FROM BUS SHELTERS TO TRANSIT ORIENTED DEVELOPMENT

A Literature review of Bus Passenger Facility Planning, Siting, and Design

Florida Planning and Development Lab
Florida State University

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Transit-Oriented Development:
A Literature Review of Bus Passenger Facility Planning, Siting, and Design

Report Prepared for:

Florida Department of Transporation
Public Transit Office

By:

Florida Planning and Development Lab
Department of Urban and Regional Planning
Florida State University

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The Florida Department of Transportation (FDOT) has requested that Florida State University (FSU) provide small Florida transit agencies design guidelines for bus passenger transit facilities. Beyond identifying the minimum standards, the purpose of this study is to provide transportation agencies with feasible alternatives when developing bus passenger facilities that focus on the interaction of transit facilities with transit operations and the built environment.

The following FSU staff and students participated in conducting the research, analysis, design, and preparation of this report:

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Introduction

The recent California Supreme Court decision in *Bonanno v. Central Contra Costa Transit Authority,* 30 Cal. 4th 139 (2003) ruled in favor of a pedestrian who was tragically hit by a car while crossing a dangerous intersection to reach a bus stop. Although the $1.6 million verdict undoubtedly sent a chilling message to hundreds of public transit agencies that now they can be held liable for the location of their property, it reaffirms the importance of good planning, siting and design of bus passenger facilities—often a low level priority vis-à-vis other transit operation concerns. The judges' decision underscored the significance of effective interagency coordination in enhancing safe bus service provision. The car driver was sued and bore the bulk of total liability. However, the lack of coordination between the county owning the right of way along the busy street and the public transit agency which neglected to relocate its bus stop to a safer location was what ultimately resulted in avoidable physical trauma and injury to bus patrons.

This court case brings attention to the bus stop, an often overlooked, yet fundamental component of overall safe quality transit service which provides a viable alternative to the automobile. As the Bonanno case demonstrates, bus stops and other bus passenger facilities have been treated as residual elements in a transportation system biased toward rapid automobile flow and characterized by poor speed limit enforcement. Regarding safe pedestrian access to transit facilities, the transportation system's decision-making structure is typically balkanized among state departments, transit agencies, and local governments regarding the design, maintenance, and safety conditions of the right of way where bus stops must be located. Transit-oriented development and bus stops will remain marginal planning and urban design considerations as long as the focus remains set on rail and as long as local land-use planning and transit planning continue to be out of sync.

The current planning and design philosophy toward more livable, equitable and environmentally friendly cities expressed in several Smart Growth and New Urbanist manifestos is strongly reliant on practical transit mobility solutions. In some instances these solutions are offered as alternatives to the automobile, while in others they are complementary. Although Curitiba-inspired bus rapid transit (BRT) (Cervero 2003) is at the center of new regional design and mobility schemes like Peter Calthorpe's "urban network" (Calthorpe 2001) as well as a nationwide flurry of light-rail based transit-oriented development (TOD) initiatives (Cura 2003), we must not forget that these transit mobility schemes are dependent on subsidiary bus feeder and pedestrian mobility networks and as well as on the "buying-in" of a large number of transit agencies and county and city departments. As of late, some progressive transit agencies have assertively advocated for transit review in local site plans and development review processes, but this is more the exception than the rule; the vast majority of bus passenger facility design and siting decisions take place divorced from the development review process. Although a literature review may be no direct remedy to this problem, a comprehensive compilation of work regarding effective bus passenger facility

planning, siting, and design, that can help transit and transportation planners assess the state of the art in these rubrics is a step in this direction.

CONCEPTUALIZING BUS PASSENGER FACILITIES

Bus passenger facilities from the bus stop and shelter to the intermodal station are vital elements of multimodal environments that contribute to people's accessibility to places. The design and location of these facilities with respect to surrounding land uses and the modes of travel they interconnect (particularly for pedestrians and automobiles) are critical to enhancing people's overall accessibility to the bus network, people's transferability within the bus network and, ultimately, people's ability to reach their desired destination.

