investment for bike-n-ride. Light rail is considered medium; buses and subway are considered low. They feel that many are just as likely to walk or bike as to combine modes and bike-n-bus. However, their supporting reference is inappropriate, as Martens was referring to the Dutch context (Martens, 2007).

They focus the rest of their paper on the Boulder, CO "Final Mile Initiative," which loans 200 bicycles to transit riders on the BOLT light rail line. They utilize factor analysis to guess at the relative popularity of bike-n-bus at different stops. Their analysis is based on six variables:

1) median household income,
2) percent population between the ages of 20 and 39,
3) density as measured by gross number of dwelling units per network buffer,
4) percent who commute by transit at least three days per week,
5) percent who commute by bicycle at least three days per week, and
6) kilometers of bicycle lanes.

(Krizek & Stonebraker, 2010).

However, they cite no references for using these particular variables. They call their approach "robust", but offer little explanation of it.

Nevertheless, the authors seek to help "develop a methodology for evaluating the need for bicycle infrastructure such as parking and [bike] stations." (Krizek & Stonebraker, 2010). They see a greater need for quantitative analysis in studying bike-transit integration:

> "The ultimate goal is research that will result in 'better than back of the envelope data' and that can be used within a relatively robust framework to advise advocacy organizations, municipalities, and/or transit agencies about the merits and costs of differing alternatives." (Krizek & Stonebraker, 2010).

Krizek and Stonebraker recommend additional research and case studies because they understand the varied nature of bike-n-ride users and contexts that must be accounted for.

> "Those seeking guidance on cost-effective strategies to maximize bicycling-transit integration… will likely reject a 'one-size-fits-all' approach." (Krizek & Stonebraker, 2010).

2.3 International Experience – Is the U.S. behind?

While not on the cutting edge in terms of bike parking (technology), U.S. transit agencies do have greater experience with bike-n-bus than countries like Japan, which focus primarily on bike-n-rail. While the sparse suburban environment and auto-dominated roadways of the United States discourage bike-n-bus use, this has forced the U.S. to develop bike-load systems solving the egress problems that governments in Europe are still trying to overcome.

Internationally, the majority of the attention is on biking to the rail station.

> "[Bike-on-bus] appears to be rare in Europe and nonexistent in Japan, although bicycles were formerly carried on a widespread basis by rural and intercity bus services in Europe several decades ago." (Replogle, 1987).

Nevertheless, a number of transit passengers use their bikes just to local bus service (4-6%) (Martens, 2004). Table 3 shows what percent of transit trips are accessed by bike in each of these countries. As can be seen, bike-n-bus is still not as popular as bike-n-rail. Table 4 shows that bike access mode shares are higher in more rural towns, where people live further from transit (Martens, 2004).

With both these generalizations, however, one should note that there is wide variability in the prominence of bike access. For example, at some stops Martens found that bike access to

express bus shot up to 81%, 16 times the national average of 5% (Martens, 2004). These numbers would vary from stop to stop.

Table 3 – European bike-n-ride share by transit mode (Martens, 2004)

Table 1
Share of the bicycle (%) in access trips to various types of public transport

	The Netherlands	Munich	UK	Copenhagen
Bicycle share in all trips	27	13	2	26
(Regional) train	30	16	3	25
Suburban train	–	10	–	22
Express bus	14	–	–	12
(City) bus	6	4	4	4
Metro	1	5	–	–

Sources: Ministerie van Verkeer en Waterstaat (2000) for train stations in the Netherlands; Van Goeverden and Egeter (1993) for bus and tram/metro in the Netherlands; Van Uum et al. (1995) for selected express buses in the Netherlands; Mobinet (1999) for Munich; MVA (1997) for train stations in Hampshire County Council, UK; Taylor (1996) for selected bus stations in the UK; Ege (2001) for Copenhagen.

Table 4 – Bike access as a function of city order, the Netherlands (Martens, 2004)

Table 5
Location of train stations and shares of the bicycle in access and egress, the Netherlands

Location	Access	Egress
Main city (%)	22	5
Medium-sized city (%)	32	8
Large town (%)	41	9
Suburb (%)	43	12

Source: Nägele et al. (1992).

2.3.1 Japan

Prosperity during the 1970s enabled a process of suburbanization along rail corridors (though this development was not as auto-oriented as sprawl in the U.S.). This increased need to access rail stations lead to a rapid increase in the number of bikers. The number of bikes parked at train stations quadrupled between 1975 and 1980 (Replogle, 1984). Replogle attributes this to very low levels of bike theft – few riders even locked their bikes (Replogle, 1992). Officials struggled to provide bike parking to address the "bicycle pollution" problem (Replogle, 1984). As early as the 1990s the Japanese had established viable bike-rental programs to address the need for bicycles upon egress from the train. Today companies are experimenting with automated bicycle parking systems to pack in more bikes at a lower cost. Still, in the dense city centers, walking is the predominant means of accessing transit (Replogle, 1992).

A similar trend in suburban growth occurring in Europe created a less-pronounced, but still highly noticeable increase in bike-n-ride. Denmark, for example, saw biking to transit double during the 1970s (Replogle, 1984). As measured by the number of bikes parked at train stations or transported on intercity rail, Europe saw a surge in bike-n-ride during the '70s and '80s. It took transit agencies some time to adapt. By the mid 1980s only a quarter of European transit agencies allowed bicycles on the train (Replogle, 1987). Some countries were quicker than others to expand bicycle amenities (Martens, 2004).

2.3.2 Denmark & Sweden

In Denmark, the number of bikes carried on trains (commuter and inter-city rail) doubled in the 1970s. In addition, "Several Danish and Swedish bus companies providing suburban and regional services have relied for many years on rear-mounted bicycle racks or baggage compartment storage." (Replogle, 1987).

2.3.3 Germany

"Germany takes the intermediate position [on addressing the concerns of cyclists]… It has been characterized by moderate levels of bicycle ridership in the 1970s and 1980s and has seen a substantial rise in more recent years." (Martens, 2004). The share of bike trips nationwide was 12% as of 1995, but "many German cities show higher bicycle shares than the national average." (Martens, 2004).

While Germany's federal government supported bike infrastructure programs in the 1970s to great success, "many towns and cities still lack basic bicycle facilities—e.g., nearly half of all main streets in towns and cities do not have separated bicycle paths" (Martens, 2004). Bike parking at stations was neglected in the '70s and '80s and "has only recently [during the 1990s] risen to the political agenda in Germany." (Martens, 2004).

2.3.4 The United Kingdom

In the UK, little attention has been paid to bicycle infrastructure or bike-n-ride, except in a few cities and at some commuter rail stations. Nevertheless, bike-n-bus finds its niche in access to express bus services (Martens, 2004).

2.3.5 Netherlands

> "The Netherlands represents one extreme of the spectrum, as it has the highest level of bicycle use within the industrialized world. More than 27% of all trips are made by bicycle, a figure that has been relatively stable over the last decades (Pucher and Dijkstra, 2000). Medium-sized cities, in particular, show high levels of bicycle ridership, with some reporting a bicycle share of trips exceeding 35%. The position of the Netherlands goes hand in hand with a well-developed network of bicycle infrastructure. The Dutch have invested in bicycle paths and lanes since the early 1970s." (Martens, 2004).

Because of the major focus on bicycles in this country, as well as rail transit, bike-n-rail has received considerable attention:

> "Traditionally, train stations have been equipped with guarded bicycle parking, but lack of investment during the 1970s and 1980s resulted in problems regarding the quality, quantity and accessibility of many of these facilities. In the early 1990s, a program was launched to systematically upgrade and extend the existing parking facilities at all train stations. In contrast, the combined use of the bicycle and other types of public transport has been largely overlooked in the Netherlands. Generally, bicycles were seen as competitors of buses, trams and metro lines." (Martens, 2004).

However, according to a native of that country, response to parking demand along bus routes has been "piecemeal" (Martens, 2004).

Comparing bike-n-bus with bike-n-rail in the Netherlands, Martens observes (as of the early '90s) it has been five times more common to bike to the train station (30% of train passengers) than to bike to the bus stop (with 6% of bus riders biking). Martens indicates that this split may be due to necessity, as rail stations are far less frequent than bus stops and require longer trips suitable to bicycle travel (Martens, 2007).

He also indicates that a difference in the availability of bicycle parking may also be to blame for the discrepancy between biking to bus and rail. In the early 1990s, a study of regional bus service providers found that less than 20% of bus stops provided bike parking. This number was interpreted as too low and read as a sign that bicycling was being neglected. At that time, most transit-supportive bicycle-parking centered around train stations and major bus transfer points. The national Bicycle Master Plan, initiated in 1992, brought attention to bike issues through well-publicized case studies.

Even though the Netherlands gives great attention to the bicycle as a mode of transportation, major investment in bike-n-ride facilities was only brought about through a dedicated bike-to-transit program. The main challenge was found to be confusion over which transportation agency was responsible for these investments. The Bicycle Master Plan, combined with the pressure from public attention, helped overcome these obstacles (Martens, 2007).

Bike-n-ride continues to expand. Nederlandse Spoorwegen (Dutch Railways) planned a 75% increase in the number of bicycle parking spaces from 1992 to 2010 in response to increasing demand. Covered bicycle parking or even secured staffed bicycle garages can be found at train stations, as shown in Figure 2. While there are fees to park a bike, these operations are partly subsidized by ticket fares. Efforts to encourage biking go beyond the station; the Netherlands has invested heavily in bike paths, lanes, and traffic calming to make biking safer and more attractive (Replogle, 1992).

In the Netherlands, bicycle travel has long been viewed as competitor to bus travel. (With a well developed rail network, buses generally make shorter trips than in the U.S.) When someone in the Netherlands bikes to transit, they usually leave it at the stop or station until they return. (Examples of this are shown in Figure 3 and Figure 4.) In this environment, "The possibilities to promote the combined use of bus and bicycle are more limited. The smaller catchment areas, the lower number of passengers per stop, and the slower service make it more difficult to assess whether or not [bus] stops may attract bike-and-ride users." (Martens, 2007)

Bicycle access on the other end of their trip – the destination end – is more difficult. Because of the many bicycles used in that country, passengers are limited in when they can bring their bicycle along. For this reason, only about one in six bike-n-bus trips use a bike on the activity end of the trip (vs. ¼ of train trips, 40% for tram-users) (Martens, 2007).

Bike-n-bus use is not as high in the U.S. as in the Netherlands, but due to the proliferation of FMRs in this country, the problem of egress has largely been solved. Still, the U.S. may now be suffering from the same problem the Netherlands realized in 1992: confusion over who is in charge of bike parking at bus stops (Martens, 2007). Perhaps a push from the national level similar to the Bike Master Plan would further develop bike-bus integration.

Figure 2 - Bike Parking at Commuter Rail Station, Weesp, NL (Andy McBurney)

Figure 3 – Bicyclists Returning from Rail Station in Evening, Kampen, NL (Andy McB.)

Figure 4 – Bike Parking at a Bus Stop, Broek in Waterland, NL (from Google Maps)

2.4 History of Bike-n-Ride in the United States

Replogle traces the history of bikes and transit since its inception in the late 1890s. The first mention of bike hooks appears in the 1897 Street Railway Journal. At first, it was feared that bicycles would compete with transit lines. However, bikes on transit proved popular. While there was political push back to charging fees for bikes, streetcar riders gladly paid a double fare to transport their bicycle. This level of bike accommodation generally continued into the bus era: "As motorbuses were introduced, bicycles were not uncommon elements of baggage, particular[ly] for rural or longer-distance travel." (Replogle, 1987). On urban bus routes, however, it seems bike-n-bus commuting never really caught on. Meanwhile, a much larger shock to bike-n-ride was struck by the post-war shift from transit to automobile:

> "Bike-and-ride transit access declined sharply with the decline of transit in the 1950s and 60s. Since that time, it has received only passing attention in most American communities, and has frequently been addressed only as an afterthought, rather than being integrated into transportation and transit system." (Replogle, 1992)

While they remained on intercity and commuter rail lines, bikes lost their ride as streetcars were abandoned. The newer rail systems allowed bikers to ride to the station and park, but would not allow bikes on board. Prior to 1980, only 3 subway systems in the world allowed bicycles on board, but agencies soon began to bend to the new demands of customers. Through the early 1980s, as agencies began to allow bikes on subway cars, all systems but Atlanta required permits (Replogle, 1987). Since then bike-n-ride has continued to receive greater attention and continues to expand.

The push for bikes on the bus began on the west coast, first in San Francisco, San Diego, and then in Seattle, driven by the desire to get bikes across highway bridges.

> In the early 1970s, bicycle activists in the San Francisco Bay area pressed local transportation officials for bicycle shuttle services across the Oakland Bay Bridge, which was closed to cyclists. AC Transit, a local bus agency, removed half of the seats from a

> bus to make room for up to 24 cyclists and their bicycles, initiating the "Pedal Hoppers", which offered limited weekend services across the bridge.
>
> California cyclists pressed ahead and won the attention of the State Legislature, which in 1974 required Caltrans to develop solutions to the problems of bicycle and pedestrian access to State-owned toll bridges. Shuttle van services using bicycle trailers were introduced by Caltrans at several locations, including the Oakland Bay Bridge and the San Diego-Coronado Bay Bridge. Although these services were popular and well used, the costs were considered excessive.
>
> Seeking a cheaper way to provide bicycle access across the Coronado Bay Bridge, Caltrans provided a demonstration grant to San Diego Transit to replace the bike shuttle with a bike-on-bus service starting July 1, 1976. Rear-mounted bike racks were put on three buses that operated on Route 9 over the Coronado Bridge. In 1977, service was expanded to other routes serving the beach communities and two major universities.
>
> In Seattle, limited access highway bridges across Lake Washington posed major barriers to cyclists. Local bicycle activists pressured the city's transit agency, and in 1978, Seattle Metro installed rear-mounted bicycle racks onto their buses that cross the lake. A year later, front-mounted racks were substituted because of unconfirmed reports that children were hitching rides on the rear racks. ("Case Study No. 9," 1992)

Today, King County DOT allows deadheading buses to pick up bikers for free crossing the Evergreen Point Bridge over Seattle's Lake Washington, as it does not accommodate bicycles. The agency posts information about the bridge crossing on their website.

Santa Barbara was the first agency to initiate bike-on-bus services for reasons not related to bridges. Instead, the agency's primary goal was to develop new transit ridership. To do this, SBMTD utilized a Mercedes 20-foot bus towing a trailer on key routes. The agency experimented with various designs of custom-built trailers from 1975-79 (Replogle, 1987). The program saw a substantial increase in ridership (21% in two years) due to bicycle access. The program's success can be attributed to the areas hilly topography, college-student ridership, and customizing transit service for bike access (Replogle, 1984, 1987).

In seeking ways to transport bicycles, transit agencies tried various types of vehicles, specially-outfitted buses, bike-towing trailers, and a variety of vehicle-mounted racks. Early programs made use of rear-mounted racks, but by the early 1990s these were falling out of favor to the front-mounted racks (FMRs) ("Case Study No. 9," 1992; Replogle, 1987).

Sacramento was seeing high levels of bike access by the early ‘90s, with 6% of bus and 8% of train riders accessing the bus by bike. This was attributed to easy station access:

> “All light rail stations in Sacramento, except one… provide at grade pedestrian and bicycle access. Some 17 of the system's 28 stations are within three blocks of a city or county bikeway facility. Linkages at most stations are via residential or connector streets with low traffic volumes, presenting little or no problem for bicycle access. Four LRT stations are located on pedestrian/transit malls.” ("Case Study No. 9," 1992).

“Bicycle on bus, in particular, has become quite common owing to increases in federal funding sources, transit agencies replacing old buses with newer models, and private industry developing bicycle rack designs to overcome operational limitations.” (Schneider, 2005). The American Public Transit Association (APTA) has attempted to capture this trend in data. They rely on reports from member transit agencies to identify characteristics of public transportation in the United States. Figure 5 shows the percentage of buses equipped with racks since APTA began collecting this data in 2001. While these numbers are not perfect, they suggest an upward trend in the use of bike-load, with the number of FMRs more than doubling in less than a decade. While these numbers are probably inflated (not all bus agencies are APTA members nor do all contributed to the survey; those agencies not reflected in the data are likely to be smaller, slimmer operations without bike amenities, and those agencies that do have FMRs are more likely to self-identify) their findings suggest that most transit buses in the U.S. today do accommodate bicycles. Those agencies who have not installed FMRs are increasingly in the minority.

This widespread adoption of bike-load and proliferation of FMRs seems to be unique to the United States. At the present time, no scholarly literature refers to FMR use in other countries. While the technology could work in similar contexts around the globe, it may be that the auto-oriented environment of the U.S. is actually what has allowed bike-load to grow in this country. In highly-developed countries of Europe and Asia, bikes and buses are alternatives that are

mutually exclusive, competing with each other in local transport and as a feedering mode to rail. In the U.S., bus routes are more central to the transit network and must also serve large areas of low-density suburbs. Sparse bus service creates a gap with long distances required to access transit (on both ends of the trip). In these environs, the bicycle acts as a bridge over this barrier to transit use.

The use of bike-on-bus to transport the bicycle along with the passenger also solves the egress problem faced in other countries. With low levels of biking, agencies so far have generally been able to accommodate the few who do bike to transit with FMRs. However, as bike-n-bus ridership continues to increase, it is unclear if this system will continue to work.

