CALIFORNIA PATH PROGRAM
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY

Institutional Aspects of Bus Rapid Transit – A Macroscopic Examination

Mark A. Miller
Stephen M. Buckley

California PATH Working Paper
UCB-ITS-PWP-2000-7

This work was performed as part of the California PATH Program of the University of California, in cooperation with the State of California Business, Transportation, and Housing Agency, Department of Transportation; and the United States Department Transportation, Federal Highway Administration.

Report for MOU 394

July 2000

ISSN 1055-1417

Institutional Aspects of Bus Rapid Transit—A Macroscopic Examination

Mark A. Miller
Stephen M. Buckley

July 14, 2000

ABSTRACT

This report investigated the institutional aspects of Bus Rapid Transit through a macroscopic examination of relevant issues ascertained through a literature review, a series of project team brainstorming meetings, and input from members of the Federal Transit Administration's Bus Rapid Transit staff. The literature review provided insight into the history of Bus Rapid Transit concepts ranging from very early research in the United States in the late 1950s, continuing with dual mode systems and early busways in the 1960s and 1970s, international experiences in Latin America and Canada, and the return of interest in and research on Bus Rapid Transit in the U.S. Several dozen issues were identified and were grouped into the following nine categories: intergovernmental and inter-organizational; intra-transit agency; political; public relations and marketing; funding and finance; labor; safety and liability; planning and land use; and the physical environment. The issues that were investigated for this macroscopic examination form the basis of a survey currently being administered to members of the U.S. Bus Rapid Transit Consortium, a group of seventeen transit agencies who are each interested in developing their own Bus Rapid Transit system. Responses will provide valuable insight into and comment on Bus Rapid Transit institutional issues actually being experienced. This project will continue with site-specific case study analyses of institutional issues.

Key Words: Bus Rapid Transit, institutional issues, intelligent transportation systems

EXECUTIVE SUMMARY

Applying various areas of intelligent transportation systems (ITS) to the transit field is receiving much attention. Such areas include advanced transportation management and information systems, advanced vehicle control and safety systems, automated highway systems, and advanced public transportation systems. Several applications to transit have either already been deployed or are being considered and include advanced vehicle identification and location systems, electronic fare/ticket payment systems, interactive trip planning systems, signal priority systems, automatic passenger counting systems, collision warning, adaptive cruise control, and precision docking systems.

Several of these applications are being further explored by means of enhancing transit bus operations and services, under the umbrella name of Bus Rapid Transit (BRT). Improvements to bus operations and services may involve the operational setting/right-of-way, implementation strategies, use of technologies, bus stop/station, vehicle design, fare collection methods, and land use applications.

Any Bus Rapid Transit concept, however, would raise technical, operational, and institutional issues of which the institutional issues may be the most challenging ones to resolve. This report focuses on the institutional issues of Bus Rapid Transit and documents a macroscopic examination of them. The approach taken consists of three phases: a high-level assessment of the relevant issues ascertained through a literature review; a series of internal project team brainstorming sessions that produced a list of individual institutional issues; and a revised issues' list based on reviewers' comments among them members of the Federal Transit Administration's BRT staff.

The literature review provided insight into the history of Bus Rapid Transit concepts ranging from very early research in the United States in the late 1950s, continuing with dual mode systems and early busways in the 1960s and 1970s, international experiences in Latin America and Canada, and a resumption of interest in and research on Bus Rapid Transit in the U.S.

Several dozen issues were identified and have been grouped into the following nine categories: intergovernmental and inter-organizational; intra-transit agency; political; public relations and marketing; funding and finance; labor; safety and liability; planning and land use; and the physical environment.

Many Bus Rapid Transit projects operate across multiple jurisdictional boundaries involving numerous stakeholders. This situation can often complicate the decision-making process as each stakeholder usually brings its own philosophies, priorities, and agendas. Achieving intergovernmental and inter-organizational agreement among stakeholders could prove to be a difficult task. Institutional issues may also arise not only among transit agencies, political jurisdictions and highway agencies, but also internally within an individual transit agency. The deployment of a Bus Rapid Transit system is one stage in the process of design, development, testing, evaluation, and deployment of a completed system. At each stage, decision-makers in the local jurisdictions where a Bus Rapid Transit system would operate can impact the specific deployment path a particular system would take. Moreover, support of and commitment to Bus

Rapid Transit initiatives by decision-makers can influence its success. This can be greatly affected by how Bus Rapid Transit is "sold" to many stakeholders, including bus passengers, employees, general motorists, the general public, as well as decision-makers. However, great care must be taken in selling it as misconceptions and unrealistic expectations may present significant problems as well.

Financial and funding issues may also create institutional issues for BRT. There could be concerns over long term funding commitments to BRT and concerns over its potential to redirect funds away from existing transit services. Other potential issues include the lack of understanding of funding mechanisms available for BRT, transit agency reluctance to expand services due to current fiscal constraints, concerns over the need for a new bus fleet, and the capital and operating costs associated with building, operating, and maintaining a BRT system.

Bus Rapid Transit may also create labor issues, especially with bus drivers. An important concern is the level of support from such staff. Bus Rapid Transit may affect their roles and duties and may result in concerns over additional work and responsibilities without assurances of additional staff, needed resources, and/or pay.

With the implementation of a Bus Rapid Transit system, changes may occur involving new or different procedures for operations and the delivery of services, the use of new systems and/or technologies, and changes in personnel tasks and responsibilities. With the use of these new systems is the potential for components not to function as anticipated resulting in unintended safety-related consequences and issues related to assignment of risk and liability.

The deployment of Bus Rapid Transit will have impacts, both short- and long-term, on the overall transportation system and its surrounding operational environment. Concerns in this area could include: integrating BRT projects into the metropolitan planning process; lack of empirical evidence on the effects of BRT on land use; coordinating a BRT project with local planning agencies' land use plans; gaining community support for transit oriented development; and concerns of potential developers over BRT's lack of permanence as compared to a rail system.

The physical setting of a BRT system may also raise institutional challenges. Many project areas may simply lack the physical space to accommodate certain BRT strategies. Transit agencies may also encounter opposition if BRT is viewed as competing with other interests for high value real estate resulting in inflated costs or overly complicated operational requirements. The availability of adequate and obtainable physical space could present problems for certain projects.

These issues form the basis of a survey currently being administered to members of the U.S. BRT Consortium, a group of seventeen transit agencies who are interested in developing Bus Rapid Transit systems. Responses should provide valuable insight into the institutional challenges experienced by these agencies. Finally, our study of this topic will conclude with site-specific case study analyses of BRT institutional issues.

TABLE OF CONTENTS

1. INTRODUCTION

This report constitutes the interim deliverable for PATH Project MOU 394 — "Institutional Aspects of Bus Rapid Transit Operation". The project examines institutional issues on a generic or macroscopic level and through site-specific case studies. This document focuses on the macroscopic perspective. The remainder of this section provides motivation and background material for the project and discusses the specific objectives for this part of the project before reporting on the findings.

1.1 Motivation and Background

Interest in applying intelligent transportation systems (ITS) to the transit field is receiving much attention and support. Examples of ITS technologies within Advanced Transportation Management and Information Systems (ATMIS) and Advanced Public Transportation Systems (APTS), with transit applicability either already deployed in particular settings or at least under investigation, include:

- Advanced vehicle identification and location systems
- Electronic fare/ticket payment systems
- Interactive trip planning systems (kiosk, personal computer)
- Signal priority systems
- Automatic passenger counter systems
- Geographic information systems

A recent publication of the Intelligent Transportation Society of America provides a broad overview of transit-related technologies and their current and/or planned uses in how to address commonly experienced transit problems. The book serves as a reference source of ITS technology tools that may be applied to improve transit operations and services (1).