Although traditionally the bus stop is conceptualized as "an area where passengers wait for, board, alight, and transfer between transit units" (TCRP 1999, page 6-35), they are seldom thought of as key nodes connecting the bus service network to other mobility networks. For instance, a bus stop on a service arterial or street is a connecting node between the pedestrian network of sidewalks and the bus-service network. The bus patron must use the pedestrian network of sidewalks and paths before he or she can get to the bus stop to await bus service. Likewise, a park and ride bus transfer stop is a nodal facility connecting several mobility networks, connecting pedestrian networks (sidewalks and crossings), bicycle networks (lanes), automobile networks (roads), and the bus route network. One can think of bus stops at airports or train stations as more complex bus passenger facilities linking all of the previously mentioned networks to air and railroad mobility networks. The bus stop acting as the interface between the other mobility networks must be pedestrian accessible, ADA compliant, and must maximize the safety of riders transferring from one mode to another. As is well known and illustrated by the Bonanno case,[1] public pedestrian infrastructure, chiefly built by local governments, continues to be disregarded or relegated to a low priority even in metropolitan planning organization's (MPO) transportation enhancement programs in many American cities. At the same time, transit agencies are increasingly called to task over becoming more actively involved in the development review process and over strengthening interagency coordination to promote the provision of pedestrian, bicycle, and transit-friendly development.

ORGANIZATION OF THE LITERATURE

This annotated bibliography assembles a large body of literature related to the planning, design and siting of bus passenger facilities. Its organizing themes were conceptualized using brainstorming and nominal group techniques. The techniques were applied during an advisory group session held in Fall 2002. Session participants represented an array of specialties from the Florida Department of Transportation, such as pedestrian and bicycle transportation and livable communities planning, transit design and demand analysis, and roadway design. Other advisers in the session included the city's transit agency planner, transportation consultants and academics, and landscape architects. The aim of this compilation is to offer to planners and transit planners, and most particularly to those planning bus transit facilities, a variety of sources to the relevant literature concerning good bus passenger facility planning, siting and design. It is organized along the following themes.

I. Accessing BusTransit Facilities

1. ADA Americans with Disabilities Act (1990) and Manual on Uniform Traffic Control Devices (MUTCD)

Federally regulated design for:

(1) accessibility for people with disabilities and (2) traffic control devices on highways, streets, bike and pedestrian ways

2. Bicycle-oriented considerations

Integration of bicycles and transit

3. Pedestrian-oriented considerations

Guidelines and research for pedestrian-oriented design that is transit-supportive

4. Security and crime prevention

Crime prevention at bus stops through design and other strategies

II. Building Bus Transit Facilities

1. Transit facility design guidelines

Guidelines and standards for transit facilities design and planning

2. Intelligent transportation systems

Technological solutions that can increase the attractiveness and competitiveness of transit

3. Bus passenger facilities

Bus passenger facilities profiled in research or in the media

4. Green design considerations

Solar design and other green building techniques applicable to transit facilities.

III. TOD Transit-Oriented Development Siting and Land Use Issues

1. TOD planning and strategies

Planning and design guidelines for transit-oriented development (TOD) and research assessing TOD effectiveness

2. Parking and auto relationship to transit demand

Strategies for curbing automobile and parking demand that work with transit

IV. Funding and Marketing Transit

1. Funding

Strategies that transit agencies are pursuing to identify new sources of funding

2. Transit image marketing and community visibility

Transit image and ways to strengthen it

Each chapter presents an introduction to the annotated literature highlighting the most salient sources. In these introductions, reports which provide the most up-to-date research findings or that offer state-of-the-art reportage of current transit practice are weighted more heavily than academic articles devoted to transportation modeling techniques or still experimental approaches. A special effort was made to locate the internet address of each document and as of the date of this writing, more than fifty percent of the bibliographic entries have an accompanying active web link.