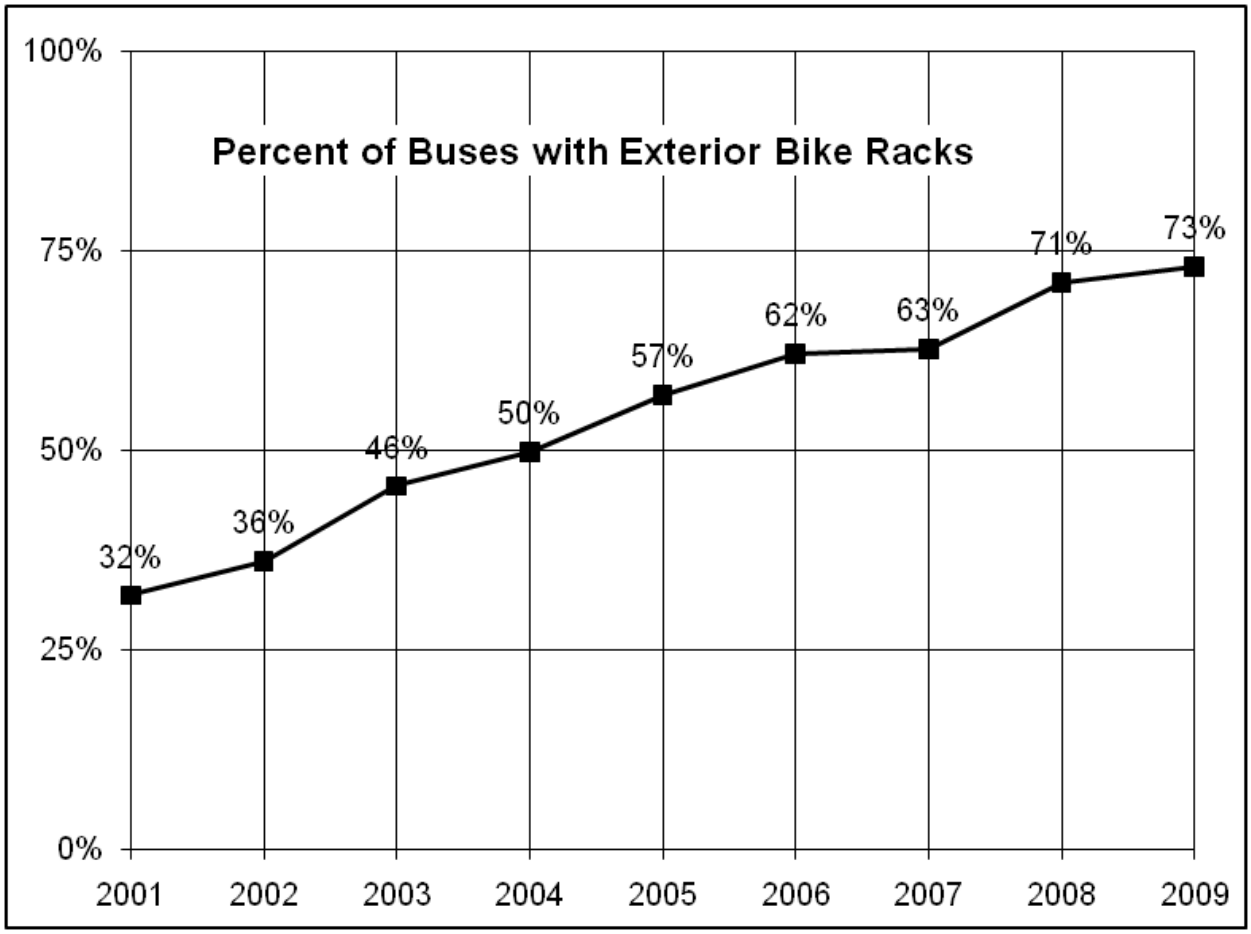

Figure 5 – Expansion of Bike-Load in the U.S. during the 2000s (Neff, 2008-2010)

Table 5 – Early Bike-n-Bus Programs ("Case Study No. 9," 1992)

Table 9. Bike-on-Bus Services in the United States

Transit Agency	Year Started	Permit?	Route/Time Restrictions	Use
REAR-MOUNTED RACKS				
San Diego, CA	1976	No	3 routes; designated stops only	8 bikes/ day
Humboldt Transit, CA	1984	Yes	designated stops only	898/month in 85; 264 permits in 87
Santa Cruz, CA	1980	No	3 routes; spec. load/unload stops	400 bikes/mo
FRONT-MOUNTED RACKS				
Seattle	1978	No	45 racks on 12 routes	no survey
SCRTD, Los Angeles, CA	July 1991	Yes-$6	1 route only; 6 buses/day	1 bike/day
Phoenix, AZ	March 1991	No	3 routes; going system-wide 7/92	Heavy
Roaring Fork Transit, Aspen, CO	1980	No	System-wide; no restrictions	High use
Tri-Met, Portland, OR	July 1992	Yes-$5	Weekdays: 4 routes; Weekends: 5-6	
North Cty Transit, San Diego	1980 (began with rear racks; 1989 switched to front)	No	75% of routes equipped; load/unload at designated stops	Week in Aug 91: 292 users
BIKES IN BUS				
Santa Clara Cty, CA	July 1988: front-rack demo route; 1990: demo inside bus on 7 routes; 1991, system-wide	No	Weekday: 2 routes; Weekends: 7 routes	
DART, Dallas, TX		No	All routes; nonpeak hour weekday; weekends all day	
Toronto Transit, Canada		No	All buses; nonpeak hour on weekdays	
RTA, Sacramento,CA	1990	Yes-$5	All buses; nonpeak on weekdays	
Windham Reg. Transit, CT	1980: demo rear racks; discontinued. In 1984; switch to inside bus	No	1 route (only route in system); load at designated stops	Popular in community
Sonoma Transit, CA	April 1991 (use disabled tie-down space)	No	3 routes to University; no stop restrictions	10-15 bike trips/day
Metro-Dade, Miami, FL	FY 1993 Capital Project		Estimated cost: $2,000/bus	
BUS AND TRAILER				
SF Bay Area (Caltrans Bridge shuttles)	1991: Benicia-Martinez Bridge (14 bikes); 1977: Oakland Bay Bridge (14 bikes)	No		6-8/day on Benicia Bridge but high on Oakland Bridge (13,154 in 1991)
Santa Barbara Transit, CA	1979-83: demo; discontinued due to budget cuts		Equipment wore out; too costly to repair and maintain; no bike/bus service now	

TABLE 9: Bike-on-Bus Services in the United States. (Continued on next page)

2.5 Benefits of Bike-and-Bus - Still Room for Growth

Every author on bike-n-bus alludes to its benefits…

> "The benefits of bicycle-transit travel in comparison with automobile travel are readily recognized: lower air pollutant emissions, reduced highway congestion, lower capital costs for park-and-ride facilities, and improved neighborhood environments."(Doolittle & Porter, 1994).
>
> "Bike-and-ride offers a number of environmental and societal benefits over the use of the private car. The environmental benefits include reduction in energy use, air and noise pollution." (Martens, 2004).

Indeed, it seems sensible that bike-n-bus would be a good thing; biking and transit are automatically understood as environmentally friendly and socially conscious forms of transportation. It is no surprise that combining them should yield benefits – even beyond the benefits of each mode on its own.

Hagelin's cost-benefit analysis makes the most complete assessment of the gains bike-n-bus might yield, separating them out in detail. Table 6 shows just some of these benefits, along with some common costs. Overall, he finds that bike-n-bus is an unquantifiably good return on investment (Hagelin, 2005).

The benefits of bike-n-bus will fall into one of three categories laid out by Schneider: (1) Improving transit by extending its reach (2) providing a transportation alternative for cyclists, and (3) diverting people from automobile use (Schneider, 2005). These categories are generally similar to the benefits presented in the FHWA brochure shown in Figure 6. In this study, the benefits of bike-n-bus are presented in similar categories in a slightly different order.

Table 6 – Benefits of Bike-n-Bus (Hagelin, 2005)

Table 2.2: BOB Returns/Benefits

Benefits	Definition	How Measured?
BOB Ridership	Total number of BOB boardings	Percent of total unlinked passenger trips that are BOB users
Expansion of Service Area	Bicycle access to transit expands the service area buffer zone	Distance bicycled to and from transit stops to destinations
New Riders	BOB users that were not using transit prior to program	Percent of BOB users new to transit and report switching to transit because of bicycle access
Frequency of Use	Increased frequency of transit use due to use of Bikes on Bus program	Percent of BOB users that have increased the number of transit trips since using program
Bicycle locker rental fees	Fees from lockers rented at transit stations	Money collected from the renting of bicycle lockers per year
Improved bicycle safety	BOB gives bicyclists the option of boarding the bus and avoiding dangerous corridors	Decrease in bicycle-car crashes on roads served by BOB transit, comparative crash rates
Reduced traffic congestion and improved air quality	Impact of switching to transit and bicycling from another mode	Number of vehicle trips reduced/eliminated by those BOB users that are new to transit
Health	Bicycling provides the necessary daily exercise	Individual health improvements translated in societal level benefits
Transit agency image	Public perception of a transit agency's multi-modal and environmental efforts	Changes in public perception of transit agency

2.5.1 Gives Cyclists a Lift

Most fundamentally, bike-n-bus is an added amenity available to cyclists:

> "Bicycle-on-transit services provide bicyclists with the option to take transit to avoid riding after dark, up hills, in poor weather, or in areas that do not provide comfortable bicycle access (e.g., bridges, tunnels, construction areas, and narrow roads with high traffic volumes). Bicycle-on-transit is also an option for bicyclists who have mechanical problems or need to get home in an emergency." (Schneider, 2005).

This study interviewed a transit professional from Houston who expounded on this idea…

> "The bike lane rider who reaches an unsafe place in the City could combine his trip with a bus to continue his trip; or perhaps he reaches a point of heat or fatigue and could use the bus to finish his trip. The recreational rider who would rather not ride in the street could access the bike trails that are close to a bus route." (Houston Metro)

Indeed, the earliest bike-n-bus programs in California and Seattle were in response to the demands of cyclists who could not cross topographical boundaries (highways being for autos only). First and foremost, bike-n-bus is for those who travel by bike. This view is also the consensus among agencies surveyed for this study. The PACE respondent stated that while bike-n-bus could benefit anyone, bicyclists benefit immediately, because they can reach their destination more easily.

These bikers are often individuals who have limited travel options. To them, bike-n-ride offers greater flexibility in using their bike, and a back-up should the bike fail or the weather turn foul. This means "Bike-and-ride is important from a perspective of social justice as it provides a relatively high quality service for people who cannot (afford to) drive a car." (Martens, 2004).

2.5.2 Widens Rider Base for Transit

Facilitating broader access to transit serves both the needs of individual and directs customers to transit. "Bicycling extends the catchment area of transit services and provides greater mobility to customers at the beginning and end of their transit trips." (Schneider, 2005)

"Most bus riders walk no more than 1/4 mile. Bicycle access to bus stops would appear to hold significant potential to expand the transit market area in a cost effective manner." ("Case Study No. 9," 1992) As a Metro respondent noted in this survey, "given that bicyclists can access a bus stop or train stations three times the distance of a pedestrian, [bike-n-ride] outreach could possibly make the transit system accessible to more people." (Houston Metro). (Three times is perhaps a conservative estimate – see Bus routes in need of riders, below.)

Individuals in need of transit

Bike-n-bus offers a particular advantage to the individuals who are most needy. In his early case studies, Replogle found some of the riders were from homes with limited access to a personal automobile, emphasizing the importance of bike-n-bus for those with limited mobility. Hagelin found 35% of bike-n-bus users do not even hold drivers license (Hagelin, 2007). Three-quarters of biking passengers make less than $30,000 per year (Hagelin, 2005). So, enabling those with limited mobility to access transit is no small concern.

> "Despite the importance of the automobile in American transportation, one-third of all citizens do not possess a driver's license. Even in suburbia, some 12% of all households lack an automobile… Although not suitable for everyone in these market segments, bike-and-ride travel may offer a strong appeal to many such people." (Replogle, 1984)

Specifically, there are three ways bike-n-bus aids the mobility-limited person. For those so distant from transit that they are left virtually stranded, bike-n-bus opens the door to a regional transit system. For those who are reasonably close to transit, it allows them speedier, easier access. Finally, for all those who rely on transit, enabling the use of a bicycle broadens access to jobs, shopping, and housing options located well beyond the transit line.

Bus routes in need of riders

Better bike access to transit is also good for transit agencies.

> "The combined use of bicycle and public transport may also increase public transport ridership on specific lines, thereby strengthening the economic performance of these services." (Martens, 2004).

People may travel greater distances to reach a bus stop – up to about 1.5 miles (Hagelin, 2005, 2007; Replogle, 1984), six times the ¼ mile typically assumed for walking. This increases the area that can be served by a single bus stop by a factor of 36, drastically increasing the number of people within range of the bus. By enabling bicycle access, the same old bus routes suddenly cover a wider territory and can have higher ridership.

A positive feedback loop

This could lead to a positive feedback loop, whereby the advantages of bike access can be translated into a cost-saving route structure, while still attracting riders. Hypothetically, if bus routes were designed around bicyclists' range instead of pedestrian walking distance, many cost-saving measures could be realized. First, bicycling would allow greater spacing between bus routes. Rather than spacing parallel routes ½-1 mile apart, transit agencies would only need to have routes every 2-4 miles apart. Bicycles would reduce the need for buses to meander through neighborhoods. Instead, buses could stay on the major streets, and thus travel faster. (These major streets are also where many retail destinations are located.) Secondly, bus stops along a route could be spaced farther apart. This means the bus may not have to stop as frequently and could improve its overall speed. This faster service would still serve pedestrian riders along the bus corridor, and it would increase the desirability of that transit line. Those who already ride their bike to transit would find it increasingly desirable to do so, because of the faster service. Faster service might allow the bus line to be extended, increasing the agency's service area.

While bus agencies must serve existing riders that accesses transit by foot, such a bus system designed around bike access could be acceptable in the large suburban areas not yet infiltrated by transit. By catering to bicycles, transit agencies may be able to extend service beyond their current limits. Martens agrees, saying "bike-and-ride may strengthen the economic performance of specific types and lines of public transport, as it attracts an additional group of consumers." (Martens, 2004).

Hagelin concludes with this message to transit agencies: "The BOB user survey results showed that BOB programs attract new patrons, encourage increased use of transit, and expand the

transit service area." (Hagelin, 2005). A PACE representative emphasized, "It's all about getting people that last mile."

2.5.3 Competitive Alternative to Driving

Not only does bike-n-bus help cyclists and those already inclined to use transit, it may give some travelers a viable alternative to driving a personal automobile. This yields a number of other benefits relating to the environment and reduced dependency on petroleum energy.

> "Bicycle and transit integration is also thought to decrease automobile traffic congestion, help reduce air pollution (by reducing motor vehicle trips), and improve the public image of transit." (Schneider, 2005).

Biking vs. auto access to transit

The most direct way bike-n-bus can reduce automobile trips, fuel consumption, and emission is as an alternative to automobile park-n-ride (Replogle, 1984, 1987; Replogle & Parcells, 1992).

> "Bike-and-ride may have high shares in total travel in certain localities and during certain parts of the day. Suburbs served by a high quality train service are a case in point—here, road congestion and pollution levels may be significantly reduced during rush hours." (Martens, 2004).

Transit vs. auto commute

Bike-n-bus has shown potential for attracting automobile commuters to transit. This is shown in Hagelin's findings that 24% of bike-n-bus users are new to transit (Hagelin, 2005).

Even in the Netherlands, Martens found that, while bike improvements mostly cause riders to switch their access mode from walking to bicycling, improved accommodation for bicycles did attract some new transit customers from among those who previously drove (Martens, 2007).

What prompted this switch? Hagelin found many in the U.S. wanted to get daily exercise, and/or to help the environment (Hagelin, 2005).

Enabling car-free lifestyle

"Furthermore, bike-and-ride may help to enable car-free lifestyles, as it will improve the overall competitiveness of the 'green' modes of transport" (Martens, 2007). While bikes and transit can do a lot to supplement auto ownership, good bike-transit multiplies the effectiveness of each of these. Car-share programs and a host of other alternative transportation modes could also be used in conjunction with bike-n-ride to further enable life without a personal automobile.

> "The combined use of bicycle and public transport may enable car-free lifestyles as it provides a relatively competitive alternative to the car for trips of intermediary and longer distances, suggesting a more substantial contribution of bike-and-ride to pollution reduction." (Martens, 2004).

Benefits to non-users

Even those who continue to drive can benefit from bike-n-bus. Martens finds that bike-n-ride, since it caters to the commuter, has the potential to reduce congestion along key corridors and critical intersections at the busiest times of day. This in turn leads to greater emissions reductions and improves quality of life.

Furthermore, BnB stabilizes the costs of travel by providing alternatives that consumers can trade off against one another. By reducing congestion and providing transportation alternatives, bike-n-bus can help reduce national dependence on automobiles and foreign oil. TCRP Synthesis 62 summarizes:

> "All of these benefits help communities reduce their reliance on single-occupant vehicles travel and make their transportation systems work more efficiently." (Schneider, 2005).

Clearly bike-n-bus is valuable in that it supports sustainable modes like biking and transit. "Furthermore, there are additional benefits that cannot be provided by each of the modes on their own." (Doolittle & Porter, 1994). If the combination of biking and transit can coax drivers out of their automobiles, many further benefits may be realized. Simply put, "More bicycles mean less people are driving, decreasing traffic congestion for drivers, and lowering impacts on

air quality. [Bike-n-bus] encourages both bicycle use and transit use… both for commuting and recreation.” (PACE respondent).

BICYCLES AND TRANSIT

Strategies and Benefits

There are several benefits to investing in and integrating transit and bicycle facilities:

for Bicyclists

Access to transit allows bicyclists the opportunity to make longer trips. Where physical conditions prevent a continuous bicycle trip, public transportation can provide a link to previously inaccessible destinations.

for Public Transportation Providers

Improving bicycle access attracts new transit riders. Bicycle access expands transit's catchment area. Distances to transit stops that may be too far to walk may be within range of a short bicycle trip. Bicyclists represent an important weekend or off-peak market, when transit ridership is typically lower and capacity is underutilized. Providing secure parking for bicycles at transit stops and stations is less expensive than providing parking for automobiles.

for Livable Communities

Bicycles and transit provide more mobility options to everyone, particularly those who because of age, disability, or income are unable to drive. Less automobile traffic through neighborhoods contributes to a safer, quieter, and more pleasant environment.

for Everyone

Safe and convenient transit service and bicycle facilities attracts more passengers and increases the viability of transit service. Fewer trips by automobile reduces polluting emissions. Increased use of transit and bicycle facilities can decrease traffic congestion.

Figure 6 – Benefits of Bike-Transit Integration ("Bicycles & Transit," 1999)

CHAPTER 3: METHODOLOGY

Agencies were selected to be interviewed based on a number of criteria, so the sample would be representative of the nation as a whole. Respondents were asked to participate in a 10 question telephone survey lasting 10 to 15 minutes, with an email reply offered as an alternative. Along the way, it became apparent that the wording of some questions would need to be changed, to be more neutral. A generalization of the response to each question is given, with results being discussed in more detail in the next section.

3.1 Agency Selection

This study selected 55 transit agencies from the contiguous United States from a sample of over 200 agencies listed by the American Public Transit Association (APTA). Samples were selected in a manner thought to be representative of the nation as a whole.

Agencies were selected from all 10 Federal Transit Administration (FTA) regions within the contiguous United States. These 10 regions and their relation to cities with major transit systems are shown in Figure 7. To ensure a representative sampling, agencies were selected from among those listed on the APTA website. With 580 agencies listed, it is a nearly complete listing of substantial transit agencies. (The majority of counties in the U.S. offer some meager sort of transit service, but these sorts of agencies were not of concern to this study.) As seen in Table 7, the number of agencies selected from each APTA region was kept roughly proportional to the number listed for each region. However, a minimum number of agencies (3) were selected from each region to ensure meaningful results. A list of those transit agencies who responded to the survey, with both their formal and shortened names, is found in Table 8. Also

listed is the major U.S. city where each agency is located. For ease of reference, these agencies are alphabetized by the short name that they are referred to in this study.

In addition to the geographical distribution of transit agencies, the agency size, and general topography were considered in selection, with the intent of representing a wide variety of these conditions from within each FTA region. The results can be seen in the Appendix, "Sample Agencies and their Attributes." Information about the average commute time for the urbanized area, yearly temperature and rainfall, and the population density within each agency's service area were also collected.

Topography and climate measures were selected to account for cities that might be less suited for bike access trips just because of their geography. Similarly, commute time and population density were included to ascertain if the built environment was conducive to transit use (with the assumption that dense cities with lots of congestion would be better served by transit).

Some major cities are served by multiple transit agencies. In cases where no one agency seemed to dominate, the more-suburban transit agency was surveyed, as travel within the central cities is thought to have less need for bicycles in accessing transit. Also, it is thought that these agencies operate in a greater diversity of environments, from urban to rural. This is the reason for selecting agencies such as Riverside RTA outside of Los Angeles, AC Transit in the Bay Area, and PACE suburban bus in Chicago.

Additionally, all five transit agencies were selected from the Atlanta region in an attempt to provide a greater level of detail within a particular metropolitan region. Unfortunately, none of these agencies responded to the survey.