While the focus in (1) is placed on technologies within the APTS arena, (i.e., equipment, systems, and applications used in monitoring and managing transit), numerous opportunities also exist for transit applications within the Advanced Vehicle Control & Safety Systems/Automated Highway Systems (AVCSS/AHS) arena. Such systems will play a role in the transit platform of the federal Intelligent Vehicle Initiative Program (IVI) (2) and include:

- Collision warning
- Adaptive cruise control
- Precision docking

The application of ITS technologies to transit are being further explored by means of enhancing transit bus operations and services, called Bus Rapid Transit (BRT). Strategies for improving bus operations and services could involve:

- Operational setting/right-of-way

- Implementation strategies
- Use of technologies
- Bus stop/station
- Vehicle design
- Fare collection methods
- Land use applications

Bus Rapid Transit has the potential to have significant benefits in such roadway transportation problem areas as congestion, safety, air quality, and fuel consumption. Moreover, issues such as social equity, land use, and other environmental considerations could also be addressed by Bus Rapid Transit. It could provide the opportunity for improved transit services to serve the needs of people and markets other than automobile owners and drivers.

Bus Rapid Transit has the potential to approach and potentially match the level of service of rail transit for reliability and frequency, as well as the flexibility to operate outside a fixed corridor to provide 'door-to-door' service. The capital, operation and maintenance costs for Bus Rapid Transit using advanced vehicle and/or infrastructure technologies should be substantially lower than for rail transit systems.

Bus Rapid Transit service could also help to attract commuters from single occupancy vehicles, ultimately contributing to a reduction in traffic congestion on the corridor where it is implemented. Bus Rapid Transit operations could be extended from full-size buses to smaller buses and other high-occupancy vehicles (HOVs), including carpools and vanpools. Specially equipped HOVs would be able to make more efficient and safe use of their dedicated highway lanes, providing, for example, an opportunity for progressively staged deployment of vehicle-highway automation technology.

Associated with any Bus Rapid Transit concept regardless of its operational environment (exclusive right-of-way, mixed with other HOV traffic on an HOV facility, through traffic signal prioritization on arterials, or other applications), would be numerous technical and operational issues. From the experiences of the last ten years or so with research, development, testing, evaluation, and finally deployment of intelligent transportation systems, it is well known how critical a role the institutional elements play for a successful ITS implementation. In fact, these issues can pose the greatest challenges to successfully implementing and reaping the benefits of intelligent transportation systems. An examination of Bus Rapid Transit would, thus, not be complete, without a consideration of the institutional issues that may hinder the successful deployment of such systems.

A few of these issues include:

- Potential involvement of multiple governmental organizations and their inter-relationships
- Operations of a BRT route across jurisdictional boundaries

- Consideration of transit applications as alternatives for regional transportation investment and integrating them into the local and regional transportation and land use planning processes.
- Extent to which technological changes are embraced or resisted by the transit industry and specific transit properties.
- Changing role of the driver and impacts on driver training, salaries, work rules, insurance, liability, and management/labor relationships.

The identification and resolution of the institutional issues may play an important role in determining the success of Bus Rapid Transit projects and provide valuable input for future Bus Rapid Transit system deployments.

1.2 Objectives

The primary objectives of this project are to 1. identify and investigate the institutional aspects of Bus Rapid Transit operation including their relative level of importance, their likelihood of occurring, and ease of resolution and 2. recommend strategies for the resolution of these institutional issues. With a better understanding of the institutional aspects of Bus Rapid Transit, there would be a greater likelihood for a successful implementation of this high service and low-cost transit alternative.

2. METHODOLOGY

The macroscopic examination of Bus Rapid Transit institutional issues consisted of three phases. First, a general or high-level assessment of the relevant issues was ascertained through a broad literature review. Secondly, a series of internal project team meetings that served as brainstorming sessions were held to produce what ultimately became the team's master list of individual institutional issues. Thirdly, the issues' master list was submitted to the Federal Transit Administration (FTA) and other BRT experts for review and comment outside the project team followed by revisions by the project team.

2.1 Literature Review

A review of 53 information sources was performed including 44 documents and nine Web sites. The 53 selections from the reviewed literature were chosen on the basis of the requirement that as full a spectrum of institutional topics as possible be represented. To meet this requirement, the following key words and phrases were used to identify the appropriate literature: *bus rapid transit, busway, dual mode, automated bus, automated transit, institutional issues of transit.* A bibliographical template was developed and used to help the team pursue a systematic and consistent approach during the review process. The template may be found in Appendix A and was completed for the most relevant of the 53 information sources.

The template consists of three sections, each of which captures information about the relevance of the document or Web site to the Bus Rapid Transit field. These three sections are summarized as follows:

1. Areas
    - Intelligent Transportation Systems/Advanced Public Transportation Systems
    - Intelligent Vehicle Initiative—Transit
    - General Automated Highway Systems
    - Bus Rapid Transit
2. Sub areas
    - Institutional Topics
    - Technology
    - Operational Environment
    - Impact
3. Summary

2.2 Brainstorming Sessions

The project team held a set of brainstorming sessions to identify the institutional issues. Initially, as many issues as possible were listed without regard to repetition so as not to constrain the identification process. This first stage continued until the team felt it had exhausted all potential issues. In the next stage, the team clustered the issues into readily identifiable categories. Next, issues were consolidated to develop as irreducible a set of institutional issues as possible. The goal was to develop as exhaustive and mutually exclusive a list of issues as possible. The answer to whether the list is completely exhaustive will have to wait until the team receives input from BRT Consortium members in response to the project team's survey (See Sections 2.3 and 5.1). However, because of the nature of the issues, it was not possible to develop entirely mutually exclusive categories without sacrificing some obviously important issues. The team, therefore, erred on the side of inclusiveness and the reader will observe that some issues may appear somewhat redundant and fit into multiple categories.

The set of institutional issues were grouped into the following nine categories (See Section 4):

- Intergovernmental/inter-organizational
- Intra-agency
- Political
- Public Relations and Marketing
- Funding and Finance
- Labor
- Safety and Liability
- Planning and Land Use
- Physical Environment

2.3 Review Process and Revisions

Over the course of this phase of the project, the team established a working relationship with the Federal Transit Administration authorities in charge of the federal Bus Rapid Transit Demonstration Program. As part of this working relationship with the FTA, the team will solicit the insights and expertise of BRT Consortium members through a survey based on the institutional issues the project team has identified. In this way, the team will gain a better understanding of the experiences of the BRT Consortium. The FTA and several Consortium members reviewed the draft version of the issues list and their comments were incorporated, especially the inclusion of additional issues. Further details of this working relationship and the survey are described in Section 5 (Next Steps).

3. HISTORY OF BUS RAPID TRANSIT

3.1 The Bus Rapid Transit Concept

Though there has been a renewed interest in its use, Bus Rapid Transit is not a new concept. As early as the late 1950's transportation agencies were looking for ways to implement high-quality, low-cost transit service. For example, in the 1957 study, "Report on Bus Rapid Transit between Concord and Oakland-San Francisco", the California Public Utilities Commission investigated high-speed bus operations for commuter travel to Oakland and San Francisco from Concord, a San Francisco suburb. The proposal called for using the Route 24 freeway, which was under construction at the time, for high-speed bus service utilizing "modern" improvements such as park and ride lots, pedestrian friendly designs, improved amenities and other examples of high-quality transit service. The report acknowledged that BRT was the "most economic form of rapid transit that can be operated in this area under present conditions" (3).