Chapter I looks at design concerns associated with non automobile access to bus passenger facilities. Chapter II focuses on transit facility guidelines breaking them down by whether they originate at the national level or at the regional or local transit agency level. It also compiles the most recent reports regarding transit agency adoption of intelligent transportation systems (ITS) and provides Internet links to website of large transfer and intermodal terminals that have been recently built or are in the process of being built. The last section in this chapter provides green design techniques that have been applied to passenger transit facilities. Chapter III

presents literature concerned with strategies for the realization of transit-oriented development (TOD) through the application of transit-joint development mechanisms (TJD). This section's annotated TOD studies and guidelines are grouped by type of author and scope into (1) national (e.g., TCRP reports), (2) state and regional (e.g., California Statewide TOD Study), (3) county, city or transit agency (e.g., San Diego's TOD design guidelines), and (4) academic and professional studies. The last section in this chapter looks at parking management measures that work with transit. Chapter IV looks at strategies for funding transit systems, with special attention payed to small and mid-size transit agencies. It then discusses how to increase community visability and visability relationship with funding.

LITERATURE SEARCH METHOD

A search was conducted in the Transportation Research Board's (TRB) thesaurus (TRT 2002) in order to select families of words related to bus transit facilities. Each of the family of words was scrutinized to distill only those words that relate to bus and bus transit facilities. This yielded a final list of bus-related TRB key words to which a few other key words were added. These key words[2] became the basis for searching the following sources and databases:

1. Transportation Research Board (TRB)
2. Transportation Cooperative Research Program (TCRP)
3. National Transportation Library (NTA)
   a. NTA & Federal Transit Administration (FTA)
   b. FTA National Transit Library
   c. Federal Transit Administration (FTA)
   d. NTA & Bureau of Transportation Statistics
4. USDOT Library On-Line: University Transportation Centers (UTC)
5. Council of University Transportation Centers
6. Northwestern Transportation Library
7. American Public Transportation Association: Bus Organizations
8. The Bus Stop: All About Buses
9. The Library of Congress
10. The FDOT Library
11. Geobase
12. First Search.

The literature on bus transit facilities culled from the above search was obtained from a variety of documents comprised of research projects, transit agency reports and guidelines, TRB and TCRP reports, funded research grant reports, books, electronic journals and published journals. In the latter category, fifty-four journals in planning, transportation, architecture, urban design and civil engineering were carefully examined for relevant literature.

References

Calthorpe, P. (2002). The urban network: A radical proposal. *Planning, 68* (4), 11-15.

Cervero, R. (2003). Green connectors: Off-shore examples. *Planning*, *69* (5), 25-29.

Cura, F. (2003). Transit agencies seeing increased interest in transit-oriented and joint development. *Passenger Transport*, *1*, 4-5.

TCRP Transit Cooperative Research Program (1999). *Part 6 Glossary in Transit Capacity and Quality of Service Manual.* (TCRP Web Document 6). Washington, DC: TCRP. Retrieved on Nov. 23, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_webdoc_6-a.pdf

TRT Transportation Research Thesaurus. (2002). Transportation Research Board, Transportation Research Information Services. Retrieved on Nov. 23, 2003, from http://www4.trb.org/trb/tris.nsf/web/trt

Notes

[1] National Public Radio's Richard Gonzalez reporting on the case states: "to the casual observer, there is nothing remarkable about the intersection of Pacheco Boulevard and Normandy Way. This intersection sits in an industrial section of ContraCosta County, about 25 miles east of San Francisco. There's a convenience store at the corner, a hardware store, and a tattoo shop nearby. But a pedestrian crossing to the north side of Pacheco Boulevard to catch a bus is clearly taking a risk. There are no traffic lights here, and of the approximately 20,000 cars that pass through here every day, many don't appear to pay much attention to the speed limit" (NPR, Morning Edition, April 24, 2003).

[2] See the glossary in Appendix A for list of key words.