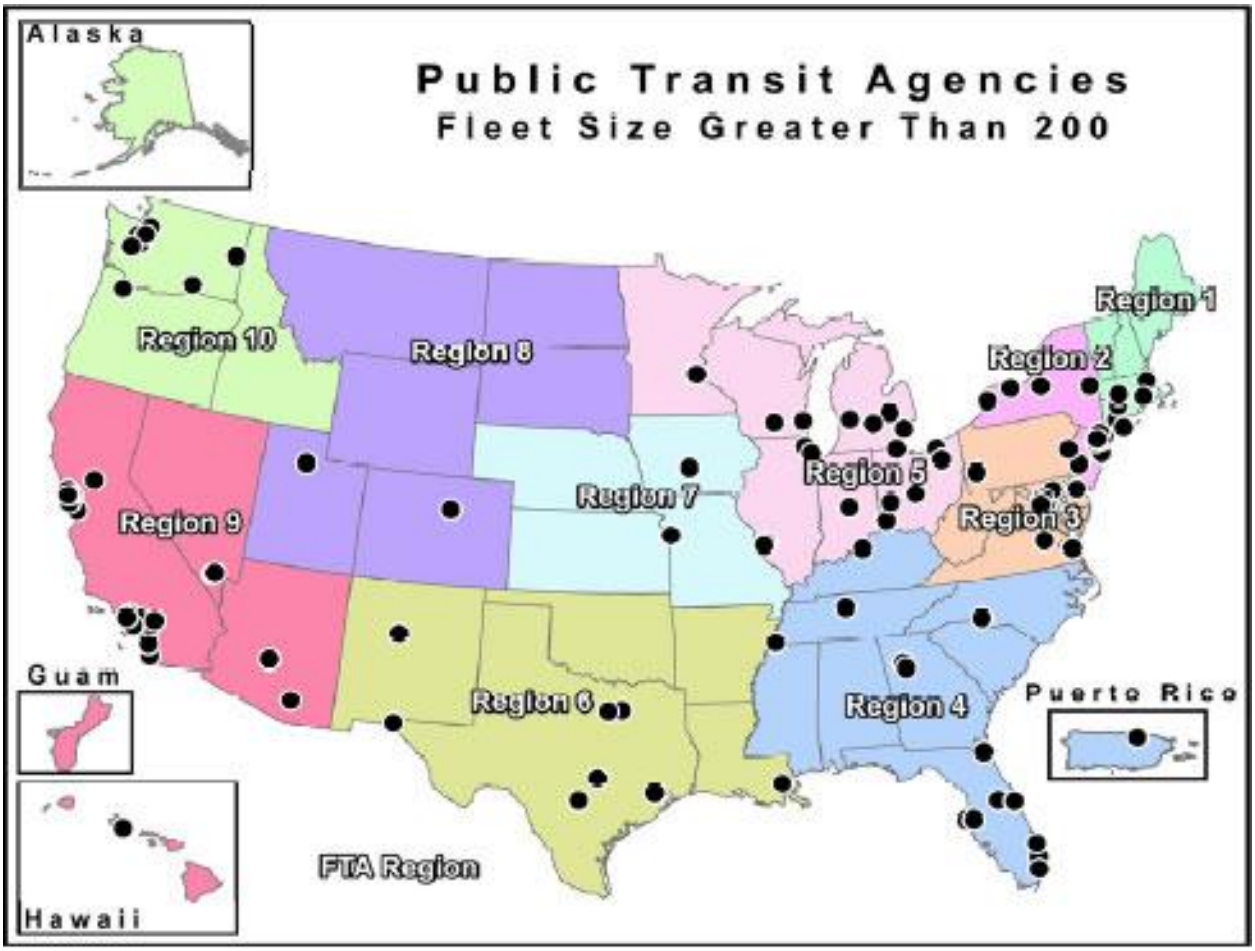

Figure 7 – FTA Regions ("Public Transit Agencies Fleet Size Greater than 200," 2009)

Table 7 – Selected Cities by Region

FTA	APTA-listed		Selected		Cities
Region	#	%	#	%	% sampled
1	43	7%	3	5.9%	7.0%
2	59	10%	3	5.9%	5.1%
3	45	8%	7	13.7%	15.6%
*4	98	17%	7	13.7%	7.1%
5	106	18%	10	19.6%	9.4%
6	52	9%	5	9.8%	9.6%
7	24	4%	2	3.9%	8.3%
8	19	3%	3	5.9%	15.8%
9	107	18%	7	13.7%	6.5%
10	27	5%	4	7.8%	14.8%
Total	***580***	***100%***	***51***	***100.0%***	***8.8%***
*5 agencies selected within 1 city (Atlanta) (55 agencies in 51 cities)					

3.2 Who Responded

From the 55 agencies contacted, 34 responded. Only one of these agencies – SMTD in Springfield, Illinois – indicated that they did not have any bike-n-bus accommodations, and thus gave no response to survey questions. Therefore, responses have been gathered for the 33 agencies with bike-n-bus accommodations. These 33 agencies make up 60% of the sample 54 agencies contacted. Overall, those agencies who responded make up 5.9% of all the (580) transit agencies listed by APTA.

As can be seen on the map in Figure 8 – Map of Selected & Responding CitiesFigure 8, responses come from agencies of various sizes from across the country. Generally, those that were least likely to respond were larger transit agencies and transit agencies in the northeast.

Table 8 – Responding Agencies

Responding Agencies			
ACRONYM or Abbreviation	**Agency**	**Urban Area**	**State**
AATA	Ann Arbor Transportation Authority	Ann Arbor	MI
AC Transit	Alameda Contra-Costa Transit District	Oakland	CA
CAT	Chatham Area Transit	Savannah	GA
CATS	Charlotte Area Transit System	Charlotte	NC
CATS	Capital Area Transit System	Baton Rouge	LO
CCTA	Chittenden County Transportation Authority	Burlington	VT
Centro	Central New York Regional Transportation Authority	Syracuse	NY
DART	Dallas Area Rapid Transit Authority	Dallas	TX
FAX	Fresno Area Express	Fresno	CA
GLTC	Greater Lynchburg Transit Company	Lynchburg	VA
GRTC Transit System	Greater Richmond Transit Company	Richmond	VA
LYNX	Central Florida Regional Transportation Authority	Orlando	FL
MAT	Fargo-Moorhead Metro Area Transit	Fargo	ND
MATA	Memphis Area Transit Authority	Memphis	TN
Metro	Madison Metro	Madison	WI
Metro	Southwest Ohio Regional Transit Authority (SORTA)	Cincinnati	OH
Metro	Metropolitain Transit Authority of Harris County	Houston	TX
Metro	Bi-State Development Agency	St. Louis	MO
Metro	King County Department of Transportation (KCDOT)	Seattle	WA

Table 8 – Responding Agencies (Continued)

Responding Agencies			
ACRONYM or Abbreviation	**Agency**	**Urban Area**	**State**
Metro Transit	Central Oklahoma Transportation and Parking Authority (COTPA)	Oklahoma City	OK
MITS	Muncie Indiana Transit System	Muncie	IN
PAAC	Port Authority of Allegheny	Pittsburgh	PA
PACE	Pace Suburban Bus	Chicago	IL
RTA	Greater Cleveland Regional Transit Authority (GCRTA)	Cleveland	OH
RTA	Riverside Transit Agency	Riverside	CA
SEPTA	Southeastern Pennsylvania Transportation Authority	Philadelphia	PA
SMTD	Springfield Mass Transit District	Springfield	IL
STA	Spokane Transit Authority	Spokane	WA
TARTA	Toledo Area Regional Transit Authority	Toledo	OH
The Metro	Kansas City Area Transportation Authority (KCATA)	Kansas City	MO
TriMet	Tri-County Metropolitan Transportation District of Oregon	Portland	OR
UTA	Utah Transit Authority	Salt Lake City	UT
Valley Metro	Regional Public Transportation Authority (RPTA)	Phoenix	AZ
Valley Ride	Valley Regional Transit	Boise	ID

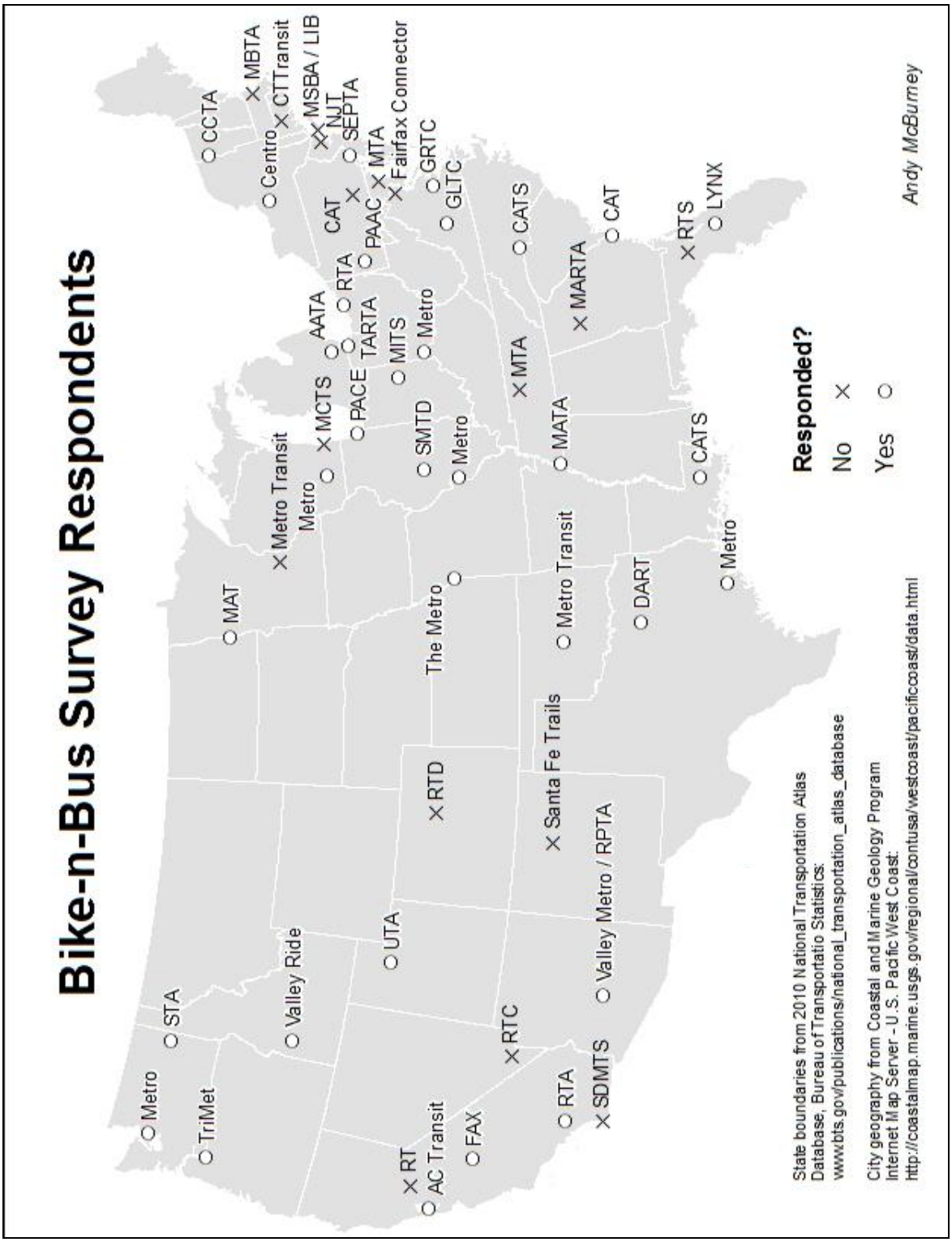

Figure 8 – Map of Selected & Responding Cities

3.3 Interview Description

Contact with the agency was made by calling the phone number available online from the National Transit Database or from the webpage of each agency. I introduced myself by indicating my role as a researcher, and named my institution (as "Georgia Tech"). I then indicated the subject of research as involving bicycles and buses, and asked for a contact person. Frequently, the receptionist needed to pause to think. In most cases the staff person was not available, so a similar introduction was left to voicemail. Those who responded were told to expect a 10 question survey that may take 15-20 minutes. A single introductory script was not followed in order to allow the introduction to evolve. If the respondent did not have time, it was suggested that the questions be sent and answered by email, though only six chose to respond in this manner (DART, Lynchburg's GLTC, Houston Metro, Burlington's CCTA, Fargo, and Pittsburgh's PAAC).

It seems from the nature of the responses that bike-n-bus is not a subject of much attention. Some receptionists receiving the phone call were confused by the term bike-n-bus or the expression "accommodating bicycles on the bus." The description "bike racks on the bus" had better recognition. In many instances, the receptionist was unsure of which person to refer the call to. This is part of the reason survey respondents occupy such a variety of positions (see Table 9).

Of those who responded to the survey, six were on the general staff as the agency Director, General Manager, or CEO, or their assistant. In nine agencies the respondent was involved in planning or scheduling work. Ten of the agencies replied via a representative from the public relations department. In eight instances the contact person was responsible for overseeing operations and maintenance. Only in one instance did a (planning) respondent specifically

indicate that he personally used the bike-n-bus system in his city. The breakdown of who within the agency responded to the survey is shown in Table 9 below.

While the introduction lacked a script, the 10 questions were prepared in advance to be asked of the respondents nearly word-for-word. Questions were left open-ended in order to encourage diversity and detail on the part of the respondents. In some cases respondents were asked to clarify their responses. The questions and a summary of the common responses can be found in the section 3.5 Survey Questions and Responses.

At first, many respondents described the procedure for physically securing a bicycle on the bus, and those who were familiar related the history of the program. However, subsequent questions were replied to with less certainty, or even conjecture. In a few instances, the interviewer received such comments as “that’s a good question,” “I never really thought about that,” or “I’ve never been asked that before.” Frequently responses were preceded by a pause, in which the respondent seemed to be searching for a response.

Table 9 – Position of Survey Respondents within their Agency

Respondent's Position in Agency	#	%
Director/ General Manage/ CEO	6	18%
Planning or Scheduling	9	27%
PR/ Marketing/ Customer Service	10	30%
Transportation/ Operations/ Maintenance	8	24%
Total	33	100%

3.4 Refining the Questions

Through the course of the interviews, it became apparent that the phrasing of the questions introduced a pro- bike-n-bus bias. Those working with the transit agencies did not view bike-n-bus as a program, with ongoing efforts toward some goal, but as a complementary amenity that has existed since the front-mounted racks (FMRs) were first installed. Efforts to maintain the racks or encourage their use were seen as a bonus. Particularly, comments from AATA in Ann Arbor triggered the change. They said that bike-n-bus has never been looked at by the agency as a program, but as an amenity. Their goal was never to attract ridership, only accommodate it. They do not have a problem with attracting ridership; installing FMRs was not an attempt to get people to ride. Similarly, MATA in Memphis said they have gotten compliments from non-users thanking them for providing the FMRs as an amenity; it is seen as being "cool" and people "get a kick out of it." For such reasons as these, the interview questions were revised to eliminate references to bike-n-bus as a "program."

Noteworthy changes were made to four of the ten questions:

Question 2 – "What policies have your agency instituted in the bike and bus program?" was changed to be more tentative and less assuming: "What policies have your agency instituted to accommodate bicycles?" To mitigate confusion, this question was immediately followed by generalizing "policies" to mean anything formal or informal.

Similarly, in Question 6 wording was changed from asking "What metrics or performance measures are used to evaluate the bike and bus program?" so as not to assume that the agency has such things in place: "Does your agency have any metrics or performance measures…?"

Question 8 was originally worded “What challenges are associated with attracting bike and bus ridership?” However, some respondents claimed that it was not the agency’s job to attract bicyclers, but only to accommodate bicycles brought by transit riders. Therefore, the question was restated in the negative, to ask “Do you have any sense of what may be deterring people from biking to the bus?”

Question 10 – “Do you feel your bike and bus program has potential for improvement or growth?” – was clarified by saying “…growth, either by improvement or expansion.”

3.5 Survey Questions and Responses

Refined questions and general description of responses:

1. *I understand that your agency has a bike-and-bus program. Could you describe its history and current extent?*

   Respondents spoke about persons or groups who influenced the decision to install FMRs, when the installation began, and how long it took for the system to meet 100% accommodation. SMTD in Springfield, Illinois was the only respondent that did not have bike accommodations. Pittsburgh stated that only half of their buses were equipped with FMRs. MATA in Memphis was the only other agency to not be near 100% FMR equipped.

2. *What policies has your agency instituted to accommodate bicycles? They can be formal or informal. Can I get a copy of your written bike-and-bus policies?*

   Many respondents seemed baffled by the term “policy” in relation to the bicycle program. Most respondents identified a written copy of the bike-loading instructions either in the

form of a pamphlet or on the agency website. A few clarified that the driver did not assist with the loading of the bicycle or discussed the bike-on-bus policy.

Specifically, seven agencies identified a "policy" relating to bicycles. Centro, in Syracuse, says that their only policy is the 2-bike limit of the rack. PAAC (Pittsburgh) refers to their how-to website. Charlotte CATS says that they have policies but they are informal. The only written material would be in the training instructions for bus operators. PACE made a similar statement about policies being informal. Houston Metro refers to their informational flyer. The Metro in Kansas City has an informal policy of getting racks on every bus. They do have a written code of conduct, displayed on website, which was developed for the program to lay out expectations. The code was developed by an internal team and got feedback from a focus group made up of customers (called CATS).

Seattle Metro has some of the most detailed policies. There, bikes are not allowed to board or unload in the fare-free area of Seattle between 6 am and 7 pm, due to space constraints and safety concerns. Also, deadheading buses are allowed to pick up bikers for free crossing of the Evergreen Point Bridge over Lake Washington, as it does not accommodate bicycles. There is no extra charge for carrying a bike. They also forwarded the driver training manual that teaches bus operators how to handle bicyclists. In Portland, instruction to the bus operators is integrated with the safety training they receive. The policy for MAX LRT is much more extensive.

3. *Have any parties outside of your agency had an opportunity to help shape your bike policy?*

Bicycle advocacy and cycling interest groups are the predominant groups with which the transit agencies have interacted. In some agencies, the BnB program is a response to pressures from these groups. In other cases, the agency has reached out to these groups for help promoting the program. Some respondents described agency involvement in Bicycle & Pedestrian Advisory Councils (BPACs) at the Municipal Planning Organization (MPO). These groups are made up of representatives from various municipalities and interest groups, along with regional transportation planning officials, to discuss concerns of bicycle use. Still, with regard to their bicycle accommodations 9 of the 33 respondents described no regular interaction with other groups.

4. *(Of those agencies who mentioned particular literature a copy was requested.)*

Many respondents referred to the transit agency's website as the most comprehensive document. All websites that mentioned front-mounted racks gave instructions for physically loading and unloading a bicycle, either in text, with pictures, or in some cases with an additional movie. Some sites mentioned other guidelines for bringing your bike; such as how to communicate to the bus operator that one was going to remove one's bike. A few agencies referred to a printed brochure. Only Seattle Metro mentioned a document internal to the agency. They shared a copy of their bus-driver training book.

5. *Who do you understand to be the stakeholders in the bike-and-bus program?*

Respondents frequently identified users to be typical transit riders, often commuters and students. Some emphasized the diversity of those who bike to the bus; it is not just the young men and students one might stereotypically expect. The BnB program is popular with those already committed to recreational cycling and vehicular bicycling, and it is

thought to be of particular concern to environmentalists and transit advocates. It is also thought that municipalities and the region as a whole have a mentionable interest in the BnB program.