In "The Rapid Transit Bus Concept", released in 1963, John Crain presented a BRT concept, calling for transportation planners to devise new transit services that replicate the high performance, door-to-door service offered by automobiles, while remaining within the economic reach of most cities. Such a system, Crain states, "combine(s) the best features of rail rapid transit and conventional bus operations by retaining the flexibility of one while obtaining some of the speed and capacity of the other" (4). Combining the flexible collection capabilities of the bus with the high-speed trunk line service of rail could produce a one-seat transit trip that could compete effectively with the automobile. He describes the use of exclusive lane use and preferential traffic controls for the rapid bus concept. He stresses the "people-throughput" capacity of such a service and notes this standard must be recognized if this concept is to be effectively sold to politicians and the public.

Crain promoted most of the features that are being incorporated into today's BRT systems including exclusive lanes, signal priority, rapid fare collection techniques, quick boarding and alighting, and enclosed pre-boarding payment stations. His preliminary cost estimates show BRT producing high capacity service (10,000-20,000 passengers per hour) at a fraction of the cost of

rail. His estimates show that BRT would cost only 2% of the cost of rail for at-grade BRT service and only 10% the cost of rail for an elevated BRT system (5). He also discusses the importance of providing up-to-the-minute schedule information to passengers (a precursor to automated vehicle location systems technology), the importance of overcoming the negative sentiments of transit (bolstering its image), and the need to properly sell the service (marketing). All of these concepts have been incorporated into what we today know as Bus Rapid Transit. Finally, he concludes his report by calling for creation of a demonstration project in a city with a population of approximately 750,000 people — one that is large enough to require higher service, but does not yet economically warrant a rail system.

3.2 Dual Mode Systems

Several additional reports from the 1960's outline many of the same goals and operational characteristics sought in today's BRT but envisioned an even more sophisticated system. Many of the BRT concepts that were being explored during the late 1960's and early 1970's focused on providing BRT with, at least, partial system automation. The most common concept involved the use of "dual-mode" buses that could operate under both manual and fully automated control. The idea was to combine the flexible collection and distribution capabilities of a bus system with the high line-haul performance of an exclusive right-of-way rail system, all with a single seat trip and utilizing automation. The most emphasized features of the systems during this period tended to be full bus automation (for a portion of the route) and exclusive right-of-way of the line-haul segment. The hope was that this automation component would permit a reduction in operating costs by eliminating the need for a driver for a portion of the trip, while providing greater line-haul capacity than could be achieved through manual driving alone. Meanwhile, exclusive right-of-way (busway or bus lane) would remove the vehicle from the most heavily congested portions of the trip (nearing the Central Business District (CBD)), and permit higher operating speeds, making the transit trip more attractive.

Three characteristics of this concept appeared to eventually lead to its decline. First, the technological capabilities for cost effective full automation for vehicles at the time did not materialize. Second, operational savings based on the assumption that the vehicle would be "driverless" for the line haul portion of the trip was questionable, at best. The labor time saved in removing drivers from a vehicle for the line haul portion, and having for them a vehicle immediately available to drive, would likely have created scheduling difficulties, thereby negating much, if not all, of the cost savings that automation was intended to provide. It was determined that the line haul portions would have to be a significant length (estimated to be 10-15 miles) to realize any labor productivity benefits out of such an operation, and very few regions warranted such an extensive system. Third, the costs of obtaining or constructing grade separations envisioned for high performance guided busways, greatly reduced the capital cost savings as compared to a rail system.

3.3 Early Busways

During the 1960's and early 1970's Bus Rapid Transit projects were inaugurated in several regions around the country, but appeared as a watered down version of Crain's original concept. Most bus services that were implemented utilized exclusive bus lanes on freeways, but none really utilized a mix of multiple strategies. These projects, therefore, functioned merely as express bus services, whose effectiveness depended primarily on congestion free bus lanes to provide most of the operational improvements. The most notable projects during this period were the Shirley Busway in Washington D.C., the El Monte Busway in Los Angeles, the Holland Tunnel bus lanes in New Jersey and New York, and bus lanes on various bridges in the San Francisco Bay area. Eventually all of these facilities, with the exception of I-495 in New Jersey, were converted into high occupancy vehicle (HOV) facilities to improve their utilization. Studies investigating the use of busways were also performed in cities such as Milwaukee and Atlanta, but these projects never materialized.

Factors that may have contributed to precisely why these systems did not utilize the entire BRT toolbox may have been that at the time these technologies were not sufficiently developed nor cost-effective, or perhaps there was a lack of political will to commit to their use. Domestically, during the following two decades BRT faded into the backdrop as the U.S. transit industry's preference for rail projects continued to make it the mode of choice for high traffic corridors.

3.4 International Experiences

Five thousand miles to the south of the United States, however, a rapidly growing city in Brazil was facing overwhelming transportation congestion. During the 1960's, Curitiba, Brazil experienced rapid growth (about 3% per year) due to large in-migration from the rural surroundings. A 1965 regional plan called for the establishment of a transportation plan with strong developmental policies. The goal was to encourage growth patterns that would be sustainable and support a strong public transit system. The plan called for a mono-centric city with four radial corridors that would bear most of the burden of growth and development in the region. Lacking adequate financial resources for a Metro system, an approach being taken by many of its larger neighboring Latin cities, Curitiba opted for a Bus Rapid Transit system. Whereas, an underground Metro was priced at approximately $60 million to $70 million dollars per kilometer ($97 million to $113 million dollars per mile) *(1965 $US)*, the express bus roadways were only $200,000 per kilometer ($323,000 per mile) (6).

The busway opened for service in 1972, and incorporated many, if not most, of the features outlined in Crain's paper. The system relied on features such as high platform boarding, pre-boarding fare collection, signal priority, and high frequency service to ensure high-quality Metro-like service. Over the last twenty-eight years, Curitiba has been able to incrementally expand and upgrade the system as finances permitted and demand warranted. Instituting strong land use controls, the government has also been able to effectively guide growth to encourage development patterns along structural axes that reinforce and encourage use of the bus system. This has kept Curitiba's central city both a vibrant and a pleasant urban environment.

With the success in Curitiba, several other developing Latin America cities such as Sao Paulo, Brazil, Porto Alegre, Brazil, and Quito, Ecuador have since implemented systems based on the Curitiba transit model.
Similarly, Ottawa, Canada also turned toward the Bus Rapid Transit concept when it decided to upgrade its transit system. Ottawa made the decision to use the bus as the backbone of the city's transit system, and started its "Transitway" in 1973 with approximately 6.8 miles of bus lanes. By 1983, the first of several busways were opened providing buses with exclusive, grade-separated right-of-way (7). Today, the system utilizes 16 miles of exclusive right-of-way, approximately 7.8 miles of priority lanes, and operates for 2 miles in mixed traffic. It has been extremely successful, making nearly 200,000 trips per day, and capable of carrying 10,000 riders per hour in each direction (8).