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1: Accessing Bus Transit Facilities

Bus is the prevalent mode of transit mobility in urban America and with the exception of bus riders on wheelchairs or on bicycles, every bus trip begins and ends in a pedestrian trip including those made by park-&-ride patrons. Accessible bus networks must support pedestrian, bicycle, and disabled bus riders whose needs extend beyond the bus stop. For this reason wheelchair ramps, and bicycle racks are indispensable in making all bus facilities accessible to riders. Compliance with the 1990 Americans with Disabilities Act (ADA) and building complete sidewalk networks with safe and convenient crossings are crucial to bus accessibility. However, since the responsibility for building pedestrian and bicycle facilities often falls outside the purview of transit agencies, many bus stops are physically inaccessible (e.g., across from ditches or swales) or unsafely sited (e.g., across from dangerous and fast moving traffic or busy driveways or parking lots).

In addition to works referring to ADA standards and recommendations the literature in this section consists of pedestrian and bicycle facilities design manuals and handbooks commissioned by local, state and federal transportation departments. Transit agencies along with developers, residential communities, and local traffic engineers are part of their intended audiences. These publications exhort transit agencies to coordinate and cooperate with local traffic engineers to improve pedestrian access to transit facilities. Often this literature aims to provide agencies with jurisdiction over the public right-of-way with a common design vocabulary and a design philosophy emphasizing that the street rights-of-way must be shared among many users beyond car drivers. Balancing the needs of the pedestrian with bicyclists and motorized traffic is part of this philosophy.

A design vocabulary of the *pedestrian realm* identifies appropriate dimensions, amenities, and siting and design recommendations for buildings fronting the pedestrian path and strategies for safe street crossings. Likewise, a design language of the *bicycle realm* identifies appropriate dimensions for shared-use paths, bicycle lanes, bicycle parking, and bicycle and transit links that support the travel needs of bicyclists. These are ideas that transit agencies can adopt to guide the placing of bus stops and shelters. Moreover, these are ideas that transit agencies in cooperation with local planning departments could adapt and develop into local land development requirements for bus service provision.

This section starts with federal standards and recommendations regarding: (1) accessibility design for persons with disabilities under *ADA 1990*, and (2) the *Manual of Uniform Traffic Control Devices* (MUTCD) which regulates the design and location of all signage, signals, markings and other devises used to control traffic. It then presents pedestrian and bicycle-oriented design literature and ends with research and recommendations regarding security and crime prevention through design. Each one of these subsections presents a summary of the most salient points culled from the set of annotated entries.

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1.1: Americans with Disabilities Act (1990) and the Manual on Uniform Traffic Control Devices (MUTCD)

Handbooks on transit accessibility stress that the design of transit facilities needs to consider all possible disabled users, including: wheelchair-aided; cane-, crutch-, and walker-aided; and visually-, hearing-, and cognitively-impaired people. Accessible features in a facility must take into account the reach ranges of a person in a wheelchair, the sight and hearing abilities, and they should be easily operable. In addition, all signage, signals, markings or traffic control devices installed on, over, or adjacent to a street, highway, pedestrian facility, or bikeway by a public agency having jurisdiction, must comply with federal MUTCD regulations revised and adopted by every state. These two pieces of federal legislation must be observed at every step in the design of bus passenger facilities.

AMERICANS WITH DISABILITIES ACT (ADA)

Designing with ADA in mind means that all key internal areas of a bus stop and a transit station such as platform areas, ticketing areas, bathrooms, and commercial areas, as well as the pathways linking these areas need to be ADA accessible. Also key outdoor facility areas such as the approach to the transit facility from the street, parking areas, and other modes of transit must be accessible to patrons with disabilities.

The sources in this section including Balog et al. (1992) *Accessibility Handbook for Transit Facilities* and the Department of Justice's (1994) *ADA Standards for Accessible Design* provide specific ADA standards and guidelines derived directly from the *U.S. Code of Federal Regulations*, generally referred to as *American with Disabilities Act Accessibility Guidelines* (ADAAG). These guidelines offer detailed information to help transit managers and planners design, build and renovate transit facilities to be accessible to individuals with disabilities of all types. They offer technical specifications, definitions, graphic conventions and dimensional tolerances. The Transit Cooperative Research Program's *TCRP Report 12* by KRW Inc. (1996) specifically provides transit operators with guidelines for the design of appropriate signage that is friendly to new users, infrequent riders, and individuals with disabilities. Applying principles of way-finding design, the guidelines assist transit operators in the design, fabrication and placement of signs in transit facilities. Clear public address systems and simple, easy to comprehend symbols and signs, along with simple and consistent floor plans all make a transit facility more user-friendly for both the disabled transit rider and for the fully functional transit passenger.