6. *Does your agency have any metrics or performance measures that are used to evaluate the bike-and-bus program?*

   No agency reported any performance measure by which their program was evaluated. Instead, programs are assessed by monitoring complaints. Nevertheless, about half of the agencies collect data on the number of bicycle boardings. Usually agencies rely on bus drivers to keep a tally using a key on the farebox or radio. Many agencies would like to collect more data on their program, but this is a relatively low priority.

7. *Do you feel your bike-and-bus program has been a success?*

   Respondents unanimously agreed that the program was a success, as the FMRs are actually used. Some respondents seemed surprised by this. Formally agencies have no standards by which the program is evaluated. Simply providing a user the option of transporting a bicycle is seen as an end in itself.

8. *Do you have any sense for what may be deterring people from biking to the bus?*

   The safety of bicycling is the primary human determinant of bike-n-bus use. Many thought potential BnB users were discouraged by auto-dominated roadways that are unfriendly toward biking. Limited FMR capacity and shortage of bicycle parking at the final destination are also thought to be significant factors in how much the program is used. Many respondents saw increased bicycle ridership corresponding to high gas prices during 2008. Winter weather is the main natural deterrent to BnB use.

9. *Has there been any discussion within your agency or from another group to make changes to the bike (and bus) program?*

   Thirteen of the responding agencies have or are considering installing bicycle parking or bike lockers at key transit hubs. About a quarter of the agencies have or are considering upgrading to the 3-bike FMR designs. However, 42% of agencies (14/33) stated they had no plans to change.

10. *Do you feel your bike (and bus) program has potential for growth, either by improvement or expansion?*

    Agencies generally expected BnB ridership to continue to grow. While respondents seem open minded about changes to the program, few saw an urgent need. Because bicyclist safety and bicycle parking control BnB ridership, agencies are mostly dependent on local governments to commit to being "bicycle friendly."

Because of the limited attention to bike-n-bus as a program, combined with the open nature of responses, not all responses corresponded directly to one particular question. Some questions triggered a more detailed response to a previous question. For the sake of evaluation, it was decided to list all unique responses in a spreadsheet and keep a tally of how many respondents made such a response. This allowed greater detail in evaluating responses. Note that the open-ended nature of questions means that agencies only divulge the information that the speaker finds to be important. For example, 4 of 33 respondents mentioned circulator or paratransit vehicles, but officials of other agencies did not specifically think to mention these.

In some cases, these responses may be tempered by the "Hawthorne effect," with respondents giving the response they believe the interviewer wanted to hear. For example, question 10 might have been answered "We are always looking for ways to improve the program," even

though the only instituted mechanism for user feedback is overwhelming customer complaints. For this reason, subjective information within the responses should be interpreted as the views of individuals working within transit agencies, not as a thorough examination of agency views.

The next chapter incorporates these findings, organized by topic, with existing literature.

CHAPTER 4: FINDINGS

This report now proceeds into a direct discussion of bike-n-bus. Sections follow a progression from the fundamental issues of accommodating bicycles to answer broader questions about how bike-n-bus is used. It includes the various ways to accommodate bicycles with bus transit, the dynamics of starting a bike-n-bus program, the effort required to publicize the program, and the on-going discussions with other groups concerned with bike-n-bus. It further discusses the hindrances faced by would-be bike-n-bus users, and assesses who is likely to use BnB, as well as identify its other stakeholders.

Research from other literature is included throughout this chapter to complement these discussions and to draw parallels between this study and others. This chapter also includes some story boxes, to provide color to the facts citied about some of the transit agencies.

4.1 Ways to Accommodate Bicycles

Bicycles on transit can be handled in a number of different ways. On Amtrak inter-city rail, they must be partly disassembled and shipped in a special box. On coach buses, such as those used by Greyhound and for express bus services, bikes can be stowed in the undercarriage storage spaces (sometimes in special boxes, bags, or trays). Inside buses and rail vehicles, bikes can be hung vertically from hooks, secured with the wheelchair restraints, leaned against seats or simply held by the rider. Folding bikes can also be used and easily carried aboard. Bikes can be carried outside the bus on a trailer, rear-, or front-mounted bike rack (FMR). FMRs are far-and-away the most common form of bike-transit integration. FMR racks are available from a number of vendors in a variety of designs. Normally they can accommodate one, two, or three bikes, but custom racks are seeking to increase this number even more.

When not transported on transit, bikes can be parked at rail stations, bus stops, or transfer centers. The simplest form of bike parking is the "bike rack." One of the most popular designs for a bike rack is the structure with the "inverted-U" shape, as it allows the owner to lock both wheels and the frame of the bike. Bike rack parking can be upgraded to sheltered parking by placing under an overhang or by constructing an awning over the rack to provide protection from the rain. Bike lockers provide both shelter and enhanced security. A transit rider usually will rents a locker space from the transit agency at a station or transfer center. These can be used for day-time parking, or for overnight parking for a bike used during the day. Secured bicycle parking overseen by a staffed supervisor makes sense in locations with hundreds of bicycles. These sorts of facilities can be designed to store bicycles more densely than conventional bike racks. Additionally, bike-share and bike rental facilities can provide bicycles when they are needed only on the destination end of the transit trip, in addition to serving tourists and visitors to the city.

This study focuses on bike-load with front mounted racks (FMRs), bike-in-bus, and bicycle parking at bus stops.

4.1.1 Bike-Load with Front-Mounted Rack

Bike-Load involves transporting a bicycle on transit. However, instead of carrying the bike inside of the bus, it is mounted on a contraption external to the bus. This requires the passenger to load their bike prior to boarding. Bike-Load is the most common form of bike-transit integration in the U.S. today. Bike-Load is nearly synonymous with the use of front-mounted racks (FMRs). According to APTA, nearly three-quarters of transit buses in the U,S, are equipped with bike racks (Neff, 2008-2010). FMR racks are available from a number of vendors in a variety of designs. Usually they are designed to fit two standard bicycles, though

three-bike racks are now available on the market. Hagelin found that agencies paid on average $465 per bike rack (Hagelin, 2005).

This section discusses the basics of FMR design, three-bike FMRs, loading and unloading procedures, capacity limitations, the safety of the bike-load user, the security of bicycles outside the bus, the potential for bike loading to delay the bus, and FMR maintenance.

Front-mounted rack design

Racks have come in a variety of designs, although it seems engineers are arriving at consensus on what works best. Most racks have slots for the wheels of the bicycle and some sort of bar clamping over one of the wheels to secure the bike. Sportworks has patented their arm design that provides "three points of positive contact on the tire." Their testimonials find this to be quite secure (Sportworks Northwest, 2011).

A LYNX (Orlando) planner found the bike racks easy to use. Cincinnati's SORTA affirmed their decision to buy Sportworks brand FMRs, finding them as being low-cost and reliable. However, four agencies did note that bike racks cannot accommodate all sizes of bicycles, such as recumbent bikes and children's bikes, suggesting that they may have had incidents where this was a problem for passengers. There are no brands that accommodate all sizes of bikes.

Three-bike FMRs

While most front-mounted bike racks (FMRs) accommodate two bicycles, three-space bike racks have recently come into the market. However, these larger racks have faced challenges. The main concern is that with the new design bikes will block the bus headlights at night. It is uncertain how much of a danger this poses. Nevertheless, engineers have been working toward a solution, and acceptable 3-slot rack designs will soon be available. Beyond the headlight complication, some agencies are hesitant to purchase racks that will protrude even

farther from the bus. Two-slot bike racks already extend the length of the bus, making it more difficult to turn in tight spaces. Riverside RTA shied away from three-bike racks because loading bikes takes longer. With few calls to dispatch about the rack being full, planners find it doubtful that three position bike racks would be needed. On the other hand, Madison Metro, which started their program with two-bike FMRs, now has three-bike racks on half of its buses, with plans to upgrade the rest by the end of 2009. "It's very well used," they say. (This may be due to the large student population at the University of Wisconsin).

Loading & unloading procedures

Four agencies stated that the responsibility for loading and unloading a bicycle belonged entirely to the user. The advantage is that the bus driver does not need to leave his or her seat. AATA's representative claims drivers are only permitted to give verbal instruction to those who encounter difficulty loading the rack. However, Riverside noted that in some cases a bus driver trying to hurry will exit the bus to assist the user having difficulty with the rack.

Memphis's MATA and Boise's Valley Ride spokesperson pointed out that bike-load requires the bicyclist be physically able to lift his or her own bicycle. This has implications for out-of-shape and impaired riders. One senior woman in Phoenix is trying to design a roll-in bike rack to accommodate bicyclists with weak arms. At the time of this study, she had not received feedback from the manufacturer she submitted it to.

Riders may encounter extra difficulty when trying to load non-standard bikes. Riverside noted two occasions in a six month period where a bike would not fit the rack. In the past, young riders discovered that the rack is not designed for children's bikes. Bi-State Metro, in St. Louis, has also found that bicycles with tires over 28 inches do not fit in the rack. Because of the variety of bicycles in the world, no FMR brands accommodate all sizes of bikes. It is perhaps

for this reason that, motorized bicycles are not allowed in the rack. Madison further clarified that it allows only “standard” sized bicycles.

It is recommended that bicycles be mounted so that the bar locks over the front wheel, but Bi-State Metro has had no problems in instances where bikes were secured backwards. There is no consensus on whether the front or back bike slot should be loaded first.

A detailed description of safety precautions for loading and unloading given by Bi-State Metro can be found later under the heading “Safety of user.”

Capacity limits

Limited bicycle capacity is the most noticeable constraint to Bike-n-Load. Eight of the 33 interviewees mentioned this “first-come, first-served” issue. From time to time a rider will discover when the bus arrives that the rack is already full. Except in those cases where bike-in-bus is allowed, this means a rider must be passed by. How she reaches her destination is dependent on her choice; she may choose to wait for the next bus, to peddle to a different route, drive the bike toward her destination, find a location to park her bike near the stop, or simply not make the trip. It is unknown how much this risk of being turned-away deters travelers from bike-n-bus. Hagelin found that 26% of those who bike-n-bus, particularly those who commute, were concerned about full racks (Hagelin, 2005). The latest transit synthesis also finds that “One of the most commonly cited challenges for bicycle-on bus programs was limitations on capacity,” especially during peak periods (Schneider, 2005).

A respondent from Riverside RTA describes capacity limits as the “double edged sword” to promoting the bike-load program. This tension is already seen every year on Bike to Work Day. This official feels that limited capacity is a bigger challenge than encouraging use: “If you really promoted it, you could fill a bus with bikes.”

One respondent compared these capacity challenges with those of wheelchairs. (A typical bus only has two spots with wheelchair securement.)

To reduce the chances of turn-aways, agencies may invest in the larger three-bike-racks, or bicycle parking at bus stops.

Safety of user

Transit agencies may be concerned about the safety of entering in front of the bus and some are concerned about increased insurance fees because of bike-n-bus. In the past, some agencies have required permits that waive liability to the agency. However, little evidence has been found to validate this concern, and few incidents with bike-n-bus have lead to lawsuits (Doolittle & Porter, 1994; Hagelin, 2005; Schneider, 2005).

To ensure safe operations, three transit agencies (FAX, PACE, and TriMet) specifically noted in the interview that the passenger should get the driver's attention before stepping in front of the bus. KCDOT and Valley Ride Boise also expressed general concerns about the safety of allowing bikes on FMRs.

The respondent from St. Louis was able to describe in detail the loading procedure, with emphasis on the safety precautions. The passenger should notify the driver before loading or unloading the bicycle. The drivers have been instructed to then put on the air (parking) brake, which locks the rear wheels and disengages the accelerator. The passenger should be able to hear the driver do this. The passenger then knows it is safe to walk in front of the bus. Occasionally, eager drivers will neglect to take this extra safety measure. In St. Louis, no permit is required to use the bike racks. Users are supposedly required to be at least 13 years of age, but this limit is impossible to enforce (Bi-State Metro).

The chief message for safe loading and unloading is communication. FAX reiterates that the passenger should notify driver when you load and unload.

As indicated by Bi-State, passengers should also notify the driver when disembarking from the bus, exiting from the front door. The advantages to this are twofold: it ensures that the driver will engage the air-brake (Bi-State Metro), and ensures that the bus will not leave before the rider has removed his or her bicycle. TriMet's respondent said that when the bus leaves with a rider's bike still on it, it is typically because they exited through the rear door of the bus and did not notify the driver. Between bike and rail operations, TriMet removes about 1,000 bicycles per year from its vehicles.

The official at Valley Ride in Boise, Idaho said that safety is the main challenge – but they consider the issue very broadly. Not only do they ask "Is it safe to step in front of the bus to load your bike?" and "Is the bike secured well enough?" They ask "Will this affect how bus operators interact with other drivers on the roadway? Can they still see pedestrians on tight downtown curves?" Integrating buses into the road environment is complex; attaching a bicycle is easy, but contributes to a number of other concerns. TriMet pointed out that instruction to the bus operator for managing bicycles is integrated with the safety training drivers receive. Anything that would block the driver's view is not allowed in the rack.

Security of the bicycle

A bike owner may feel insecure about putting his bike on the front of the bus. Because the bicycle is not locked onto the FMR, it is easy for the bicycle to be removed by any stranger. For this reason, the bicyclist is encouraged to sit near the front of the bus, to keep the bike under surveillance. The FAX respondent points out that the advantage of the front-mounted rack is that they are visible. Each summer Valley Ride receives as many as 5-10 complaints of someone stealing a bicycle off of the front of the bus.

Beyond the threat of theft, there are other circumstances in which the rider may not retrieve his bicycle successfully. One might forget the bike is on the bus until it pulls away, or the driver may leave before the biker gets to the FMR. Some of this may simply be forgetfulness on the part of the user. But, as the spokesperson from MATA asked, how could one forget one's mode of transportation, in which one has invested? In Portland they find that these misconnections are often because the passenger disembarks through the rear door without notifying the driver, who subsequently leaves before the passenger has time to retrieve his or her bicycle. As mentioned in the safety section, it is important to leave the bus through the front door and communicate to the driver that you will be taking your bike.

The frequency of these misconnects varies greatly from city to city. PACE finds it rare that a rider will not retrieve a bicycle, and a Kansas City agent estimates that the agency lost-n-found only sees about 2 or 3 per year. However, Riverside's correspondent estimates that about one phone call per day is received regarding either a lost or a stolen bicycle. The agency has retrieved enough bicycles to "fill a warehouse" from the racks in the system, some being of remarkably good quality. The official relates other agencies in Southern California have similar experiences. The TriMet official estimates that about one passenger per day leaves his or her bike on the bus – each year for the combined bus and rail system, about 1,000 bikes are discovered on the racks.

The staff at FAX has a process for handling bicycles left on the bus. They store the bicycle in a bike locker at the garage, waiting 30 days for a claim, requiring ID and verification of time and route the bike was left on. Bikes must be retrieved from the garage. Unclaimed bikes are sold in a police auction.

The rates and causes of these mis-connections would be worthy of further research. The causes of this misconnection might be related to communication with the bus driver, or to levels

of driver distraction. Insomuch as it depends on communication, the percentage of bikes lost tells of the social patterns for interacting with bus drivers in that city. In the latter case, the percentage of bikes stolen is telling of which routes are most demanding on the driver's attention.

Delaying the Bus

Some bus operators have expressed a concern that the time it takes to load and unload a bike could slow the bus down. Valley Ride affirms that loading and unloading bicycles can be time consuming. However, SORTA notes it has had no complaints about biking passengers slowing the bus. As a precaution against delay, Seattle Metro does not allow bicyclists to board or unload in the fare-free area of downtown Seattle during the day (6 am - 7pm). This also reduces safety concerns. (They have discussed allowing bikes at midday or all day only as a trial.) Hagelin points out that loading a bike is still faster than a wheelchair (Hagelin, 2005).

Maintenance hassle

While a major reservation at the outset of bike-n-bus development, maintenance concerns have largely disappeared. Particular maintenance issues mentioned in this survey included corrosion, incompatibility with the bus washer, complications caused when trying to tow the bus, and the need to remove the rack after a bus crash. One agency, Houston Metro, reported some maintenance difficulty with its first FMRs. As a result, they delayed equipping the rest of their fleet for many years.

In the agencies Hagelin surveyed, bike-rack related maintenance amounted to one day per week by a single staff person. Most of this maintenance came from damage to the racks, not corrosion (Hagelin, 2005), but this survey targeted agencies in warm climates. Whereas Hagelin finds racks to last a little more than 12 years (Hagelin, 2005), Synthesis 62 finds them

to last only 6-7 years. Nevertheless, the TCRP report found maintenance to be minimal, costing no more than $100 per year per rack (Schneider, 2005).

This survey also found maintenance to be a small concern. SORTA notes that, while maintenance is a major concern for transit operations, the FMRs are exceptional – they are relatively easy to maintain. MITS says the racks are "almost invisible," hardly wearing out, and they do not make washing the bus a challenge. The only time racks need to be replaced is on the rare occasion that the bus collides with something. Bi-State Metro's experience shows that damage to the bike racks is only occasional. Problems with the rack being damaged in the bus-washer can be avoided simply by making sure the rack is properly adjusted. The story of MITS illustrates how some agencies have adapted to maintenance concerns.

Undercarriage stowage

Houston Metro, AC Transit, and Centro report that, while the coach buses in their fleet are not equipped with bike racks, these buses do accommodate bicycles in their undercarriage storage bays.

Mr. Warner and FMR Maintenance – MITS, Muncie, IN

In 1995 only a few transit agencies had installed bike racks on their buses. But in Muncie, one MITS board member was determined. Mr. Warner kept pressuring the agency to install racks for his bike, in spite of the staff's concern about maintenance. But, discovering some old racks on sale, they decided they could afford the experiment.

The bus maintenance staff was wary of how much work these racks would require, especially in Muncie, IN. The corrosive road-salt the DOT spreads every winter would be a threat to the new investment. To hedge their bets, they developed a solution unique to Muncie. Every November near the end of the month the racks are removed (which requires only the removal of two bolts). Buses operate without bike racks in the winter, and the racks stay in a warehouse out of the corrosive road-salt.

Is this difficult for users, who cannot bike-n-load during the winter? The MITS staff does not think so. They feel riders would make little use of the program during winter months. However, they have noted that if the agency does not reinstall the racks early in March, it soon receives complaints from riders.

4.1.2 Bike-in-Bus

Bike-in-bus involves users wheeling their bicycle into the vehicle and staying with it in the passenger space. While research has found no problems with this practice it seems agencies have allowed it only to a very limited extent (Doolittle & Porter, 1994; Hagelin, 2005; Schneider, 2005).

Hagelin advocates for bike-in-bus, arguing that it is an immediate and costless way to overcome limited FMR capacity. He points out that there have been four lawsuits with bikes on FMRs, but none for bikes inside the bus (Hagelin, 2005). Nevertheless, it is thought that bikes in the bus are dirty and could cause injury, according to a KCDOT agent.

By discretion

Four agencies reported that if demand exceeds the capacity, they may permit bikes on board the bus at the discretion of the driver or of dispatch. In Syracuse, some drivers allow extra bicycles into the bus, although that is not official policy and not encouraged because of safety concerns. Likewise, COPTA allows bikes on board only informally. Most agencies that do permit bikes on board do so only when it is seen as necessary. For example, AC Transit allows bikes on board at driver discretion only at night. Riverside Transit Agency, which requires a "desk instruction" over the radio to allow bikes onboard, agrees that the last trip of the night warrants bike-in-bus. The St. Louis official contrasts their strict no bike-on-board policy with DART's policy to discretionarily allow bicycles in the rear of the bus.