In many ways, the Transitway has conventional transit system attributes:

- Conventional bus length (standard and articulated)
- No low floors
- No wide doors
- Two right hand side doors and no left-hand side entry, i.e., no median entry
- No automatic stop: passengers must inform driver of their desire to stop and exit
- Entrance via front door depends on time-of-day and day-of-week, e.g. weekends
- On-vehicle fare collection (or show a paid-for-in-advance monthly fare card)
- Only static information is available: published schedules, other routes, and route connection information are posted at bus stops and stations, not on board the bus.
- Only on-board signage is sign indicating the next stop has been requested and "EXIT AT REAR" sign.
- Right-of-way allows mixing with non-bus vehicles in certain locations, e.g. in the Ottawa CBD.
- Ordinary bus stops/shelters exist along the route though are not indicated on the published Web site route map.

The Transitway, however, has features that make it special. In the outlying areas as it gets away from the more urbanized areas, the Transitway's right-of-way is an exclusive bus lane that is at- and above-grade depending on location usually with one lane per direction. At each station, the right-of-way expands to two lanes per direction. On the exclusive busway speed limits vary between approximately 35 and 50 miles per hour and within the station area, the speed limit is approximately 30 miles per hour, unless a stop is required for passenger drop-off or pickup. Moreover, at some locations, the exclusive right-of-way is directionally separated by barrier or a grassy median. In a few locations, the bus uses the freeway for short distances (1-2 miles) in an exclusive bus lane. This lane is the freeway's right-most lane that is an exit-only lane for use only by Transitway buses. It is separated by means of a virtual barrier with diamond symbols painted on the bus lane. Some of the Transitway's stations have similarities to rapid rail stations, not in the sense that they are underground (in fact, there is only one tunnel station on the Transitway's route), but that they are infrastructurally extensive. For example, some of these

stations are adjacent to commercial office development and are linked together via enclosed walkway bridges. At one location, the Transitway has a stop immediately outside a major department store that is part of a suburban mall. The extensively built stations are fully enclosed to accommodate Ottawa's winter weather with multiple stops for entry onto and exit from buses. Also, bus routes for lines other than for the two Transitway lines converge at several of the Transitway's stations. In addition to the Transitway connecting with Ottawa's International Airport, it also connects with train service (VIARAIL/RAIL CANADA) at Ottawa's train station with an enclosed walkway bridge linking the two stations.

There is, however, no advanced traveler information systems implemented on the Transitway, such as SmartCard technology, dynamic/real-time information on bus arrivals, or communication systems linking the bus driver with a central transit operations center.

Ottawa is typically heralded as another shining success story for BRT and several other Canadian cities have since embraced this concept. Though most do not use exclusive right-of-way, projects in cities such as Montreal, Quebec, and Vancouver have been turning toward technology, in lieu of exclusive facilities, to achieve higher bus performance.

3.5 The Return of Bus Rapid Transit to the U.S.

During the late 1970's, BRT made its way back into the United States. In 1977, the Port Authority Transit of Pittsburgh opened the first of three major segments of the Pittsburgh busway system. The 4.2-mile South busway was followed by the 6.8-mile East Busway, which opened in 1983. Combined, these two facilities serve nearly 120,000 daily riders. Pittsburgh is currently in the process of a 2.3-mile expansion to its East busway, and nearing completion of a 7.2-mile West busway, planned to eventually extend to the Pittsburgh International Airport (9). This busway system, combined with several new Light Rail Transit projects, has produced an integrated, multi-modal system for Allegheny County residents.

In the early 1980's in Seattle, dual-powered buses were specially designed to operate on highway HOV lanes, which connect to a 1.3-mile downtown "bus only" tunnel. The Metro Bus tunnel permits the buses to bypass congested downtown roadways, permitting quick circulation within the central business district. Nearly 40% of downtown bus trips use the tunnel (10).

In Houston, the Metropolitan Transit Authority of Harris County (Houston Metro) — the regional transit authority, operates 86.4 miles of freeway HOV lanes on six of the cities radial corridors. Metro buses share the HOV lanes with 2+ or 3+ automobiles depending on the time of day. The HOV lanes carry approximately 85,000 daily passengers, with the network planned to expand to over 120 miles by the end of 2000 (11).

Similarly in Dallas, Dallas Area Rapid Transit (DART) has initiated express bus service on freeway HOV lanes that it constructed, operates, and maintains. There are currently 18 miles of HOV lanes in operation, which DART buses share with high-occupancy vehicles. DART's HOV system is planned to expand into a 110-mile network (12).

In February 1997 the Miami-Dade Transit Agency inaugurated its first BRT route, with the 8.2-mile South Dade Busway. The Florida Department of Transportation built the exclusive busway for Metrobus. Both conventional, full-size buses and minibuses operate along the route, which connects the southern suburb of Cutler Ridge to the southern terminus of Metrorail, the city's heavy rail system (13).

3.6 U.S. BRT Consortium

Successes in cities such as Curitiba, Ottawa, and Pittsburgh, coupled with continuing congestion and air pollution in urban areas, and inaccurate cost and ridership projections that have troubled rail projects in other cities, have sparked a renewed interest in the Bus Rapid Transit concept. In 1998, the Federal Transit Administration released a Request For Proposal for BRT demonstration projects in the U.S., with the Bus Rapid Transit Demonstration Program planned to extend over the six-year life of the Transportation Equity Act of the 21st Century (TEA-21). Of the seventeen projects that submitted proposals, ten were selected as official Demonstration projects, while all seventeen were invited to participate in the Bus Rapid Transit Consortium. The goal of creating the Consortium, as described by FTA Administrator, Gordon Linton, is "to share successes, learn from each other, avoid replicating mistakes, and explore new technology as they make bus transportation more efficient, reliable and attractive as we move into the next century." (15).

Our exploration of this topic is intended to foster a dialogue on this topic to aid in further exploring the institutional challenges of BRT that transit agencies may face.

4. INSTITUTIONAL ISSUES OF BUS RAPID TRANSIT

The project team's brainstorming sessions resulted in a set of institutional issues that were clustered into categories for further analysis. The objective of this section is to provide from a general or macro-level perspective a discussion of these issues. Recommendations for the resolution of these issues will be provided in a subsequent report for this project. Clearly, Bus Rapid Transit projects will not necessarily experience all of these issues. However, the extent to which institutional issues are successfully resolved plays a vital role in helping to determine the degree of success for BRT deployment in terms of how transit operations and quality of service for passengers are enhanced.

An overriding theme running through all these issues that should be kept in mind is the notion of stakeholders, their agendas, and the relationships among them. The following subsections provide the primary groupings of the institutional issues that were identified.

4.1 Intergovernmental/inter-organizational

Many Bus Rapid Transit projects, like their transit agencies, operate across multiple jurisdictional boundaries involving numerous stakeholders. This multi-jurisdictional element often complicates the process of decision-making and implementation as each stakeholder usually brings its own philosophies, priorities, and agendas. Achieving agreement, among all affected stakeholders, whether political jurisdictions or other transportation organizations, often proves to be a difficult task. To have a system that works effectively requires the transit agency to achieve agreement with localities and other agencies on infrastructure, operations, and responsibilities.

This issue is further complicated by the fact that many BRT projects are planned to operate in mixed traffic on public roads. To achieve the operational benefits of BRT service, preferential treatment is often required. Here, the goals of transit agencies, to provide high-level, high-quality service for their customers, may conflict with the objectives of roadway agencies, whose performance is often judged on vehicle-moving, not people-moving, capacity. These often-competing objectives complicate the implementation of bus prioritization strategies, and may require significant coordination and cooperation if multiple roadway agencies are involved.