Although much public accommodation for the disabled deals with physical impairment, little research and guidance exists for transit operators to accommodate sensory and cognitively impaired individuals. Sifferman and Koppa (1996) analyze barriers to

accommodation of the sensory impaired and provide recommendations for making facilities accessible to the hearing and visually impaired. Although these improvements may also assist the mentally impaired, a dearth of research in this area leads the authors to recommend that transit operators engage in employee training in how to interact and communicate effectively and appropriately with the cognitively impaired

American City and County. (1998). Signage helps make facility more user-friendly. *American City and County, 113* (13), 18-19. Retrieved Oct. 6, 2003, from http://www.americancityandcounty.com/ar/government_signage_helps_facility/.

The Lane County Transit District in Oregon has tried to make its transit stations attractive to disabled passengers. The new Lane Transit District Central Station continues this policy by using graphics to enhance communication and improve the facility's aesthetics. The new transit center also has an information board with route maps and a wheelchair-accessible telephone to enable passengers to call for information. Abstract by the author.

Figure 1 - Wheel chair inaccessabilitiy.
Image from: www.sacdot.com/services/ Handicap_Access.asp

Balog, J., Chia, D., Schwartz, A., & Gribbon, B. (1992). *Accessibility handbook for transit facilities*. Washington, D.C.: U.S. Department of Transportation. Retrieved Oct. 21, 2003, from http://transit-safety.volpe.dot.gov/Publications/accessability/AccessibilityHandbookJuly1992.pdf

The Americans with Disabilities Act of 1990 was designed to ensure the rights of individuals with disabilities. The U.S. Department of Transportation published regulations in September 1991 to establish specific requirements of the legislation regarding transit and paratransit services. This handbook provides expanded information about accessibility of facilities and the activities that transit systems will need to undertake in order for transit facilities to be accessible as defined in the law. The Handbook provides detailed information to help transit designers and planners to construct and renovate transit facilities so that they are accessible to individuals with disabilities of all types, including mobility impairments requiring the use of a wheelchair. The handbook includes all the accessibility requirements contained in the regulations, as well as additional information and suggestions. The handbook can be used during the planning process to ensure that any changes or construction will result in increased accessibility for the users of the transit facility. The use of the handbook in existing facilities will help planners identify how they can improve the accessibility of the facilities without renovation. Abstract by the authors.

KRW Inc. (1996). *Guidelines for transit facility signing and graphics* (TCRP Report 12). Washington, D.C.: Transportation Research Board. Retrieved Oct. 21, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_12-a.pdf

This report documents and presents the results of a research project to develop a graphics design manual describing the use of signs and symbols which

provide for the safe, secure, and efficient movement of passengers to and through transit facilities. Over the course of this 18-month project, existing signs and symbols are reviewed worldwide; compliance with ADAAG (Americans with Disabilities Act Accessibility Guidelines) is determined for existing signs; new signs and symbols were developed in five functional categories, namely Identification, Directional, Processing, Regulatory, and Warning; the key signs are tested by focus groups representing major types of disabilities as well as transit users and non-users; a standard design manual of signs and symbols is developed that could be used by transit agencies nationwide; and a plan is developed to achieve maximum dissemination of the guidelines nationwide to transit entities. The project is performed in two phases, with Phase I structured to review and document the state-of-the-practice of signage in the transit industry. More than thirty properties nationwide, representing a broad cross section of the industry are surveyed and their signage practices documented. Signage information from both international and domestic transit providers are reviewed, and the information needs of transit users that could be satisfied by signs and symbols are identified. Phase II efforts involved the design of candidate symbols and signs and their evaluation by a broad cross section of transit riders and non- riders, graphics designers, and transit personnel. The evaluation results are factored into the development of these graphics design guidelines incorporating the best of those signs, symbols and graphics design standards. Abstract by the author.