GLTC and Riverside Transit Agency secure bicycles brought on board in the wheelchair space using the straps provided. The representative from Lynchburg explains that while bikes are currently not allowed inside the bus, the agency "did consider using wheelchair securement spaces on board the bus to store extra bicycles in anticipation of higher usage, but it never materialized, so the policy was never put in place." COPTA simply permits these bicycles in the rear of the bus, away from most of the passengers, assuming the bus is not nearing passenger capacity.

Safety concerns

Five agencies explained their safety-related concerns of allowing Bike-in-Bus (BiB) operations, including MITS and KCDOT, in addition to those already mentioned. An agent from Bi-State

Metro details the risks: Inside the bus, bicycles pose a tripping hazard and could fall on a person if the bus stops fast. In a crash, a bike could become a dangerous projectile, and if the bike blocked an aisle, it could delay evacuation of the bus, which is critical in the event of an emergency. Perhaps it is for this reason that seven agencies outright forbid bringing bicycles on board the bus, including Cleveland Metro, GLTC, Madison Metro, MITS, Bi-State Metro, STC Spokane, and Valley Ride Boise. Still, some sympathetic drivers may violate regulations and allow bikes on board anyways (Hagelin, 2005).

Folding bikes

Phoenix's Valley Metro replied that they would like more bikes on the bus – if they came in the form of folding bikes. Two other agencies also mentioned such bikes. Portland's TriMet, stated that it allows folding bikes on board its buses. The use of folding bikes could even be promoted as part of a system-wide program, as described by the respondent from PAAC, who writes: "As part of a sustainable living initiative, [Pittsburgh's] Port Authority now permits cyclists to bring their foldable bikes onboard our buses, light rail cars and the Monongahela Incline during peak and non-peak hours."

Replogle points out that folding bikes are not often used as often as they might be, perhaps because they are expensive and do not always perform as well as standard bicycles. However, he suggests that transit agencies might rent folding bikes to their patrons. BART undertook just such project from 1983 to 1984, hoping that passengers would eventually buy their own. Passengers were interested, but the program was unsuccessful because bikes kept breaking (Replogle, 1987).

4.1.3 Bicycle Parking

For those who do not need a bicycle on both ends of their transit trip, it is not necessary that they transport their bicycle on the bus. If secure bicycle parking were available at or near their bus stop, this would free up FMR capacity for other users. Replogle argues that a large "supply-push" is the only way to release latent demand, and test if bike parking would be used (Replogle, 1984). While covered and uncovered parking is often available at transfer stations, it is rare at bus stops. Agencies doubt that bus-stop parking would be used because of passengers' fear of vandalism (Schneider, 2005).

Responses from transit agencies having or considering bicycle parking varied. Some, like UTA, took the lead in installing bike racks or bike-lockers, whereas others tried to collaborate with cities to place bike racks in areas where they would serve multiple purposes. Orlando's LYNX uses DRI powers to encourage developers to install bicycle parking.

Research from Europe has much to teach about bike-to bus. In the Netherlands, nearly all trips involve parking at the transit stop. As a result, bicycle parking at transit has become the standard:

> "Throughout Europe, bikes-to-transit travel eclipses bikes-on-transit travel with transit stations routinely supplying parking for thousands of bicycles, and bicycle parking racks included in standard bus stop designs." (Hagelin, 2005).

Early on, Replogle found that the risk of bicycle theft was a major determinate of whether someone would park their bike (Replogle, 1984). This is just as true in the Netherlands, where the main concern with bicycle parking is security from theft. Protection from the elements is the next most desired characteristic (Martens, 2007).

Are bike lockers the solution to the security issue? No. In Leeuwarden, only 16% of bicycle lockers were utilized, perhaps because the rural location of the study made bike theft unlikely.

More than this, the Dutch usually use inexpensive bicycles for commuting. This explains why bike-n-bus users were found to be less concerned about vandalism than the typical bike rider. Indeed, Martens find the usage of bike lockers to be correlated to the value of the bicycles being used. Students using low cost bicycles for short access trips are likely to use conventional bike parking. Those utilizing bike lockers are more likely to be commuting professionals making longer access trips (Martens, 2007). While a study from Utrecht showed that covered bicycle parking was most successful in attracting bicycle ridership, experience from Leeuwarden showed covered and exposed bike parking to be equally used, even during the cold, rainy winter (Martens, 2007). The key to bicycle parking seems to be providing a variety of amenities that fit the preferences of various of users.

Yet the quality of bicycle parking is less important than the bikeability of the streets that lead there. In a Utrecht case study, improved parking showed only a small increase in bike use over the short-term. However, Martens found that investments in bike lanes and bicycle parking increased the distance bus riders were willing to travel, bringing more people to each bus stop (Martens, 2007).

Users tended to park their bicycles on same side of road as the originating bus stop, even if covered bicycle parking was provided across the road (Martens, 2007). This makes sense, as catching the bus is more urgent than returning home. Either riders are concern that they will get passed-by if they are still securing their bicycle when the bus arrives, or crossing the road by foot just seems to take longer than riding directly to the stop.

While this international experience is insufficient for determining user preferences in the United States, these examples illustrate that bicycle integration into bus stop design merits further study.

A number of guidelines for bicycle parking are available online:

- The Pedestrian and Bicycle Information Center (BicyclingInfo.org)
- The Association of Pedestrian and Bicycle Professionals (APBP)
- The Victoria Transport Policy Institute's "TDM Encyclopedia"
- "Bicycle Parking Plan for Miami-Dade Transit" (Hagelin, 2002).

4.2 Program Creation

The agencies in the survey started their program over a range of dates. AC Transit, Seattle Metro, and Phoenix were all started early enough to be included in Replogle's case studies (Replogle & Parcells, 1992). Most started in the late 1990s or early 2000s.

In Portland, bus operators were the biggest advocates in starting the program, as many of them were interested in biking. Cincinnati's Metro formed an exploratory committee made up of representatives from different bicycling groups, along with city engineers. This committee reviewed how such a program would work and helped set up the policies now found online. The agency still works with these bicycle groups for Bike to Work Day. In Seattle, the program was pushed by an active outdoor sports community that was interested in better access to the countryside.

The first TCRP synthesis report lays out a methodology agencies can follow in creating new bike-n-bus services – shown in Table 10 below.

Table 10 – How to start a Bike-n-Bus Program (Doolittle & Porter, 1994)

TABLE EIGHT
PROCESS OVERVIEW

1. Examine operating environment
    - Identify beneficial service area characteristics
    - Determine level of support from the organized bicycle community
    - Assess opportunities for coordination with local and regional agencies
    - Obtain support of upper management and board
2. Set goals and identify target markets
    - Conduct market research
    - Form an internal multidepartmental working group
    - Form an external technical advisory committee
    - Identify constraints, including financial and regulatory
    - Develop bicycle elements for short- and long-range plans
    - Design a framework identifying components and service area
3. Formulate operating rules and regulations for inclusion in standard operating procedures and customer information
    - Establish standards for minimum service, i e minimum number of lockers per site, minimum number of routes or trips per route etc.
    - Decide on use of permits and fees
    - Set time of day restrictions, if any
    - Outline loading, storage and unloading procedures
    - Determine age categories
    - Select demonstration routes, services and facilities
4. Operate a demonstration program for 6 to 12 months
    - Prepare equipment design criteria
    - Formulate specifications and purchase equipment
    - Conduct pilot testing
    - Prepare and conduct staff training
    - Prepare and conduct user training
    - Design and conduct promotional campaign
    - Operate demonstration service
5. Evaluate demonstration program
    - Conduct user and staff survey
    - Monitor use
    - Acquire technical advisory committee input
    - Modify equipment, regulations, training, promotion, and services as suggested by evaluation results
    - Assess potential for system-wide or limited expansion
6. Establish a permanent program or abandon
    - Schedule incremental expansion
    - Maintain demonstration service
    - Revamp demonstration design
7. Evaluate on-going program
    - monitor use
    - conduct periodic user and staff survey
    - continue to work with technical advisory group as needed
    - continue promotional activities

4.2.1 Startup Dates

Some respondents were able to report years in which their bike-n-bus program started. However, due to the turnover of employees, many respondents were uncertain of exact startup years. Responses from recently started programs tend to be more complete and precise. In some cases, where the process of equipping buses was gradual, these start-up dates may not be of great significance. Startup dates as they were reported are shown in **Error! Reference ource not found.** as an indication of the general trend. As can be seen in Figure 9, program beginnings are widely distributed over the decade from 1996 to 2006. All of the responding agencies started offering bike racks before 2006.

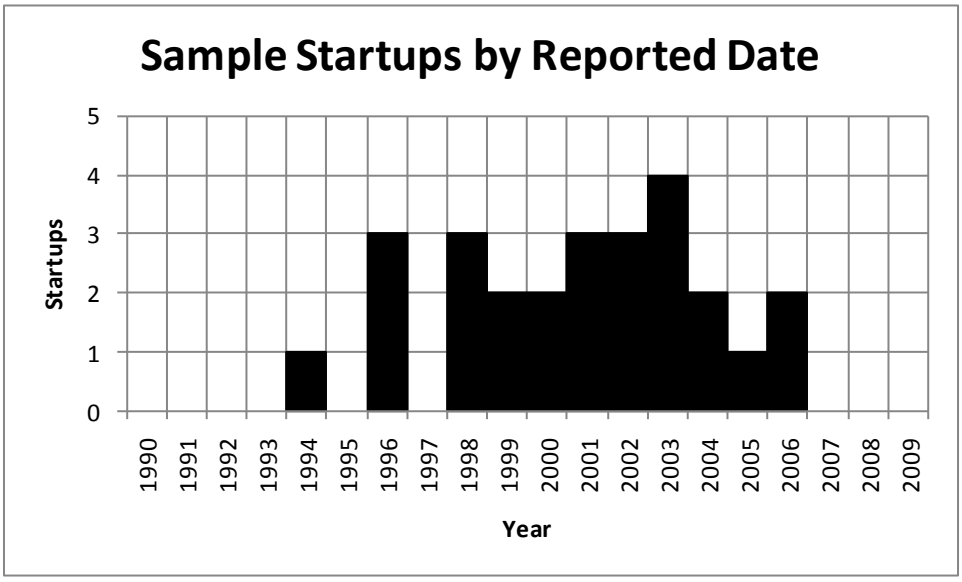

Figure 9 – Startups Dates Reported by Respondents

Finding Initial Funding

The TCRP Synthesis found common "Federal sources [for installing FMRs] included FTA Section 5307 and Section 5309 Formula Funds, the CMAQ program, and Surface Transportation Program Enhancement Funds," in addition to funding from state and local sources (Schneider, 2005). In this study, the few agencies that mentioned where initial funding sources did so as an example of how transit agencies have collaborated with other groups.

KCATA and the St. Louis Metro are the two respondents that mentioned using CMAQ money for equipping their fleets with FMRs. KCATA applied for funding through the Mid-America Regional Council, the MPO, receiving an 80% match from CMAQ air quality money. This is the same vein of funding that finances bike lanes, trails, sidewalks (Kansas City Metro). In Cleveland it was a non-profit grant secured by local bike-advocacy groups that got their bike-n-bus program rolling. GRTC relates a similar story about a ride-sharing group that secured the money for the FMRs.

The respondent Spokane, WA says further investments seem unlikely, as resources are already stretched. Although 2008 ridership was up 20% (vs. 5% nationwide), sales tax revenue fell because of a slow economy. Because of the increase in overall ridership, bike racks reach capacity more often. This is frustrating for biking passengers, but in Spokane's case, everyone is feeling the crunch; passengers are already being turned away because the bus is overcrowded.

4.2.2 Outfitting the Fleet

Eighteen of the 33 respondents with bike-n-bus programs said they retrofitted their existing buses with FMRs. Nine agencies transitioned more gradually by buying new buses with the FMRs already installed. Six agencies employed a combination of both methods (Centro, GLTC,

LYNX, Savannah, Memphis, and St. Louis), retrofitting some buses at the beginning, and then purchasing buses with the racks already mounted. The retrofit process can be accomplished within a few months. FAX (in Fresno), for example, outfitted all of their 125 buses over the course of a year.

Only two agencies, MATA in Memphis and PAAC in Pittsburgh, indicated that their fleet was not yet fully equipped for bicycles. While only half of PAAC's 861 buses were FMR equipped at the time of the interview, the representative anticipated that the rest of the fleet would be outfitted in the near future. At the time of the interview, only about 1/3 of MATA buses were equipped with FMRs, and 30 of these buses had FMRs that only fir one bicycle. As a result, some effort was need just to allocate FMRs to the various routes. System maps must show which routes are FMR equipped. The agency does modify bus assignments for a passenger wanting to bring a bike. Rather than outfit the whole fleet at once, they are simply requiring that new buses be bike-rack equipped. In addition to these two agencies, Bi-State Metro left 50 of its buses without FMRs, as these buses are operated under contract for a neighboring county in Illinois. The leadership in that county is opposed to the racks on the bus.

Though not explicitly asked, 19 agencies promoted themselves as being 100% equipped with FMRs or otherwise being able to carry bicycles (with undercarriage storage on coach buses). Three agencies – Centro, Houston Metro, and AC Transit – specifically mentioned the use of undercarriage storage in their fleets. For more detail, see section 4.1.1 Bike-Load with Front-Mounted Rack."

Not included in the consideration for being "fully equipped" are paratransit vehicles and small neighborhood circulator buses. Usually these vehicles do not operate on a fixed route, or operate only short routes specifically designed for increasing range for pedestrians. Four agencies specifically mentioned the debate of whether or not these small vehicles should also

be rack-outfitted. COPTA in Oklahoma City claims they were ridiculed for putting racks on their paratransit vehicles, but argued their action was appropriate, since paratransit vehicles operate on fixed routes during low-demand times. The respondent from Spokane Transit notes that the trolley circulator bus through downtown is not equipped with front racks, but the entire circuit is only 2 miles. With trips that short, it makes more sense to ride a bike.

4.3 Promotion to the Public

While respondents to this survey focused on the initial provision of FMRs, all understood the importance of announcing the new amenity, educating would-be users, and continuing to promote the full use of the racks. Moreover, good communication between the agency and passengers supports the use of those who have switched to bike-n-bus.

4.3.1 Educating Riders

Four agencies described their agency's program to educate the public about bike and bus: Centro, CATS, MAT, and FAX. MAT requires rider education as part of its permit program. "We have a demonstration model and passengers must come to our transit facility for training and practice before they receive a permit to use the racks."

Kansas City's Metro has developed a written code of conduct, displayed on the agency's website, intended to lay out expectations for the program. It was developed for a PR campaign to educated riders which including workshop sessions. The code was developed by an internal team and got feedback from a focus group made up of customers (called CATS). FAX finds its website the most popular form of communication for public education. They published no other formal policy or brochure for BnB. (At the time of the interview, the agency was taking more rural lands into its service area as part of their merger with Clovis. As such, they had determined a need for a BnB brochure.) In addition, FAX holds fairs to educate students about

buses, where bicycles are a common topic of inquiry. Centro says that the Bike to Work Day promotion in May is the time when many people learn how Bike-n-Bus works.

Fargo MAT is unique, ensuring that users are educated through a permit program. "We have a demonstration model and passengers must come to our transit facility for training and practice before they receive a permit to use the racks. They also sign a waiver of liability form. If a minor, the parent or guardian has to sign the waiver form." GLTC and Baton Rouge CATS formerly required permits to ensure users could operate the racks safely. They have since dropped the requirement in order to attract ridership. TriMet was proud to allow public use from the beginning. Similarly, KCDOT and TARTA point out that they do not charge a fee to use the racks.

Four Agencies – GLTC, Cincinnati Metro, MITS, and Bi-State Metro – made reference to their website. Muncie's MITS has a policy/ information about the program is available on the website and also published in the "Bus Book" rider-guide. In St. Louis, the program is also promoted on trailnet.org.

4.3.2 Bike-to-Work Day

The League of American Bicyclists designates May as "National Bike Month." One Friday in May is designated as "Bike-to-Work Day" and the work week leading up to it as "Bike-to-Work Week" ("May is National Bike Month," 2011). A number of agencies mentioned these days as an opportunity to promote bike-n-bus. In Syracuse, Centro allows cyclists to ride for free on Bike-to-Work day. (get people to try it, learn it). Cincinnati Metro and Metro Transit (Oklahoma City) always works together with bicycle groups on this same day. In Oklahoma City, this involves a ceremony with media coverage and a mayoral appearance, with two buses loaded with bikes as the backdrop. UTA tries to encourage bike-to transit by holding an annual "Bike Bonanza," and participating in bike month and week every May. Valley Ride officials list bike

month as just one of their measures to encourage bicycling. However, outside of Los Angeles, Riverside Transit has found that there is a "double-edged sword of promoting" – on Bike-to-Work Day they run out of room for bikes.

4.4 Collaborating with Other Organizations

Nine agencies not only coordinate with local groups, but also get help in promoting their program: Centro, PACE, Madison Metro, TARTA, Houston Metro, The Metro (COPTA), Bi-State, Valley Ride. Centro, Cincinnati Metro, COPTA, UTA, and AC Transit mentioned bike-to work day as an event that brings them into collaboration with others. GRTC works with a ride-sharing group that helps arrange carpooling and promotes non-auto modes towards the goal of improving air quality. Cleveland Metro works with the City of Cleveland to identify sites near "key transit areas" for bike racks.

Nine agencies, however, made no mention of coordinating with other groups. This may be because the agency is able to ascertain from its own sources the needs of bike-transit integration, or that the biking interest in that city is not well organized. Enhancing bike-transit integration is only a major issue if other groups in the city are effective in creating a bikeable environment. In Charlotte, CATS started their program before the BAC existed, but they worked with cycling advocacy groups when starting the program.

4.4.1 Bicycling Advocates

Seven agencies said they made it a point to collaborate with a bicycling advocacy group when launching their bike program. Centro started their bike program in response to requests from the local bike advocacy group. Charlotte CATS also worked with cycling advocacy groups when starting their program. Several bike advocacy groups in the Cleveland area were instrumental in securing a non-profit grant for the bike-n-bus program. PACE worked with the Chicagoland

Bicycle Federation and other local and county governments to get their program started. PACE continues to collaborate with the Chicago Bicycle Federation on events and promotions. (The Bike Federation also works with government agencies on trails projects.) When starting their program, Madison's Metro consulted with their local Bike Federation as well. This group proved instrumental in the implementation and promotion of the program. Madison Metro also looked to transit agencies who were further along in starting their Bike-n-Bus program. Fargo MAT made sure to involve a bicycle vendor when purchasing their first bike racks. Bike advocates in Houston have long been pushing bike-n-bus, and lately have lobbied for bike lockers at the METRO stations. BikeHouston has made offers to train Houston Metro bus operators how to deal with cyclists on the road. METRO also works with cyclists on the new rail system, designing for it to accommodate bikes.

Three agencies launched their bike-n-bus program before the rise of bicycle advocacy in their cities: Charlotte CATS, AC Transit, and TriMet. TriMet bus operators were the biggest advocates in starting the program, as many of them were interested in biking. AC Transit named active cyclists as a major stakeholder group. Informally, the agency consults with East Bay Bike Coalition and various other groups in each city. Bicycle Friendly Berkley is a particularly active advocacy group. The agency outfitted their fleet with racks early, when there was little push for bike-n-bus.