The selection and incorporation of new BRT infrastructure may also prove difficult. For many projects, transit agencies are "tenants" of streets or highway departments, often dependent on the cooperation of the roadway operator for the right to use their infrastructure such as the roadway, signal poles and boxes, etc. Many BRT strategies also utilize infrastructure, which not only needs to be incorporated into the existing roadway facilities, but also must be operated and maintained. With new infrastructure come additional financial responsibilities. Reaching agreement on acceptable designs, and operational and maintenance responsibilities would likely involve coordination among several agencies.

BRT operations will be effective only if laws and regulations regarding transit prioritization are adhered to and enforced. Effective enforcement carries with it financial responsibilities that may be thrust reluctantly upon local jurisdictions. Infrastructure and enforcement are two factors vital to the success of BRT, which often lie outside the control of the transit agency. Enlisting the support of the affected parties in these two areas may ultimately determine the success and effectiveness of the BRT system.

BRT prioritization may also occur at the expense of other roadway users. This issue will require discussion and agreement on where and how these preferences should be given, while considering its impact on existing roadway operations. Any impacts to existing services will require the consent and support of highway agencies or street departments, and local governments.

Finally, in attempting to make a seamless transit system, BRT services should be coordinated with neighboring transit agencies. This may require them to revise their operations and schedules to provide better feeder services for the BRT system.

The following list summarizes the intergovernmental/inter-organizational institutional issues:

- Integration of multiple priorities, objectives, and agendas
- Impacts of BRT on roadway operations
- Streets/highway departments "relinquishing" control of their infrastructure
- Agreement on performance measures
- Maintenance responsibilities for shared infrastructure and hardware/software
- Responsibility for enforcement on bus lanes/ busways
- Institutional fears of new technologies
- Coordination on selection and implementation of technologies
- Coordinating other transit agencies' services and BRT operations

4.2 Intra-agency

Institutional issues may arise not only among a transit agency, political jurisdictions and highway agencies, but also internally within an individual transit agency. Concerns over preferences in funding and scarce resources, the delegation of responsibilities, and increased responsibilities for staff may result in internal resistance and morale issues for a transit agency. Unless there are additional funding sources available, increased spending on one route will usually mean decreased funding on others.

Bus Rapid Transit systems may require additional resources to support the service offered. Additional operations, new technologies, new vehicles, and new infrastructure will require training and maintenance. Achieving agreement on roles and responsibilities may be difficult if employees are merely required to shoulder additional duties and responsibilities for BRT without additional compensation or support.

For many transit agencies most of the BRT strategies are foreign. Agencies may need time and resources to locate or develop both design and operational standards for many of these strategies. Initiating BRT service may also require additional work to reschedule existing services to support the BRT system. As many BRT systems will operate as trunk lines, feeder services will need to be coordinated to achieve the full benefit of the system.

Even gaining internal agreement on what strategies should be implemented, what fare structures should be used, and what technologies are appropriate will require time and resources. Many agencies will need additional time to identify and digest best industry practices for these issues. Even then, identifying and attempting to accommodate a transit agency's departments' needs may cause internal strife. As new strategies may affect the duties of department staff, it is vital that they are consulted and strategies are selected with their concerns in mind.

The following list summarizes the intra-agency institutional issues:

- Concerns (or perceptions) that BRT is given special preference over other transit services

- Defining and agreeing on new roles, responsibilities, and organizational structures to support BRT
- Creation of design and operational guidelines for BRT
- Determining an appropriate fare structure and medium
- Internal coordination on selection of technology
- Coordinating schedules of other transit routes with BRT operations
- Insufficient understanding of the "state of the art" of technologies and how they can be used in BRT operations

4.3 Political

The deployment of a Bus Rapid Transit system is one of many stages in the process of design, development, testing, evaluation, and finally deployment of a completed system. At each stage decision-making stakeholders are involved in a variety of ways that impact the specific deployment path a particular Bus Rapid Transit system will take. The decision-makers are by definition major players in the political arena that govern the local jurisdictions in which the Bus Rapid Transit system would operate. The commitment to Bus Rapid Transit by such major players is of crucial importance to the success of a Bus Rapid Transit system.

One concern in the political arena may be whether a proposed Bus Rapid Transit system is a solution in search of a problem, whether appropriate technologies are being used, and whether there is a market for these enhanced bus transit services. Does it result from a technological push or a market driven pull?

Bus Rapid Transit is typically one of several transportation alternatives that could be utilized. This may affect how BRT is viewed relative to other modal alternatives, in particular, rail. Actual or perceived competition with other modal alternatives could pose problems in terms of diluting interest in and support of Bus Rapid Transit.

Bus Rapid Transit success stories could be an effective tool to help generate interest in these systems. However, there is somewhat of a chicken-or-the-egg problem here. Until recently in the U.S., there have been very few examples of BRT and very little time to determine such systems' success. There are international success stories but some of those may not be applicable to the U.S. setting. Thus, the inability to produce documented domestic BRT success stories could hinder a transit property's ability to generate political support, yet it is precisely the political support that is needed to drive the process eventually leading to a successful BRT system.

To establish and sustain a high level of interest and commitment to BRT will likely require a political champion. Whether it is an individual or organizational entity, a political champion would aid in coalition building and sustaining interest in BRT when interest could wax and wane with the whims of the political process. The strength and capability of the political champion would help determine if the project could weather the political storms of opposition arising from various quarters, for example, the local business community or local residents. However, gaining such championing decision-makers often requires proof of the operational and quality-of-service

benefits of BRT, but political support is required to perform the testing that could result in the quantifiable benefits. Here again we encounter the chicken-or-the-egg dilemma.

There may also be issues regarding legislative restrictions on the procurement of new vehicles that could delay or slow deployment. Legal issues may also arise as a result of changes in service associated with BRT operation. For example, route changes, the elimination of stops, or lengthening the distance between consecutive stops could potentially present legal challenges.

The following list summarizes the politically related institutional issues:

- Concerns of BRT being a top down solution
- Perceived or actual competition of BRT with rail transit
- Lack of domestic BRT success stories
- Lack of empirical evidence of BRT's operational effectiveness
- Finding political champions to support BRT
- Concerns over long-term level of interest, potential for waning
- Local and business community opposition to the removal of, or restrictions on, parking spaces for BRT use
- Local and community opposition to BRT
- Concerns over the distribution of the costs and benefits of BRT
- Legal issues associated with service changes
- New vehicle procurement

4.4 Public Relations and Marketing

The ultimate success of any new product, no matter how good its potential may be, depends largely on how information about it is communicated.

To gain support for BRT, it needs to be properly "sold" to many stakeholders, including bus passengers, employees, general motorists, the general public, as well as decision-makers. However, selling BRT requires setting expectations. Setting high, yet realistic expectations, will be crucial for the long-term success of the system. Failure to produce what was proposed could lead to public disappointment and tarnish the sponsoring agency's name and reputation, resulting in BRT being "too hot to handle" for some period of time.

It would also be important to educate the public and passing motorists on new interactions they may have with specific elements of a Bus Rapid Transit system, such as bus lanes, signal priority systems, queue jump lanes, and others. If incorporated, changes in the fare structure would also require comprehension and acceptance on the part of the public. There are other concerns that need to be addressed through education such as the potential for motorist backlash over operational preferences given to Bus Rapid Transit. Moreover, the transit agency needs to take into account its current performance, both actual and perceived by the public. Before taking on the additional responsibilities of a Bus Rapid Transit system, an agency must ensure its current operations are performing satisfactorily. Otherwise, the agency may face political and public opposition if it is perceived the agency is overextending itself beyond its capabilities.