Eight agencies stated that they continue to work with cycling groups on an ongoing basis. CCTA collaborates with local bicycle groups and advocates, including Local Motion (local bike/ped non-profit) and a newly created Safe Streets Collaborative, as well as governmental groups, to ensure that CCTA buses and facilities are bike-friendly and accessible. SEPTA works with a local bicycle advocacy "consortium" whose stakeholders include cycling advocates, recreational cyclists, and environmentalists. Bicycling advocates currently have only informal

input in the Memphis bike program, as does the Sierra Club. However MATA said they intended to establish a more formal relationship with stakeholders in the coming (2009) year. PACE has worked with the Chicagoland Bicycle Federation, and other local and county governments since starting their program. They collaborate with the bicycle federation on events and promotions. (The federation works with governments on trails projects). Several bike advocacy groups in the Cleveland area secured a non-profit grant for Cleveland RTA to start their bike-n-bus program. "Cites are always asking about bicycles," says the RTA representative. In Fresno, the Council of Governments (COG) has been pushing employer rideshare programs, congestion management, and traffic mitigation, including FAX's bike-n-bus program. Seattle Metro works with the Cascade Bicycle Club on an ongoing basis. Bi-state Metro's involved organizations include Trailnet, which advocates for all types of biking, and the Bike Federation, which focuses more on bicycle commuting. Both groups have promoted the program since its beginning.

4.4.2 Bicycle Advisory Committees

Eight agencies made some mention of Bicycle/ Pedestrian Advisory Committees. BPACS are a group of bicycle and/or pedestrian stakeholders that typically meet once a month to share their concerns for their region. These groups are organized by and provide advice to the area's Metropolitan Planning Organization (MPO). As such, BPACs typically include representatives from the constituent local governments, officials from various government agencies, as well as any other key advocates/ experts in bicycle issues.

CCTA says that while they coordinate with the Chittenden County MPO's bike/ped committee, they also work directly with local bicycle groups and municipal bike/ped planners. In Orlando, the BPAC was in charge of orchestrating bicycle parking around the new LYNX transfer center. The LYNX respondent says that the year and a half they have been on the BPAC demonstrates

how the agency joins with the city in making bikeability a goal. They will keep working with the MPO to improve connectivity. TARTA's respondent said that the agency "made friends with the MPO" through their involvement on the bike/ped committee. Charlotte CATS started coordinating with the Bicycle Advisory Committee (BAC) – made up of a Charlotte DOT Bicycle Program Manager and other cycling activists from the region – although CATS dealt with bikes before the group was formed. DART gets input from a panel of citizens that meet on a regular basis to help brainstorm and shape the agency's bike program. These people are from all over the Dallas/Ft.Worth metroplex and have bicycling experience ranging from weekend cyclists to commuters who take their bikes to work every day. Bi-State Metro's respondent says the bike/ped committee of the East-West Gateway MPO has been advocating for bike access to transit since the 1990s. AC Transit says that there each city has its own BPAC that they work with. The Metros in Houston and Cincinnati had their own internal committees for garnering bicycle advice. The story box below tells of the Houston Metro's unique relationship with its staff bicycle experts.

TEAM METRO SHOWS BIKING SPIRIT! – HOUSTON METRO, HOUSTON, TX

Team METRO is a cycling group formed as a way for Houston Metro employees to associate their passions with their work. Team Metro welcomes employees of METRO and their family members to join. Whereas METRO cannot financially support them (with tax payer money), they are allowed to wear the METRO logo on their official team wear, and the agency allows their bike rides to count toward the organization's wellness program, reducing the employee's contribution to their health insurance plan. On another note, Team METRO does community projects, like the Elves [Christmas volunteering] project here in Houston – promoting both METRO spirit and bicycling spirit (Houston Metro).

On National Bike Day [Friday, May 15, 2009], 10 members of Team METRO, along with other Houstonians, joined Mayor Bill White, biking from Memorial park to city hall downtown. About 300 cyclists pedaled the 15-mile route, making it a leisurely and conversational event. The ride began at 7:30 a.m. when the day was still refreshingly cool.

Tom Pham, a ride leader of Team METRO, said this annual event helped trigger the creation of METRO's bike team. "We're supporting the mayor's efforts to extend bike trails all over the city, and we're also promoting our bikes-on-bus program." (Sit, 2009).

4.4.3 City and Regional Governments

Some agencies were able to describe a working relationship with local governments in their area. In Fresno, the city and employers are active in pursuing connectivity and encouraging bike lanes, which both support FAX's bike-n-bus program. In Boise (where Valley Ride is), a local university professor is collaborating with downtown to encourage the installation of bike racks. There are 15-20 bike shops in the area, four of which are downtown. Efforts to improve the corridors are "very informal," as bike racks are owned by others. The chamber of commerce might be asking businesses for more input. LYNX works closely with municipalities, especially the City of Orlando. The MPO's MetroPlan also addresses station access. LYNX may have a particularly well developed relationship with governments in the region because of their power over development of regional impact (DRI powers).

4.5 Hindrances to Bike-n-Bus Use

The main hindrances to greater bike-n-bus use, as identified in this report, are climate and terrain, limited FMR capacity, limited bike parking, routes that are not bikeable, and a general culture that gives little consideration to non-auto travel.

4.5.1 Unfavorable Climate and Terrain

It's nature; you can't do anything about it. Some cities are inevitably more suited for biking, and some days are better for riding than other. This does not prevent bike-n-bus from working; it just means that ridership levels will fluctuate from place to place, season to season, and day to day.

Terrain

Three agencies listed terrain as a determining factor to bike-n-bus use. In Cincinnati, the metro respondent said that "inclement weather and hilly terrain are obstacles to bike ridership."

COPTA responded that, while hot summers in Oklahoma City may be a seasonal deterrent to bike use, the flat terrain does encourage bicycling. Similarly, Valley Ride's representative said that the "flat terrain, good weather, and outdoors-oriented city make Boise a bike-friendly city."

A recent Belgian study compares the flat Flanders region with the hilly Wallonia region to the south. Bicycling is widespread in the plains, but less common in the south. Curiously, the study finds cyclists in hilly areas to be more sensitive to traffic on major roads than in flat areas. The authors suggest that this is because in areas where biking is popular, drivers understand the concerns of cyclists. On the other hand, drivers in the hilly area are less accustomed to interacting with bicycles. The authors argue that in hilly regions it is much more critical to have well laid-out bike routes. (Vandenbulcke et al., 2011).

Weather and climate

Eleven agencies named weather as a deterrent to bike-n-bus use in their region: CCTA, Centro, PAAC, PACE, Cleveland Metro, Cincinnati Metro, TARTA, AATA, Houston Metro, Metro Transit (COPTA), and TriMet. Others report on the impacts of favorable weather. TriMet, for example, finds that usage is especially high in the summer. Of course, in cities like Houston and Oklahoma City, summers can get too hot for comfortable bike riding.

What, specifically, about inclement weather deters use? Two agencies (Centro, TARTA) described the cold weather as the factor that deters riders in winter. Two other respondents (TriMet and Valley Ride) claim bikers are thwarted by icy or otherwise slick road/ sidewalk conditions. Still two other agencies (Centro, PACE) claim that the accumulation of snow prevents bike travel. The PACE respondent describes how one cannot count on having a route year-round. "Snow is not always removed from suburban sidewalks (where they do exist), which makes any sort of access to transit more difficult." All of these agencies agree: bike-n-bus ridership is lower during winter months.

To address these concerns over winter weather, an agency would have to identify the particular problems users faced. Cold temperatures are inevitable, but icy conditions can be remedied through proper drainage and ice-melt. Snow removal can be dealt with to a limited degree. Some responsibility for winter maintenance does fall to a transit agency, but fully addressing the problem would require a major collaboration with government agencies.

More precisely, it may be the mere threat of inclement weather that deters bike use. Unpredictable weather might have as big an impact on ridership as poor climate. The PACE representative notes that unpredictable weather is a challenge, "even when it's not 8 degrees." The MATA respondent judged that Memphis's polarity between very hot and very cold weather keeps people in their cars: "Wild variations in temperature make it difficult to establish regular usage." Oddly, AATA's respondent observed that bike-n-bus ridership is actually higher when weather is bad, as those who would only bicycle to and from work instead choose to do a portion of the trip on the bus. Even anticipation of inclement weather can cause a shift, for those looking for peace of mind.

A study based on 2001 Canadian Census data looks at cycling all across that country. The study considered the effects of snow fall, rain, freezing temperatures, days with snow on the ground, average summer and winter temperatures and wind speed. It found the two most significant weather factors to be precipitation in any form (decreasing the odds of biking by 16%), and freezing temperatures (decreasing the odds of biking by 9%) (Winters, Friesen, Koehoorn, & Teschke, 2007).

Experience from Europe finds that, for all transit modes, the number of people who bike-n-bus varies greatly with weather and season. BnB ridership is generally about 2.5 times higher on good-weather days than bad (Martens, 2004). However, it is difficult to predict how many will

ride on a particular poor-weather day; it depends on the riders and their needs. In fact, some commentators seem surprised by the diversity of weather and climates in which BnB persists:

> “In Phoenix, racks continue to be used during summer's 100+ degree days, although the number of users is somewhat lower than during cooler months. There is extensive bicycle use in rainy Seattle and cold Madison, Wisconsin. Several agencies without bicycle programs, however, cite weather conditions as a reason for not adding the service.” (Doolittle & Porter, 1994).

4.5.2 Limited Capacity Leads to Turn-aways

Nine respondents said insufficient FMR capacity could discourage Bike-n-Bus use (CCTA, Centro, CAT Savannah, Madison Metro, CATS Baton Rouge, UTA, AC Transit, FAX, Riverside RTA). As the CCTA respondent describes, "the limit of two bikes per bike rack deters/prevents some passengers from biking to the bus. Because the two spaces in each bus's bike rack are on a first come-first serve basis passengers face uncertainty about whether there will be space available on the bike rack when the bus arrives at their stop." The Spokane Transit manager pointed out that this situation is similar to that of wheelchairs, with buses limited to a capacity of two.

Six agencies said they were already at capacity – Madison Metro, MAT, FAX, TriMet, Spokane Transit, and Valley Ride. AC Transit is at capacity on few of its key routes, but finds that "other issues grab attention." Most of these look to 3-bike FMRs as a potential solution, but are hesitant because of problems with the design. TriMet finds that their FMRs do fill up often, and capacity is often reached at peak times. Unfortunately, this means that the usage statistics the agency keeps will not be able to reveal how high bike-n-bus demand truly is. Moreover, usage statistics do little to indicate where there is demand to access the bus by bicycle. Spokane Transit must turning away bicyclists as well as regular passengers, due to their problem with widespread overcrowding.

PAAC admitted it was limited by having only half of its fleet equipped with bike racks. MATA, though only 1/3 equipped at the time of this survey (and half of those FMRs only accommodating one bicycle), did not feel usage was high enough to have capacity shortages. Four agencies (SEPTA, CAT Savannah, Cincinnati Metro, and Houston Metro) said they would look at expanding their program as it gains riders.

Hagelin found that 31% of users felt the racks on the bus were full “often” or “all of the time” when arriving at their stop. This suggests that limited rack capacity is a bigger deal than agencies realize (Hagelin, 2007).

Potential ways to expand bicycle capacity on routes with high demand include using larger 3-bike FMRs, installing bike parking or lockers in key locations, or by allowing bikes inside the bus (perhaps hung on hooks). For more ideas, see section 4.1 Ways to Accommodate Bicycles.” Alternately, an agency with extremely high bike use overall might adopt an additional fee or time restrictions for bringing a bicycle, in order to manage demand.

How big a deal is a turn away? It’s hard to say. If the biker is not far from their destination and the journey is not too difficult, they may simply choose to ride the whole way. If they are in an urban area, there may be an alternate bus route nearby. Or, on a high-activity route (though it may attract many bikers,) it would only be a short wait to the next bus. However, in remote areas with sparse, infrequent transit service, the rider may be feel quite stranded if turned away. This event is especially likely in recreational areas with high levels of bike use.

4.5.3 Insufficient or Inadequate Bicycle Parking

Six respondents pointed out that even if there is space on the racks, there may not be bicycle parking at the final destination (GRTC, LYNX, CATS Charlotte, PACE, DART, AC Transit). To some extent, this could be addressed by parking at the bus stop. Some agencies have considered bike racks at stops throughout the system. An AC Transit transportation planner compared bike parking with the “near Universal” accommodations at BART and CalTrans rail facilities. Kansas City looked at bike lockers, like those in Denver and Washington DC, however the bicycling community is not as strong in Kansas City as it is in those large cities. A crime concern accompanies bike lockers, as people may be stashing more than bicycles. The Cleveland official agrees, saying it is a continuing challenge to provide bus-stop amenities. Safe storage of a bicycle is also a challenge, as bicycle theft is a concern. Indeed, Replogle guessed that “High rates of bicycle theft and vandalism pose a major barrier to bicycle-transit integration in the U.S..” (Replogle, 1992). This threat applies as much to bikes at the destination as at a station. The case study of the Alameda Contra-Costa Transit District shows how a transit agency can proactively take on bike-parking and capacity issues.

A Bike-n-Bus Laboratory – AC Transit, Oakland, CA

The Alameda Contra-Costa Transit District provides bus service in the eastern side of California's Bay region. Their service area covers 13 cities and unincorporated parts of two counties. They began offering bike-n-bus services as a reaction to increasing bridge tolls and pressure from Metropolitan Transportation Council (the Bay-region MPO) to encourage non-automotive transportation alternatives. AC Transit offers either FMR undercarriage bike storage (in the case of coach-style express bus) on all their routes, achieving 100% accommodation as early as 2002.

Overall, AC Transit is working within a bike-oriented community. An old study found that 3% of riders access their transit system by bike – an above-average number at that time. Berkeley is noted as a major center of bike activity, likely driven by students from the University of CA Berkeley. While bike-n-bus ridership is up on those routes, "It's still just a small fraction" of bike-bus use. "It's not just young folks; it's broadening out: East Oakland is a large, low income area with lots of bike use." Bikeability efforts are supported at the local level. The City of Oakland, a well established city (400K people, established in 1850), is looking at bike lanes, even on narrow arterials (2 travel lanes, 2 lanes of parking). Cities are working hard to create a network of bike lanes, even suburban areas.

At the time of the interview, AC Transit was in the middle of three studies related to bike-n-bus:

The first study seeks to identify key locations for providing bicycle parking throughout the system, not just at rail stations and transfer centers. Not only does the study consider bike parking immediately at the bus stops, it examines parking locations further from the stop, such as in front of businesses. The goal is to establish parking where it would be useful not only to transit riders, but could also support bike activity in that neighborhood. Such parking may take

the form of bike lockers or bike stations. The construction of such parking would hinge on leadership and funding from municipalities, since parking serves bike fills a broader need than that of the transit agency.

The agency is also conducting a market segment study, to better understand who rides.

The third investigation considers how bicycles should be accommodated on new BRT service. Pending a grant award, AC Transit would study accommodating bicycles within the 60 foot long articulated vehicles (perhaps with the hooks to hang bicycles seen on some light rail vehicles). It is thought that allowing bike son board in this case would be faster than using FMRs.

The agency is considering how it could have the same near-universal bike accommodation that is available on BART and CalTrans trains. However, one biggest challenges they face is a lack of data – Currently, the only measure of bike-n-bus demand is when bike racks are full. Some routes are running out of capacity for bicycles. AC Transit would like to study using 3-bike FMRs, such as those used on Trans-Bay routes, however too many other issues are grabbing the agency's attention at the moment.

4.5.4 No Bikeable Routes

> "Bicycle-hostile street environments near most U.S. transit stops and stations also pose a significant barrier to more widespread use of bicycles for transit access. The majority of U.S. cyclists are not comfortable riding in fast or heavy traffic unless offered separate paths or lanes." (Replogle, 1992)

Not surprisingly, eleven agencies mentioned concerns about the safety of biking or suggested that adding bike lanes would increase bike-n-bus ridership: Centro, GRTC, GLTC, LYNX, CATS, Cincinnati Metro, Houston Metro, DART, CATS Baton Rouge, Metro Transit (COPTA),

The Metro (KCATA), and AC Transit. LYNX finds that "The current road infrastructure is horrible for bikes." An agent from Kansas City finds this to be Bike-n-bus's main need:

> "Routes are the most effective, and the agency feels we can do the best job, when people can get to and from the stop. The same is true for sidewalks and park-n-ride. That's the key component. Smart centers are important too, but accessibility to the stop is key." (The Metro (KCATA)).

Replogle suggested that the extensive network of suburban residential roads could be assembled into a bicycle network, using "penetrator bicycle paths" to "connect these [streets] to major transit stops, employment, and shopping centers." (Replogle, 1992). This concept is developed much more in the FHWA case study, which suggests building bicycle and pedestrian paths merits its own dedicated programs:

> "A very effective strategy for promoting walking and cycling is the provision of shortcuts for pedestrians and cyclists to overcome network barriers. Such shortcuts are needed to connect low-speed, low-volume suburban residential streets into an effective network, which may dramatically reduce the actual walking or cycling distance from homes to bus stops, stations, schools, and stores at low cost. The addition of diagonal shortcuts for pedestrians and cyclists in the vicinity and direction of the stations has been found by the Dutch to be a very effective strategy for expanding the area from which pedestrian and bicycle access trips are made, as these shorten both trip distance and trip time for non-motorized access.
>
> "Accomplishing this requires taking advantage of opportunities as they arise, as in redevelopment or through the subdivision process. However, in U.S. communities that were designed for automobile dependence, creating such shortcuts to create network connectivity may at times require the creation of special programs to purchase easements for pedestrian and bicycle access at the edge of or through already subdivided residential and commercial land parcels." ("Case Study No. 9," 1992).

4.5.5 Culture – Oddity in an Auto-centric World

Four respondents claimed that autocentric thinking discourages BnB travel – GLTC, Houston Metro, DART, Bi-State Metro. People may not even think of combining biking and transit. When they do, they must confront a social (as well as built) environment that is not for them:

> "Dallas has been a city all about automobiles for so long that there is a general resentment from drivers about sharing the roads with cyclists. With a lack of bike lanes or public storage for bikes there hasn't been a way for people to successfully utilize their bikes without feeling that they are being renegades." (DART).

While mentioning the lack of sidewalks and bike lanes and the dominance of automobiles, the GLTC respondent also acknowledges the stigma/stereotype of transit users:

> "Traditionally, in Lynchburg, transit is seen as only useful to those without other modes of transportation (i.e. a personal automobile)." (GLTC).

Certainly, anything besides automobile travel is seen as going against the norm:

> "This City is not big on bicycling overall (or for walking or transit for that matter – big SUVs and diesel trucks, massive freeways, know what I mean?)…The overall attitude in our region about bicycling is a little negative…" (Houston Metro).

The respondent from St. Louis felt that traveling by bike-n-bus mainly fit with a particular lifestyle; it is primarily a lifestyle choice and will never be considered normal.

> "Mostly, it's people's perception that they can only travel by car; they don't realize that bikes are even an option for commuting. People have a million reasons they think they cannot ride a bicycle: they will mess up their clothes, that it's too much of a commitment, that they would need rain gear…" (Bi-State Metro)

Simply overcoming the mental barrier against bike-n-bus might be considered a success. Indeed, a number of respondents indicated that the success of the program is measured by public perception. "The larger concern is how the public receives it." (Cincinnati Metro). The Metro in Kansans City finds that the program is seen as being progressive and environmentally friendly by city and business leaders. A person at Cleveland Metro observes that "everybody is interested in green, sustainable stuff these days; it's like every other person."