The following list summarizes the public relations and marketing institutional issues:

- Educating the public on BRT, and managing perceptions and expectations
- Concerns over transit agency's existing performance and reputation
- Concerns over effects of BRT on existing roadway operations
- Educating pedestrians and motorists on interacting with BRT
- Educating users on changes in and uses of multiple fare structures

4.5 Funding and Finance

Though financial and funding issues themselves are complicated enough to warrant their own investigation, we included them in our study because they may create institutional issues for BRT as well.

In the brief history of Bus Rapid Transit, we saw that interest in BRT has previously waxed and waned. Though there is a renewed interest, the fear of history repeating itself may cause concern among transit agencies that are considering BRT for their communities and lead to the following questions: Could BRT merely be another transit fad? Though the up-front capital costs for most BRT projects are relatively small compared to other capital-intensive modal alternatives, could transit agencies be responsible for higher operating and maintenance costs without the funding to support it? Though funding programs are being initiated to assist in the development of BRTs, could those funding options be withdrawn as quickly? What affects would that have on other transit operations? Would agencies have increased operations and maintenance costs without increases in revenue?

The federal government has recently broadened several of its funding programs to be more inclusive of BRT projects. Many transit agencies are currently lacking the understanding of funding programs available for BRT, and it may take some assistance to educate them on what funding is available.

Over the past several decades, many transit agencies have been struggling to remain fiscally solvent. Many may not feel capable of assuming new risk and responsibilities of a BRT system. Though it may appear that an agency should be able to have a Bus Rapid Transit system up and running in a matter of just months, there are many additional costs that are incurred by a transit agency to make a truly attractive and successful system. With much of the financial support coming from state and federal funds, whether or not agencies are able to obtain funds for specific costs related to BRT may affect how an agency proceeds.

The following list summarizes the funding and finance institutional issues:

- Concerns over long term funding commitments to BRT at the state and federal levels
- Concerns about BRT redirecting funds away from existing service or other routes
- Lack of understanding of funding mechanisms available for BRT

- Agency reluctance to expand services due to current fiscal constraints
- Ability to use existing buses or need for new fleet
- Capital costs of BRT
- Cost of operating and maintaining (O&M) new technologies and infrastructure
- Cost of additional staff and/or training to support BRT
- Cost of additional facilities to support BRT
- Cost of and responsibility for enforcement, e.g., proof of payment

4.6 Labor

Another important stakeholder group that must be considered for BRT is the transit agency staff, in particular, bus drivers. Important questions include: What will the impact of Bus Rapid Transit be on agency employees? What input or influence will agency employees have on the design, development, testing, and implementation of a particular Bus Rapid Transit system by their employer? With the deployment of a Bus Rapid Transit system, there could be concerns over additional work and responsibilities without assurances of additional staff, needed resources, and/or pay.

Bus drivers would have a direct and potentially the closest connection of all agency employees with any new technology implemented as part of a Bus Rapid Transit system. How would such employees embrace such new technology (ies)? Would it mean any change in the definition of their job? Could the implementation of a Bus Rapid Transit system mean that some bus drivers would lose their jobs or be replaced by individuals with more familiarity with and experience in advanced technology applications to transportation? Will there be assurances to retrain and re-educate bus drivers to use these new systems?

Another concern of bus drivers could be the use or perceived misuse of technology by agency management for driver performance monitoring. Drivers may fear their employers using "Big Brother" privacy-threatening tactics under the guise of improving transit operations and service.

Finally, drivers might need to switch back and forth between BRT and non-BRT routes over the course of relatively short time periods, possibly even the same day. Thus, training for new driving conditions and situations including new fare collection methods and the ability to smoothly switch between BRT and non-BRT routes could be of concern to drivers.

The following list summarizes the labor-related institutional issues:

- Lack of support from transit agency staff
- Changing role of drivers
- Use of Automated Vehicle Location (AVL) systems for monitoring schedule adherence
- Different responsibilities between BRT and non-BRT routes

4.7 Safety and Liability

With the implementation of a Bus Rapid Transit system, changes may occur involving new or different procedures for bus operations and the delivery of services, the use of new systems and/or technologies, and changes in personnel tasks and responsibilities. Associated with the use of any new system is the potential for a component or components not to function as anticipated which may result in unintended consequences. Questions that need to be considered include the following: Does the implementation of Bus Rapid Transit change the risk associated with and responsibility for bus transport? If so, does it increase or decrease this risk? If there were to be a system or system component malfunction or failure, who is liable for such malfunctions and to whom is the liability assigned? The issues of safety and liability could potentially affect not only those organizations immediately connected to the BRT system, i.e., the transit agency, but also individuals who come into contact with a BRT system, such as pedestrians and motorists. For example, pedestrians using high platforms or motorists interacting with particular BRT technologies such as signal priority, queue jump lanes, and others.

The following list summarizes the safety and liability-related institutional issues:

- Insurance industry-initiated changes in assignment of risk and responsibility for bus transport
- Potential changes in liability associated with technological and/or operational malfunctions of BRT systems
- Safety issues arising from changing interaction of pedestrians and motorists with new technologies and/or strategies
- Safety concerns of residents along BRT corridors

4.8 Planning and Land Use

Changes to a transportation system will impact over both the short- and long-term the overall transportation system and its surrounding land uses. Bus Rapid Transit would be no different, as high-level transit services, which BRT is attempting to replicate, have often significantly altered surrounding land uses. The decision to introduce a Bus Rapid Transit system in a particular setting involves the input from and influence of numerous stakeholders.

Concerns that may arise in this area include: Planning requirements such as transportation improvement programs could delay implementation of a Bus Rapid Transit system; the unknown impacts of a Bus Rapid Transit system on land uses; garnering community support for potentially high density, mixed-use development around Bus Rapid Transit stops and stations; and finally, the advantage of a Bus Rapid Transit system's inherent flexibility from its lack of permanent or fixed infrastructure could, in fact, be a disadvantage by leading to a reluctance on the part of developers to invest around potential BRT service corridors.

The following list summarizes the planning and land use-related institutional issues:

- Integrating BRT projects into the metropolitan planning process
- Lack of empirical evidence on the effects of BRT on land use
- Coordinating BRT project with local planning agencies' land use
- Gaining community support for transit oriented development
- Concerns of potential developers over BRT's lack of permanence as compared to rail

4.9 Physical Environment

The physical imposition of a BRT system may also raise political and institutional challenges. Many project areas, especially in older city centers, may simply lack the physical space to accommodate certain BRT strategies. In other areas, transit agencies may encounter opposition if BRT competes with, or at least is viewed as competing with, other interests for high value real estate. This may inflate costs or overly complicate operational requirements. Though eminent domain is an option, it usually is an undesirable, drawn-out process. Ensuring there is adequate and obtainable physical space could present problems for certain projects.

Secondly, image is a strong marketing tool for BRT. Many design guidelines suggest making the system unique and easily identifiable. Many projects are including as part of their systems station area improvements. However, these improvements are usually being inserted into existing urban design. Finding station area designs that promote a strong image, while being acceptable to local interests, may be a challenge.

The following list summarizes the physical environment institutional issues:

- Availability and acquisition of right-of-way or physical space
- Reaching agreement or consensus on bus stop/station area enhancements

5. NEXT STEPS

This section describes the activities for the remainder of the project.

5.1 Coordination of Research with Federal Bus Rapid Transit Program

With the formation of the BRT Consortium representing 17 different transit properties around the U.S., the project team saw an opportunity for a synergistic exchange with members of the Consortium. With the Consortium's formation of a BRT institutional issues committee, the team felt it would be mutually advantageous to solicit the insight and expertise of Consortium members through a survey of their opinions of and experiences with these institutional issues. The FTA has assisted the team in this effort and administering the survey is underway.

The Consortium, who has identified institutional issues as a potentially major concern, benefits from gaining insight into what issues have presented the greatest challenges thus far. Some of these issues may be encountered in the future as individual BRT projects progress through

different phases. The FTA benefits because it has access to the research results that will advance the state of knowledge in the study of institutional issues associated with BRT. This could also benefit future researchers examining issues associated with other advanced technologies applied to the field of transportation. The project team benefits because it would be able to obtain the insights and expertise from people around the U.S. who are actively working on real-world projects and who face such issues on a daily basis. This will permit the team to validate its hypotheses with the field experience of Consortium members.

After completed surveys have been returned, they will be analyzed. The findings will be documented as part of a subsequent report for this project.

5.2 Site-specific Case Studies

There are numerous corridors in urban areas of California that offer the opportunity for BRT application, in the context of either limited access facilities and/or signalized arterials. Their attractiveness for BRT application is the fact that many contribute to the long haul portion of commute trips in congested areas. Limited access facilities could include High Occupancy Vehicle lanes, bridges, toll ways, e.g., the El Monte Busway and the Harbor Transitway in Los Angeles, the HOV facility on I-15 in San Diego, the San Francisco Oakland Bay Bridge and the Golden Gate Bridge in the San Francisco Bay Area, and SR 91 and other toll facilities in Orange County. Signalized arterials include El Camino Real in Santa Clara County and Santa Monica Boulevard in Los Angeles County. Numerous other potential BRT corridors exist in the major urban areas of the State[1] where the focus of a portion of the project is being placed.

Specific sites will be selected for case study analyses of their institutional aspects. While there certainly will be institutional themes common across all urban areas of California there will likely also be regional variations that can hopefully be captured through the application of case studies. For example, the San Francisco Bay Area and metropolitan Los Angeles are significantly larger regions than San Diego and Sacramento. This fact could increase the likelihood of crossing multiple jurisdictional boundaries along a potential BRT corridor. Yet, there are differences between the Bay Area and the Los Angeles region that could contribute to institutional variations. Such differences include: the physical layout and configuration (natural boundaries and physical constraints on transportation corridors), the transportation network, political climate relative to organizational and inter-jurisdictional relationships, and the significance of (or the perception of the significance of) transit to overall regional mobility.

6. REFERENCES

1. Smith, H., *Improving Transit with Intelligent Transportation Systems*, Intelligent Transportation Society of America, Washington D.C., December 1998.

[1] San Diego, metropolitan Los Angeles, San Francisco Bay Area, and metropolitan Sacramento

2. Volpe National Transportation Systems Center, *Transit Intelligent Vehicle Initiative (IVI) Forum and Roundtable*, U.S. Department of Transportation-Federal Transit Administration-Office of Mobility Innovation, Washington D.C., February 1998.

3. California Public Utilities Commission, Transportation Division, Traffic Engineering Section. Report on Bus Rapid Transit between Concord and Oakland-San Francisco. San Francisco, CA: California Public Utilities Commission, 1957, p. 6.

4. Crain, John L. The Rapid Transit Bus Concept. Menlo Park, CA: Stanford Research Institute, November 1963, p.1.

5. Crain, John L. The Rapid Transit Bus Concept. Menlo Park, CA: Stanford Research Institute, November 1963, p.16.

6. Rabinovitch, Jonas and John Hoehn. "A Sustainable Urban Transportation System: The 'Surface Metro' in Curitiba, Brazil". Environmental and Natural Resources Policy and Training Project, working Paper No. 19, May 1995.

7. Web Site: http://www.octranspo.com/octranspo/administ/Administration/milestne.html, April, 25, 2000.

8. Web Site: http://www.octranspo.com/octranspo/administ/Administration/atrwy.html, April, 25, 2000.

9. Web Site: http://www.portauthority.org/grow/history.html, April, 25, 2000.

10. Web Site: http://transit.metrokc.gov/bus/tunnel.html, April, 25, 2000.

11. Web Site: http://www.ridemetro.org/hov.htm, April, 25, 2000.

12. Web Site: http://www.dart.org/home.htm, April, 25, 2000.

13. Web Site: http://www.metro-dade.com/mdta/busway.htm, April, 25, 2000.

14. Federal Transit Administration. Issues in Bus Rapid Transit. Washington, D.C.: United States Department of Transportation, January 1998.

15. Federal Transit Administration. Proceedings of the Bus Rapid Transit Demonstration Program. Washington, D.C.: United States Department of Transportation, August 1999.

7. APPENDICES

Appendix A: Literature Search Template

TITLE: _____
AUTHOR(S): _____
PUBLICATION/SOURCE: _____
PUBLICATION DATE: _____ DOCUMENT No.: XX
REVIEW DATE: XX/XX/99 KEY WORDS:

AREA:

☐ **ITS/APTS** ☐ **IVI-Transit** ☐ **General AHS** ☐ **BRT**

SUBAREAS:

	Institutional Topics		**Technology**		**Operational Environment**		**Impact**
☐	Multi-jurisdictional relationships	☐	Signal priority systems	☐	Implementation	☐	Safety
☐	Regional planning	☐	Queue jump lanes	☐	Corridor	☐	Operational efficiency and LOS
☐	Deployment process	☐	Advanced buses	☐	Regional		
☐	Land use planning	☐	Collision warning systems	☐	Limited access roadways		
☐	Industry embrace of technological changes	☐	Vehicle location systems	☐	HOV lanes		
☐	Changes to driver role	☐	Precision vehicle guidance systems (bus docking)	☐	Bridges		
☐	Driver training	☐	Advanced communication systems	☐	Toll ways		
☐	Work rules	☐	Other advanced bus technologies	☐	Transit ways		
☐	Salary changes	☐	Other bus changes	☐	Signalized arterial streets		
☐	Insurance	☐	Low floor	☐	Other		
☐	Liability	☐	Wide doors	☐			
☐	Management/labor relationships	☐	Bi-articulated buses				
☐	Other issues	☐	Advanced bus stops				
		☐	Pre-board fare collection				
		☐	Lighting				
		☐	Video surveillance				
		☐	Information display screens				
		☐	Electronic ticketing (Smart Card)				
		☐	Prepaid waiting and boarding areas				
		☐	Bus arrival information systems (communication with bus operations center)				
		☐	Other advanced bus stop technologies				

SUMMARY:

Appendix B: Bibliography

Alan M. Vorhees & Associates. Blue Streak Bus Rapid Transit Demonstration Project: Final Report. Seattle, WA: AMV, 1973.

Bailey, Diane and Randolph Hall. The Impact of Intelligent Transportation Systems on Bus Driver Effectiveness. California PATH Working Paper UCB-ITS-PWP-97-25, October 1997.

Bonsall, John A. Transitways: The Ottawa-Carleton Experience. Ottawa, Canada: Ottawa-Carleton Regional Transit Commission, June 1989.

California Public Utilities Commission, Transportation Division, Traffic Engineering Section. Report on Bus Rapid Transit between Concord and Oakland-San Francisco. San Francisco, CA: California Public Utilities Commission, 1957.

Chien, Steven I-J and Yuqing Ding. Application of Artificial Neural Networks in the Prediction of Transit Arrival Times. Washington, D.C.: ITS America 1998 Annual Meeting, January 1998.