Push-back from zealous cyclists

Some, however, found that bicycling was more glamorous than connecting to the bus. Those who do rebel from the pressures of auto commuting tend to be determined cyclists who are intent on making the whole ride by bicycle. From Oakland, the report was "Cyclists don't want to ride the bus; they would prefer to ride." While some cyclists are intentional about using the bus, seeing it as a way to extend their range, others are discouraged by the low level of bus service and see the bus as an inconvenient. The example the AC Transit respondent gives are

cyclists who ride the dangerous and intimidating tunnel to Alameda rather than hopping a bus. SEPTA's respondent found that highly-active cyclists may not have need for using a bus, whereas other cyclists are just uncomfortable using transit. To cater to these groups, SEPTA tries to provide good-quality information and let the cyclists choose if BnB is an amenity to them.

Gas Price as an incentive toward acceptance

Six respondents noted that high gas prices (such as those observed over the summer of 2008) motivated people toward bike-n-bus – Centro, CAT, MATA, Bi-State Metro, UTA, FAX. FAX found that bicycle use is being seen more and more valid as an alternative mode; biking to the bus has become more desirable with increased price of gasoline. The respondent from Bi-State Metro noted that with higher gas prices, not only do they see increased transit ridership, but bikes began replacing cars at the park-rides. It seems that gasoline over $4 per gallon has the power to change public views about alternative modes like bike-n-bus.

4.6 Users and Stakeholders

This section begins by examining both sides of the argument for and against measuring bike-n-bus use, and ends by sharing the upward trend in ridership. Along the way, it looks at studies and commentary about who uses bike-n-bus, and identifies other stakeholders in the program.

4.6.1 Need for Performance Metrics?

The 10 agencies that said they kept track of bicycle boardings either used a button on the farebox or a radio key that the driver can press. Two agencies (Cincinnati Metro and MAT) ask bus drivers to keep a tally of bike boardings. Four other agencies (PACE, Madison Metro, AC Transit, and Valley Ride) rely on bus drivers for metrics, but only ask for a tally of bicycle turn-aways. Using turn-aways as a metric means that the agency only knows when capacity on a particular trip is exceeded, but it has no way to track actual usage. Cincinnati Metro, TARTA and Riverside RTA have a sensor that records when the bike rack is down. Unfortunately, this form of data collection suffers from a similar problem, as it does not track when individual bicyclists actually board and disembark. On the other hand, TriMet's respondent points out that usage statistics will not be able to reveal what demand is when riders are being turned away. Nor are route-level usage statistics detailed enough to indicate where there is demand to access the bus by bicycle (TriMet).

Note that metrics are not the same as performance measures. COPTA points out that they track bicycle ridership daily using a fare key and report it monthly, but there is no target to which they compare it. Such performance measures are necessary to be sure the program is meeting the goals for which it was created. The case of Richmond illustrates: The respondent said that the program is seen as successful but was unaware if anyone even measured rack use. Clearly, this agency did not expect much use of the racks when forming the program. The respondent said he was even "surprised by how often they are used."

Five agencies indicated that they receive feedback on their program only through passenger complaints. The Metro in Kansas City says this makes it difficult to know the challenges the program is facing. Seattle Metro also said that their evaluation is “ad hoc” relying on initiative from the bicycling community. FAX calls complaints the “barometer” of ridership on a route. They must have a significant level of ridership, because they have created a complaint code just for insufficient bicycle capacity. As is the case in most agencies, SEPTA hands off complaints/suggestions to a group to look for quick-fixes or nagging problems. They see the program as a success because one can see that bike-n-bus is being used, but the program receives few complaints. Yet, the volume of complaints is not telling as the rate (complaints per bikes transported). Complaints are a good measure of service quality, but they cannot tell use. Fewer complaints may mean improved bike service, or it may mean fewer people are riding.

Seven respondents were either unsure if they had statistics on bike use or, if they did, had no process for analyzing the data collected. For example, PACE tracks anecdotal tallies from bus drivers, but does not keep records. (The agency is not too concerned with numbers, so long as they know that the general trend is upward.) Riverside RTA stated that they used to collect data on bike use, but stopped once they saw a minimal level of use.

Other respondents question the accuracy of bike counts. UTA has been measuring ridership for a decade, but the new electronic process instituted a few years ago has not been very accurate. Houston Metro and GLTC are also suspicious of tallies made by bus drivers. Bus operators are already very busy and may miss tallying a few bicyclists. Thus, any ridership numbers gathered would be underreported. Still, even a farebox key must rely on drivers for metrics, a Valley Metro representative points out. Houston calls their farebox key method “crude”.

In contrast, three agencies have a regular report on bike use: Charlotte CATS, Houston Metro, and MAT. CATS reports this data from the farebox on a monthly basis – carrying 5,600 bicycles

per month, as of November 2008. Houston's reporting allowed them to distinguish a drop in bicycling (as well as overall ridership) following Hurricane Ike.

Still, nearly half of the agencies (15) gave no measure for assessing bicycle use. The respondent at Bi-State Metro explains "Ongoing data collection is usually only warranted when high maintenance costs are challenging profitability." This may also be because the program's "success" is not tied to the level of use. If FMRs are indeed viewed only as an amenity, as AATA articulates, "The goal was never to attract ridership, only accommodate it." "The need to evaluate the bike racks is limited; its usefulness is obvious, so it's standard equipment." (Bi-State) Otherwise, the lack of performance metrics could indicate that the agency does not understand how FMRs add value to their business. For example, MATA said that while they have no performance measures at this time, higher usage might warrant tracking. Or perhaps they feel that precise evaluation of such a low-cost program is not necessary. Centro in Syracuse has no performance measures, but they say "It's not hard to figure out that popularity is on the rise."

Nevertheless, seven respondents, from among agencies (both those that did and did not collect data) said they should do more to study bicycle use. "There probably should be [data collection]; there are metrics for everything under the sun," said one. Other agents explained that funding was too tight to allow for such data collection. Cincinnati Metro's representative says "It would be nice to know what percentages of people use their bike for recreation vs. transportation." In Baton Rouge they need to know how many riders they get and on what routes (one of the reasons they hired a new planner). Once data is gathered, they might try to increase bike-n-bus ridership on the heavier-traveled routes. Once the investment in data collection is made, there are lots of ways data could be evaluated, and with a little effort could

be put to good use (Bi-State). Bi-State's respondent suggested bicycle counts may be interesting material for the agency's website.

4.6.2 Bike-n-Bus Users

Few studies have been done in the U.S. on the characteristics of BnB riders. On-board surveys conducted by transit agencies as part of market segment studies provide the most detail. In Europe, only Martens has collected such information in a way that is accessible to readers in the U.S.

Some studies

Within the U.S., Hagelin is the only researcher who has attempted to survey bike-n-bus users across various transit agencies. He finds that 90% are male, and that "[FMR] users are also more likely to have limited access to a car with over 45 percent coming from households without cars. In addition, 35 percent of BOB users do not hold a valid driver's license." (Hagelin, 2005). However, all incomes groups are represented in his survey, and users are distributed fairly evenly across age groups (Hagelin, 2005).

Replogle had similar findings. "Only one-fourth to one-third of passengers who park bicycles at bus stops had an automobile available." Bike-and-ride users generally come from households with less access to automobiles (Replogle, 1984).

LYNX, TriMet, and The Metro have done market segment studies of their biking riders. AC Transit was completing a study at the time of the interview, but older passenger profiles found that 3% of their riders arrived on bike (a rate higher than most U.S. transit systems). With bike ridership at capacity on some commuter routes, marketing began the new study in 2008.

A Canadian study on biking (not just to transit) found the biggest factors behind bike-riding were demographic. Young people were drastically more likely to bike (those under 20 being 2.98

times more likely to bike, with those in their 20s setting the average). Men are indeed more likely to ride. Lower-income groups also tended to ride more than average. (Winters et al., 2007).

Research from Europe also confirms what one might guess: Bike-n-bus appeals to commuters, students, and the transit-dependent.

Martens looks at the trip purposes of Europeans linking bikes with transit. Presented in Table 11, it breaks down trip purposes by mode and country of study. (Numbers are given as a percent of passengers who biked.) The majority of bike-n-ride trips, between 50 and 80%, are for commuting to work or school. A greater share of school trips are done with bike-n-bus than bike-n-rail. Martens speculated that this is because students live closer to their school than employees from their work. The next largest uses are for shopping and other non-work trips. He finds that shopping is "a substantial share of all bike-and-ride users, especially in [the] case of locally oriented public transport types such as bus and metro." (Martens, 2004).

Martens also finds that the number of people using bike-n-ride because they had no access to a personal automobile varied widely, from 45 to 88%. The higher numbers were generally associated with bike-n-bus, with premium modes of transit attracting more choice riders.

If these conclusions from Europe hold true in the U.S., then bike-n-bus is particularly good at serving the niche of students and transit-dependent shoppers – even better than bike-n-rail does.

Table 11 – European bike-n-ride trip purposes (Martens, 2004)

Table 4
Travel motives of bike-and-ride users for the Netherlands, Germany and the UK (access trips)[a]

Travel motive	Train			Bus		Metro	
	NL	GE	UK	NL	UK	NL	GE
Work (%)	40	64	66	21	45	33	49
Education (%)	30	14	12	51	7	22	32
Shopping (%)	6	14	1	10	31	19	11
Business (%)	3	–	4	1	0	4	–
Other (%)	21	9	17	18	17	22	7

Sources: Van Goeverden and Egeter (1993) for the Netherlands; Bickelbacher (2001) for Germany; Taylor (1996) for the UK.

[a]The data refer to the national average for the Netherlands, to the Grafing train station and Kiefergarten metro station for Germany, and to five selected train stations and three P&R bus stations for the UK.

Expert guesses

What kinds of people use bike-n-bus? While few agencies have undertaken studies, planners do have a sense for who is riding. For example, while AATA has not conducted any bike-n-bus rider surveys, they know anecdotally that they serve a wide variety of users, young and old, and that college students are not as predominant as one might expect.

Cyclists and Advocates

Eleven agencies (Centro, PAAC, GRTC, CATS, PACE, Houston Metro, Metro Transit, Bi-State Metro, UTA, FAX, Seattle Metro) mentioned “active”/ recreational cyclists as a target group. The representative from Charlotte CATS said stakeholders include those who are health- and environmentally-conscious and cycling enthusiasts, encompassing bike riders of all sorts. The respondent at Bi-State Metro says “Some using the program to commute are ideologically driven; the environmentally conscious (those who would heed the Sierra Club’s support for the program), the pro-transit, and the anti-car. However, this is only a small group.” He felt that bike-n-bus only fit with a particular lifestyle; that it is primarily a lifestyle choice.

SEPTA's respondent echoed this sentiment, but also pointed out that bike-n-bus may be more of a niche market, as highly active cyclists may have little need for transit. Riverside also observed that bike-n-bus riders tend to be male. However, 13 agencies (Centro, GRTC, GLTC, Madison Metro, MITS, Houston Metro, DART, MAT, FAX, Valley Metro, Seattle Metro, STA, Valley Ride) commented that the ridership included many from beyond the core cyclists. Centro says "It's more than just hard-core cyclists" who use their racks.

Commuters

The TARTA official was surprised that racks were being used primarily for commuting, rather than casual or recreational use. Eleven agencies (Charlotte and Baton Rouge CATS, PACE, Madison Metro, TARTA, The Metro, UTA, RTA, Valley Metro, STA, Valley Ride) find commuters a substantial user group. Charlotte CATS believes that bike-n-bus caters to those looking for an inexpensive way to commute. CATS Baton Rouge finds commuters to be their main stakeholder group. These passengers have the option to park their bikes at the main terminal downtown. The respondent from Madison Metro says bike-n-bus users are generally from the outlying areas, even outside the agency's service area, commuting to work downtown. The Metro in Kansas City notes that bike-n-bus users include both choice riders and the transit dependent. Valley Ride also finds that there is a fairly even distribution between those who work in downtown Boise and other sorts of users. He even knows of an attorney that bikes and loads a $5,000 bicycle on the bus.

Students

Nine agencies mentioned students (GRTC, Cleveland RTA, Madison Metro, AATA, Bi-State Metro, AC Transit, Riverside RTA, Valley Metro, Valley Ride) as an important rider group. Madison Metro also observes that university students are a notable market segment. Riverside says there are "probably a lot of students." Three of the four schools in the RTA service area allow students to ride free by showing a school ID. It is a similar case in St. Louis. Around colleges, the racks are full and riders are being turned away. At Valley Ride, not only are there a large number of students who use the system, but students tend to use the system more frequently than other bike-n-bus riders. AC Transit responds that…

> "Intuitively, students are a major user group. Ridership is up on Line 51 to UC Berkeley – but that is still just a small fraction of bikers. It's not just young folks, it's broadening out. East Oakland is a large, low income area with lots of bike use." (AC Transit)

Typical transit users

Eleven agencies (Charlotte CATS, PACE, Madison Metro, TARTA, Baton Rouge CATS, The [Kansas City] Metro, UTA, Riverside RTA, Valley Metro, STA, Valley Ride) identified bike and bus riders as typical transit riders. MITS conjectures that stakeholders are probably not much different from typical transit riders, with bike-n-bus users coming from all age groups and a wide socioeconomic range. LYNX believes their bicycling ridership is much like bus ridership overall – of which 58% are transit dependent. In fact, seven agencies specifically identified the low income / transit dependent riders as stakeholders (GLTC, Bi-State Metro, The Metro, UTA, AC Transit, Riverside RTA, STA). Spokane Transit thought that bike-n-bus was most significant in its service to low income group, although its use is across the board. Riverside has observed commuters, lower income, and males to be most common users. GRTC's respondent thinks that many of these are workers living outside the bus service area.

4.6.3 Stakeholders - everyone else

Eight agencies listed environment or transit activists as stakeholders. While many agencies talked about the interests of bicycling advocates, CCTA and Cincinnati Metro pointed out that non-cycling transit riders had an interest in the program as well (if bike loading slows the bus, bicycle parking gets in the way at transfer centers, whether bikes should be allowed on board, and so forth). Two agencies (Cincinnati Metro and DART) mentioned bus drivers as a unique stakeholder group. GLTC's respondent mentioned the agency's board of directors. Given the tough economic climate, they wondered if the agency might cut the bike-on-bus program.

Seven responding agencies noted municipal and regional governments as bike-n-bus stakeholders that should be involved with bike-transit integration. Four respondents also listed businesses and/or the chamber of commerce as having an interest in the program. One respondent (from DART) even stated that all taxpayers could be considered as stakeholders. AC Transit pointed out that pedestrians and bicyclists on the street had an interest, because of the safety concerns of buses operating on tight urban streets. Buses must share lane space with bikes, and bikes in front of the bus could limit the ability to see pedestrians (AC Transit). For similar reasons, four respondents (PACE, Seattle Metro, UTA, and Valley Ride) mentioned other drivers, local, or state DOTs as stakeholders as well. UTA consulted with the state DOT to determine if three-bike FMRs were safe. They found the interference with bus headlights to be too dangerous, so the racks were removed.

"Basically," the respondent from Boise said, "the stakeholders in bike-n-bus are the same as those who have a stake in the transit system: Riders, planners, highway [designers], the city, businesses, IDOT [interested in multimodal travel], alternative transportation groups – It is an exceptionally bike-oriented city… in short, everybody."

4.6.4 Unquestionable Rise in Popularity

Six agencies described how ridership has gradually risen. TCRP Synthesis 62 confirms that in almost all cases, to varying degrees, bike-n-bus ridership goes up over time. Those places seeing highest levels of use are "larger transit systems, in communities [where] bus bike racks are provided on [most] of their buses, and in areas with warm climates." (Schneider, 2005). Syracuse and Lynchburg both commented that ridership was low at first, but started to increase after a few years. In other cities, success seems to be more immediate. The report from CATS in Baton Rouge is that the program has "taken off" and it is now common to see at least one bike in each rack. The GRTC respondent, upon last seeing ridership numbers, "was surprised by how often they are used."

> "Of the agencies that collected consistent data on the use of bicycle services, most found increases in use over time. Several agencies reported significant growth in use during the first few years of a new service as information about the service spread to potential customers." (Schneider, 2005).

The numbers confirm what agency officials observe. AATA tracks ridership through a farebox key and have kept a record of the number of bike boardings since 2003. They say the bike-n-bus program in Ann Arbor has seen growth every year, mostly during the summer months (when the University of Michigan is not in session). Interestingly, they have found that bike ridership generally follows the same trend as wheelchair boardings. CCTA has also tracked bike boardings on a monthly basis since 2003, and has found bike access in Burlington to be on a steady increase. Fargo MAT takes a detailed count of bikes. They keep a tally every day on every bus route. The major trend they have seen is found that, since the program's inception in 1997, bike ridership has grown considerably.

If any agency can testify to the popularity of bike-n-bus, it is Valley Metro. They carried 1.3 million bike trips between July 2007 and June 2008, wining an award for carrying more bikes than any other agency in the country. In Fresno, they also find the program is very successful. “There are lots of people riding the bus, a good number of which are coming to transit [for the first time].”(FAX).

CHAPTER 5: CONCLUSION

There is no absolute maximum to bike-n-bus use. If communities are made more bikeable, more bus trips will be accessed by bike. Likewise, bike-n-bus has the potential to expand transit ridership, attracting bike-n-bus users from those who formerly drove to work. In a future where the potential of bike-n-bus is realized, transit agencies would make strategic investments in bike-n-bus in order to achieve particular goals. In this future, bike-n-bus ridership would not be limited by rack capacity or the availability of bicycle parking.

Bike-load with front-mounted racks (FMRs) – a unique American form of bike-n-bus – is nearing its limit. Most agencies now have 100 percent of their fleet equipped with FMRs, and in some cities, demand exceeds capacity.

With the results from the ten question survey, this study can evaluate the original hypotheses:

- When and how have transit agencies adopted bike-n-bus accommodations?

  Most agencies are now 100 percent FMR equipped, with about one-third of these adopting the technology by the year 2000, as predicted. Few respondents mentioned the funding source for this change.

- Do transit agencies have clear, written policies?

  Respondents seemed confused by the use of the word “policy” in relation to bike-n-bus. As far as this study can determine, agencies offer little in terms of written policy about bikes. While some agencies have rules for bike-n-bus users, most written material is focused on explaining how to use the front-mounted racks (FMRs).

- How have transit agencies worked with other groups to develop the bike-n-bus program?

  Often agencies have a relationship with the bicycling advocacy groups in that city, but almost one-third of responding agencies do not work with other organizations on an on-going basis.

- Are agencies aware of which groups have an interest in bike-n-bus?

  Users and stakeholders consist of individuals from a broad range of interests and backgrounds.

- Do transit agencies measure the level of bike-n-bus use?

  Agencies are split on whether or not measuring bike-n-bus use is worth the effort. No agency has goals to which they would compare these numbers to.

- Can transit professionals comment on what obstacles hinder greater bike-n-bus use?

  The lack of safe, bikeable routes to transit is clearly the biggest deterrent to bike-n-bus use. Provision of bicycle parking is a secondary issue. Also, the use of bike-load in many cities has grown to such a level that the limited capacity of the front-mounted racks may discourage even greater use.

- How is it thought that bike-n-bus will evolve?