Chira-Chavala, T., et al. Bus Operations in Santa Clara County, Potential Uses of AVL, and Framework for Evaluating Control Strategies. California PATH Research Report UCB-ITS-PRR-99-25. July 1999.

Crain, John L. The Rapid Transit Bus Concept. Menlo Park, CA: Stanford Research Institute, November 1963.

DeLeuw, Chadwick OhEocha. Bus Rapid Transit in Central Areas. Manchester, UK: DeLeuw, Chadwick OhEocha, July 1971.

Diaz, Roderick and Donald Schneck. An Overview of Bus Rapid Transit Technologies in the Americas. Booz-Allen & Hamilton Inc., January 2000.

Elias, Joseph. Precursor Systems Analyses of Automated Highway Systems - Commercial and Transit AHS Analyses - Task F. Washington, D.C.: United States Department of Transportation, October 1994.

Federal Transit Administration. Issues in Bus Rapid Transit. Washington, D.C.: United States Department of Transportation, Federal Transit Administration, 1998.

Federal Transit Administration. Bus Rapid Transit Demonstration Program. Washington, D.C.: United States Department of Transportation, Federal Transit Administration, 1998.

Federal Transit Administration. Proceedings of the Bus Rapid Transit Demonstration Program. Washington, D.C.: United States Department of Transportation, August 1999.

Federal Transit Administration. Bus Rapid Transit Demonstration Program Kick Off Workshop. Washington, D.C.: United States Department of Transportation, August 3-4, 1999.

Fisher, Ronald, Alan Lubliner, and Mark Miller. Automated Highway Systems (AHS) and Transit Operations. Orlando, Florida: Third Annual World Congress on Intelligent Transportation Systems, October 1996.

Glennon, John C. A System to Facilitate Bus Rapid Transit on Urban Freeways: The Technical Feasibility of Using Traffic Surveillance and Control Techniques. College Station, TX: Texas Transportation Institute, 1968.

Hall, Randolph. Orange County Transit Probe Evaluation: Phase I Institutional Findings. California PATH Working Paper UCB-ITS-PWP-97-12. March 1997.

Hall, Randolph and Mark Hickman. Orange County Transit/ Traffic Management Integration and Traveler Information Project: Evaluation Plan. California PATH Working Paper UCB-ITS-PWP-96-15. October 1996.

Hall, Randolph, et al. Evaluation of the OCTA Transit Probe System. PATH Draft Research Report. July 16, 1999.

Hall, Randolph, et al. Evaluation of ITS Technology for Bus Timed Transfers. California PATH Research Report UCB-ITS-PRR-97-37. October 1997.

Hall, Randolph, et al. Evaluation of ITS Technology for Bus Transit Systems. PATH Draft Research Report. July 16, 1999.

Hickman, Mark. Comparable Systems Analysis of San Francisco's BART: Lessons for Automated Highway Systems. PATH Working Paper UCB-ITS-PWP-94-17. December 1994.

Hickman, Mark and Theodore Day. An Informational and Institutional Inventory of California Transit Agencies. California PATH Research Report UCB-ITS-PRR-96-12. May 1996.

Hickman, Mark, et al. Precursor Systems Analyses of Automated Highway Systems - Comparable Systems Analysis - Task G. Washington, D.C.: United States Department of Transportation, November 1994.

Hickman, Mark, et al. Functional and Interface Requirements for Advanced Public Transportation Systems, Working Paper 1: Literature Review. California PATH Reports to Caltrans 97-C40. December 1997.

Howard, Needles, Tammen & Bergendoff. Guided Bus Rapid Transit: Proceedings, International Seminar, Adelaide 1988. SAGRIC International Pty, South Australian Department of Transport, 1989.

Lubliner, Alan. NAHSC Societal and Institutional Research: Lesson Learned for IVI - Presentation. April 27, 1998.

Marion, Michael and Matthew Coogan. Precursor Systems Analyses of Automated Highway Systems - Commercial and Transit Aspects - Task F. Washington, D.C.: United States Department of Transportation, November 1994.

McCormick Rankin International. Bus Rapid Transit For Charlotte: Issues and Opportunities: Executive Summary. Charlotte, NC: McCormick Rankin International, 1996.

McCormick Rankin International. Bus Rapid Transit For Charlotte: Southwest Charlotte Conceptual Plan and Busway Design Guidelines: Summary Report. Charlotte, NC: McCormick Rankin International, 1996a.

Metropolitan Washington Council of Governments. Feasibility Study for Bus Rapid Transit in the Shirley Highway Corridor. Washington, D.C.: Metropolitan Washington Council of Governments, l970.

National Automated Highway Systems Consortium, ITS America, and American Association of State Highway & Transportation Officials. Joint Workshop on Liability Issues in Advanced Vehicle Control and Automated Highway Systems (Workshop Report). Washington, D.C.: National Automated Highway Systems Consortium, ITS America, and American Association of State Highway & Transportation Officials, February 1997.

Nawrocki, Ronald and Barbara Zumwalt. Automated Guideway Transit Socio-Economic Research Program Findings, 1976-1979. Washington, D.C.: United States Department of Transportation, February 1980.

National Capital Transportation Agency. A Study of Bus Rapid Transit Operations of the National Capital Region. Washington, D.C.: National Capital Transportation Agency, 1963.

Organisation for Economic Co-operation and Development. Bus lanes and Busway systems: a Report. Paris: Organisation for Economic Co-operation and Development, December 1976.

Parsons Brinckerhoff. Review of Societal and Institutional Factors for the Intelligent Vehicle Initiative, Task A - Identify and Analyze Impacts of IVI Deployment, Draft Report. Washington, D.C.: United States Department of Transportation, August 1999.

Parsons, Brinckerhoff, Quade & Douglas. Guidelines for Determining Operating Costs on Bus and Rail Rapid Transit Systems. New York, NY: Parsons, Brinckerhoff, Quade & Douglas, 1970.

Rabinovitch, Jonas. "Innovative Land Use and Public Transportation Policy: The Case of Curitiba, Brazil." *Land Use Policy*, Vol. 13, No. 1, 1996: pp.51-67.

Rabinovitch, Jonas and John Hoehn. "A Sustainable Urban Transportation System: The "Surface Metro" in Curitiba, Brazil". Environmental and Natural Resources Policy and Training Project, working Paper No. 19, May 1995.

Rabinovitch, Jonas and Josef Leitman. "Urban Planning in Curitiba." *Scientific American*, March 1996: pp. 26-33.

Sephton, P. J. Putting the Bus Back on the Rails: The Guided Bus Route to Rapid Transit. Bury St. Edmunds: Mechanical Engineering Publications, 1992.

Smith, Harriet R. Improving Transit with Intelligent Transportation Systems. Washington, D.C.: Intelligent Transportation Systems Coordinator, December 1998.

Transit Cooperative Research Program. International Transit Studies Program: Report on 1996 Missions. Washington, D.C.: United States Department of Transportation, October 1997.

Volpe National Transportation Systems Center, *Transit Intelligent Vehicle Initiative (IVI) Forum and Roundtable*, U.S. Department of Transportation-Federal Transit Administration-Office of Mobility Innovation, Washington D.C., February 1998.

http://brt.volpe.dot.gov/

http://transit.metrokc.gov/

http://www.dart.org/home.htm

http://www.dot.gov/

http://www.fta.dot.gov/

http://www.metro-dade.com

http://www.octransit.org

http://www.portauthority.org/

http://www.ridemetro.org/central2.html