  Many agencies have considered making changes to the bike-n-bus program in order to cope with high demand and limited FMR capacity. High bike ridership does seem to be the biggest incentive toward change. Other respondents felt they could do little to impact bike-n-bus ridership, but were dependent on community leaders to make their city more “bicycle friendly.”

These conclusions are divided into four sections. Having already portrayed a snapshot of bike-n-bus in the United States (through the end of 2008), the conclusion continues to lay out a vision of what bike-n-bus could be. This is followed with a roadmap for transit professionals seeking to refine their agency's bike-n-bus program. A third section gives tips for policy-makers for how to regard bikes and buses as part of a combined network. Finally, remaining questions are suggested for future research.

5.1 Vision of Potential

Ask the transit profession if bike-n-bus is a success, the answer is a very clear "Yes." Of the 33 agencies surveyed, 30 of them gave a positive response. Particularly, agency responses mention ridership levels, the ways bike-n-bus aids travelers, and the overall public perception of bikes on the bus as indications of the program's success. These responses are no surprise; they all flow from the core benefits of bike-n-bus to aid the cyclist, enhance transit service, and provide an alternative to automobile use. All agencies that see such results can proudly say they have implemented a viable bike-n-bus program.

Though bike-n-bus programs are successful, most feel there is still room for improvement or growth in their program. Only one agency, Fargo's MAT, expressed that the program was fully developed, with little foreseeable growth in bike use. Those who did qualify their response said the program was successful but it was not fully marketed (GLTC), lacked objectives (MIT), or did not track any performance measures (PAAC).

The dichotomy of these responses is understandable. At first, the challenge was how to sustain a bike-n-bus program. Now that agencies have seen that they can attain the benefits of bike-n-bus, the next step is to ask "how much more is possible?"

It is foreseeable that an integrated bike-transit system could realize all of the benefits of bike-n-bus. Transit dependent riders would ride transit more frequently, using their bikes to reach homes, jobs, and shopping far from existing transit service. Routes in suburban areas would see a gradual increase in ridership from bike access. In time, this would allow agencies to provide streamlined services in these areas, further attracting bike users. In some places, transit agencies may be able to expand their service into even sparser areas, expecting many of the new travelers to come by bike. This would be supported by state and local efforts to create bicycle shortcuts between major roads and suburban neighborhoods. In the city, businesses and local government would embrace the influx of bikes by constructing bicycle parking and other bike infrastructure. Eventually this would develop a well-connected network of bicycling streets and paths feeding into the transit system, relying on specialty transit services to overcome hills and other natural obstructions. Of course, even equipping buses with three-bike FMRs and allowing bicycles inside the bus when the rack reaches capacity may not be enough – agencies would have to begin installing bike racks at some of its stops, or work with businesses across the region to provide bike parking in key areas. Park-n-ride patrons may easily choose to switch their access vehicle from car to bike. Auto commuters may also choose to make a switch. Those who wish to pursue a car-free lifestyle may find that biking to the bus, along with other options like ZipCar (Krizek & Stonebraker, 2010), enable them to do this. Even those who do not find bike-n-bus travel convenient can benefit. Bike-n-bus can help alleviate some of the congestion at busy intersections and along congested corridors, reducing emissions, improving the environment, and decreasing dependence on foreign oil.

While all this may not be possible at first, a positive feedback loop reinforces the program efforts, whereby early initiatives toward bike-transit integration yield transit service and a biking environment that is more favorable to cyclists. While most today rely on the personal

automobile for all their travel, the presence of bike-n-bus as a viable transportation alternative can only decrease reliance on the car.

Of course, achieving all these potential benefits of bike-n-bus will require ongoing effort by the transit agency to study the needs and apply solutions that are within their means. It will also involve coordinating with many other groups and stakeholders. No one-sized approach is appropriate for all situations. However, all forward-looking bike-n-bus programs will have some common themes.

5.2 How to Shape a BnB Program

Clarify the agency's bike-n-bus policy. This will help avoid legal repercussions, particularly when a bus is brought on board (whether or not it is allowed). Have clear goals that define success. These might be based off of the three categories of benefits described in section

2.5 Benefits of Bike-and-Bus - Still Room for Growth." The following set of goals may serve as a template:

Make FMR equipped buses available for cyclists to bypass hills, cross bridges and tunnels, and avoid areas where the speed and volume of automobile traffic make bicycling too dangerous for the average bicyclist.

Provide greater convenience for current transit riders by increasing their ease of access and range of travel. Allow customers from greater distances to access the transit system.

Accommodate non-auto access at automobile park-and-rides. Consider bike-n-bus investments along with proposed investments in park-n-ride. Publicize bike-n-bus as an alternative to commuting by personal automobile. Recognize other initiatives that also help enable car-free lifestyles.

Meet demand. This requires that an agency at least assess how much use their bike-n-bus program is getting. In cases where the FMRs are running at capacity, assessing demand will require at least two measures: attempted boardings and actual unloading. (Counting boardings and turn-aways would lead to double-counting if the bicyclist waits for the next bus or pedals to another route.) Collect these electronically and link the data with the AVL system, so that it can be determined which stops bicyclists frequent. Reporting on bicycle use would be easiest if incorporated with the process for assessing route performance.

Define some metric by which performance can be judged. These should probably relate back to the goals for the program. Set a target and take measurements. Compare these in a periodic report, and track performance over time. As a suggestion…

> The number of bicycles transported is the most basic metric. This will vary with season, but the general trend should be upward. A more sophisticated metric would be the percent of access trips made by bike. This allows biking to the bus to be benchmarked against the percentage of trips make by bike in the region. (If 3% of trips in the region are made by bike, one can expect about 3% of transit riders will come by bike.) Complaints could be a useful measure of program quality if compared against the number of bike boardings.
>
> This is similar to what Hagelin recommends:
>
> "First and foremost, all transit agencies should collect [bike-n-bus] boarding data. Agencies with electronic fare-boxes should program a key to record BOB trips. Data can show the value of a program and as a result, provide support for funding requests and service improvements… Transit agencies should also periodically survey their BOB patrons." (Hagelin, 2005).

Bike-count data is not enough. Every few years, a market segment survey could provide greater detail about what percentage of bike-n-bus riders are new to transit, how far riders are

extending their range by bicycle, and how (much more often) they are able to take the bus. This is also an opportunity to find out what demographics are using the program, for what purposes, and to ask about other challenges biking riders are facing.

Particularly, keep track of how many bikers are being turned-away because of full racks. Too many turn-aways discourages everyone from using the program. Follow up rack crowding with investments in parking at bus stops.

Promote the integration of bikes and transit. Most agencies already have good informational material about how to use the FMRs, and many show-off bike-n-bus at publicity events. However, those most likely to use bike-n-bus are existing transit riders who are unfamiliar with bicycling, or bicyclists who have never found it convenient to take the bus. Low income groups and minorities are also likely riders, but may have never heard a presentation of how the racks work (in their language). Only 10% of bike-n-bus users are women (Hagelin, 2005), suggesting that current program outreach fails to connect with the needs of women. Many agencies conceive of bike-n-bus for recreational purposes. To cater to this sort of use requires good promotional and informational materials, showing desirable biking routes and other bike amenities, and highlighting the bus routes that tie them together. Maps showing both transit routes and the suitability for bikes could be useful for bike-n-bus users who must simultaneously think about both transportation networks.

Coordinate with other groups. Particularly, discuss with the local MPO about having a seat on a BPAC, so that the needs of transit users is represented in the regional bike plan. Also, be sure that local cycling advocacy groups are aware of the needs of biking transit passengers. If local governments and the business community are interested in installing bicycle parking, ask that this be made available near transit stops. Be aware if/where DOTs are considering building bike lanes and paths. While transit agencies cannot be expected to start advocating for bike

lanes everywhere, they can let it be known that they and their customers are stakeholders in bike issues.

Develop a long-term vision for the bike and bus systems. Largely, this would need to be developed by those outside of the transit agency, underscoring the need for coordination with other groups. In this way, small improvements can be made in a way that is consistent, not piecemeal. Plans make it so that changes can be made incrementally. For example, the plan might study how many bike lockers to have at a transfer center, so that sufficient space can be allocated for them.

Don't settle for good PR - Pay attention to details. Ask your biking riders where they want improvements and invest in those locations first. Another way to do this would be to let customers call in to request bike parking or bike lockers – that way bike investments would go to locations where they will be utilized. Also, keep extra bike parking racks or three-bike FMRs on hand, so that capacity requests can be handled right away, without going through a lengthy procurement process.

Offer your data to a research institution. Agencies do not always have the staff time to invest in detailed analysis, or the resources to hire a consultant. Researchers not only have more time to crunch numbers, they are able to analyze and interpret data in ways typical practitioners may not think of. While this may not happen right away, sharing data is the first step towards discovery.

Hire a consultant to assess latent demand for bike-n-bus. At the present time, this may not even be possible due to limited research. For the time being, investments in bike-n-bus enhancements can only respond to immediate needs. However, future development in this field of research should allow agencies to predict the use of bike-n-bus amenities before they are

built. This will enable agencies to be more proactive in their bike-n-bus investments, performing benefit/cost analyses and prioritizing expenditures based on its anticipated ROI.

5.3 Takeaways for Policymakers

The percentage of access trips made by bike should be about the same as the level of bike use in the community (Martens, 2004). If 3% of trips in the region are made by bike, one can expect about 3% of transit riders will come by bike. A bus stop is as much a destination for bikes as any other place in the region.

In the U.S., bike-n-bus can attract a good portion of its users from among those who have never used transit, around 1 in 4 (Hagelin, 2005).

Bike-n-bus is not just an amenity that an agency can install on the bus and forget about. It requires maintenance, and is more useful if the agency follows-up on its use. It should be viewed as an ongoing program; as service to customers. There are always reasons to not promote the program. Agencies with high levels of use are afraid of capacity constraints. Those who have low ridership question if it will ever be used. Bike-n-bus falls short of its potential (in part) because it does not receive enough attention from transit agencies. Particularly, agencies could pay more attention to its promotion, expansion, and in collaborating with other organizations. Bike-n-bus is highly dependent on efforts of the region, municipalities, and the business community to create “bike-friendly” community. Improved bicycle facilities benefit transit agencies, but agencies have been hesitant to make their interests known. Agencies feel that is up to others to make these investments, and are hesitant to push for these investments.

Perhaps the greatest lesson is (not for transit agencies but) for communities who are (not) considering bicycle investments. Bicycle facilities are not just for local transportation, but part of a larger transportation network. Investment in bicycle infrastructure affords bicycle access to the local community, but also transit access to the entire region.

Hot, cold, snowy, icy, humid, or rainy weather influences, but does not determine, bike-n-bus use. People ride in all kinds of weather for different reasons.

There a lots of benefits to bike-n-bus… but the simplest way to quantify this is by measuring BnB use.

Indeed, while nearly all respondents thought their program could be expanded, almost half (14/33) foresaw no changes their bike program. Agencies are hesitant to change something they see as being a successful, instead of enhancing it. This may just be a case of "If it is not broken, don't fix it" mentality.

Bike-n-bus has shown some propensity to attract new transit riders, but this is very small compared to transit ridership overall. Bike amenities should be treated as capacity for bikes, not a magnet. Expansion of bike services should be treated as an experiment that begs study.

5.4 Opportunities for Further Research

For researchers interviewing transit agency officials, note that emailed responses tend to be less detailed and are less likely to include anecdotal information. Public Relations personnel respond well, especially to email, but are less knowledgeable than planning staff. General Managers and planning staff are most able to evaluate the program, providing information about its effectiveness and explaining the forces that will shape the program in the future.

If the national transit database asked for monthly data on what percentage of riders arrived by bike, it would furnish bike-n-bus researchers with a wealth of useful data.

A possible research question regarding bike-n-bus outreach would be “What public interactions are the most effective?” This would involve case studies of various agencies’ attempts to promote bike-n-bus and the corresponding ridership trends.

Surveys of bike-n-bus users should make mention to issues of limited capacity. It is important to develop a clear answer to the question “How big a deal is a turn-away?” so that agencies know how to prioritize the expansion of bike capacity.

Case studies comparing various sorts of parking amenities at bus stops, transfer points, and rail stations would help determine what sorts of parking strategies works best. Related questions may include “how is user satisfaction and/or ridership enhanced as a response to upgraded parking facilities at transit stations? Do documented procedures exist for marrying transit stops with public bicycle sharing?” (Krizek & Stonebraker, 2010).

It seems that the percent of bicycles that are lost or stolen vary greatly from one city to another. The actual rates and causes of these misconnections would be subject worthy of further research. The causes of this misconnection might be related to communication with bus driver, or to levels of driver distraction. In so much as it depends on communication, the percentage of bikes lost tells of the social patterns for interacting with bus drivers in that city. In the latter case, the percentage of bikes stolen is telling of which routes are most demanding of the driver.

More studies of how far passengers will bike on access and egress will help judge how much individuals benefit from bike-transit integration. The more utility bike-n-bus provides, the further people will be willing to bike to reach transit. Also, this sort of research will help agencies know how much they are able to expand their catchment areas by incorporating bicycles.

How much bicycle access increases the catchment area of transit will depend on the layout of both the bike and bus networks. Network analyses in GIS that show how increases in access distances alter catchment areas would help show planning agencies see where and how bike-n-bus has the most potential. These catchment areas can roughly be translated into numbers of bike-n-bus users by multiplying the percentage bike trips in the community by the current number of transit. This will of course involve some spatial analysis to consider the varying densities, and levels of transit use across the city. Ideally, these studies could lead to the development of a "rule of thumb" that says what population density can support bike-n-bus.

Market segmentation studies are important for determining which demographics are most likely to use bike-n-bus, and it what situations. Market studies are the first step toward developing choice (logit) models. Predicting future ridership would involve creating a nested logit model to simulate the factors that go into decisions to bike-n-bus or travel by some other means. Such a study would evaluate the factors one considers when taking the bus, as well as the factors one considers when biking. Moreover, such a model would have to identify the joint probability of choosing to both bike and bus. Ultimately, the challenge is to create a module for travel demand models that simulate the decisions riders make when choosing if and how to access transit. In this way, transportation planners may someday be able to predict the latent demand for biking to the bus.

APPENDIX

Sample Agencies and their Attributes

Urban Area	State	Acronymn/ Abv.	FTA Region	APTA Category (# of buses)	Commute Time (min)	Service Area Dens. (Pop./sqmi)	Mean Temp. (F)	Rainy Days	Topo-graphy
Boston	MA	MBTA	1	1,000 or more	29	1,390	52	127	/\hilly/\
Hartford	CT	CTTransit	1	200 - 499	22	1,282	50	128	flat
Burlington	VT	CCTA	1	< 200	18	1,456	45	154	flat
Newark	NJ	NJT	2	1,000 or more	35	5,309	55	121	/\hilly/\
New York	NY	MSBA/ LIB	2	200 - 499	35	4,668	55	121	__flat__
Syracuse	NY	Centro	2	< 200	19	1,713	48	168	/\hilly/\
Philadelphia	PA	SEPTA	3	1,000 or more	28	3,992	55	118	flat
Pittsburgh	PA	PAAC	3	1,000 or more	25	1,826	51	152	/\hilly/\
Baltimore	MD	MTA	3	500 - 999	28	1,157	55	115	__flat__
Fairfax	VA	Connector	3	< 200	32	2,600	58	113	/\hilly/\
Richmond	VA	GRTC	3	< 200	22	1,980	58	114	/\hilly/\
Harrisburg	PA	CAT	3	< 200	20	2,138	53	125	/\hilly/\
Lynchburg	VA	GLTC	3	< 200	17	1,123	54	119	/\hilly/\
Atlanta	GA	MARTA	4	500 - 999	30	1,362	62	115	/\hilly/\
Atlanta	GA	C-Tran			30	3,881	62	115	flat
Atlanta	GA	CCT			30	1,934	62	115	/\hilly/\
Atlanta	GA	GCT			30	1,661	62	115	/\hilly/\
Atlanta	GA	GRTA Xpress			30	2,721	62	115	/\hilly/\
Orlando	FL	LYNX	4	200 - 499	26	606	73	116	flat
Charlotte	NC	CATS	4	200 - 499	25	1,531	61	111	/\hilly/\
Gainesville	FL	RTS	4	< 200	18	2,116	68	116	flat
Savannah	GA	CAT	4	< 200	21	530	66	111	__flat__
Nashville	TN	MTA	4	< 200	24	1,184	59	119	/\hilly/\
Memphis	TN	MATA	4	< 200	22	3,086	62	107	/\hilly/\
Chicago	IL	PACE	5	500 - 999	31	2,208	49	124	flat
Cleveland	OH	RTA	5	500 - 999	24	3,083	50	156	__flat__
Minneapolis	MN	Metro Transit	5	200 - 499	23	832	45	115	/\hilly/\
Madison	WI	Metro	5	200 - 499	20	3,298	48	125	flat

Urban Area	State	Acronymn/ Abv.	FTA Region	APTA Category (# of buses)	Commute Time (min)	Service Area Dens. (Pop./sqmi)	Mean Temp. (F)	Rainy Days	Topo-graphy
Milwaukee	WI	MCTS	5	200 - 499	22	3,967	48	125	__flat__
Cincinnati	OH	Metro	5	200 - 499	23	3,226	54	131	/\hilly/\
Toledo	OH	TARTA	5	< 200	20	2,861	50	135	flat
Ann Arbor	MI	AATA	5	< 200	22	2,525	50	135	flat
Springfield	IL	SMTD	5	< 200	18	2,032	51	113	__flat__
Muncie	IN	MITS	5	< 200	17	3,746	53	126	__flat__
Houston	TX	Metro	6	1,000 or more	28	2,177	69	105	flat
Dallas	TX	DART	6	500 - 999	26	3,381	66	79	flat
Baton Rouge	LO	CATS	6	< 200	25	1,454	69	114	__flat__
Santa Fe	NM	SantaFe Trails	6	< 200	18	1,841	57	60	/\hilly/\
Oklahoma City	OK	Metro Transit	6	< 200	20	2,903	60	83	flat
St. Louis	MO	Metro	7	200 - 499	24	1,754	56	111	/\hilly/\
Kansas City	MO	The Metro	7	200 - 499	21	1,963	54	104	/\hilly/\
Denver	CO	RTD	8	1,000 or more	26	1,126	50	89	__flat__
Salt Lake City	UT	UTA	8	500 - 999	22	1,235	52	91	flat
Fargo	ND	MAT	8	< 200	14	2,778	42	99	flat
Oakland	CA	AC Transit	9	500 - 999	24	3,888	57	63	/\hilly/\
Las Vegas	NV	RTC	9	200 - 499	24	7,035	68	26	__flat__
San Diego	CA	SDMTS	9	200 - 499	25	5,469	64	42	/\hilly/\
Sacramento	CA	RT	9	200 - 499	26	3,999	61	58	flat
Fresno	CA	FAX	9	< 200	20	3,617	63	40	flat
Riverside/ L.A.	CA	RTA	9	< 200	30	550	63	35	/\hilly/\
Phoenix	AZ	Valley Metro	9	< 200	25	3,024	73	36	flat
Seattle	WA	Metro	10	1,000 or more	28	872	52	155	/\hilly/\
Portland	OR	TriMet	10	500 - 999	24	2,184	54	153	/\hilly/\
Spokane	WA	STA	10	< 200	20	2,358	47	112	__flat__
Boise	ID	Valley Ride	10	< 200	19	4,131	52	89	__flat__
Selection Average:		-	-	-	***24***	***2,487***	***57***	***108***	-

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