Sifferman, J. J., & Koppa, R. J. (1996). *Americans with Disabilities Act: Considerations for sensory and mentally impaired individuals in public accommodations*. College Station, TX: Texas A&M University.

In this aspect of the study, “Incorporation of ADA Requirements into Transit Guidance Information,” the more general question of access to information in public accommodations for those with sensory or mental disabilities has been addressed. Regulations under the Americans with Disabilities Act (ADA) of 1990, together with standards and design considerations are summarized in this report. Elimination of structural barriers to communications for hearing impaired persons includes modifications such as visual alarms and signals. Visual impairment accommodation includes eliminating physical hazards such as protruding objects and uneven walking surfaces. Braille, raised lettering, environmental audio cues and assisted listening devices can also be employed. There is little specific guidance for assisting information transfer for cognitively impaired individuals. Even with federal standards as a guide, choosing the proper methods and tools to insure satisfactory communication is a challenging task. Designing accessible facilities for the physically and mentally impaired has many benefits beyond that of merely adhering to federal guidelines, including ease-of-use and safety effectiveness of facilities for the general public. Abstract by the authors.

Figure 2 - Wheelchair ramp access to the bus.
Image from: http://www.ican.com/news/fullpage.cfm/articleid/31AB30A2-2605-430F-91F1A248642137AD/cx/self_discovery.role_models/

U.S. Department of Justice. (1994). *ADA standards for accessible design* (28 CFR Part 36). Washington, D.C.: Department of Justice. Retrieved Oct. 21, 2003, from http://www.usdoj.gov/crt/ada/stdspdf.htm

As published in the Title III of the Code of Federal Regulations (CFR) issued by the Department of Justice, these standards are contained in Appendix A. The document sets guidelines for complying with the Americans with Disabilities Act of 1990 regarding accessibility to public and commercial facilities. These standards are to be applied to the design, construction, and modification of such facilities. It offers technical specifications, definitions, graphic conventions and dimensional tolerances. It also provides the scope and technical requirements for a variety of facilities in new construction, additions, alterations and historic preservation. Chapter 10 deals specifically with transportation facilities with the following sections focusing on bus facilities: 10.2 Bus Stops and Terminals, 10.2.2 Bus Stop Siting and Alterations, and 10.3 Fixed Facilities and Stations.

Figure 3 - A wheelchair secured by provided straps.
Image from: www.mobil-handicap-tours.de

MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD) 2000

The Manual on Uniform Traffic Control Devices (MUTCD) is approved by the Federal Highway Administrator as the National Standard in accordance with Title 23 U.S. Code, Sections 109(d), 114(a), 217, 315, and 402(a), 23 CFR 655, and 49 CFR 1.48(b)(8), 1.48(b)(33), and 1.48(c)(2). In the Millennium Edition (2000) the manual offers standards, guidance, optional and support material concerning all signage, markings and traffic control devices. For instance, section 2C.37 adds a new design and application for advance crossing and crossing signs. Because people rarely noticed the difference between a crossing sign (with crosswalk lines on the sign) and an advance crossing sign, the FHWA now mandates that these devices be redesigned. The crosswalk lines in the sign should be deleted and one sign should be used for both the advance and the crossing location. "The crossing sign when used to provide advance notice to road users is supplemented with the legend ``AHEAD'' or with an appropriate distance plaque. The crossing sign is used adjacent to crossings and must be supplemented with a diagonal downward pointing arrow when the crossing does not have pavement markings. If pavement markings are used to mark the crosswalk, then only the crossing sign is needed and the diagonal downward pointing arrow is optional" (see Internet link to FDOT's MUTCD webpage included in the corresponding annotation).

Already a new MUTCD 2003 edition has been published and the Florida Department of Transportation's (FDOT) Traffic Operations Office will update its *Traffic Engineering Manual* to reflect the new changes. However these will not take effect in Florida until the state adopts the new mandated changes some time in 2005.

Federal Highway Administration (FHWA). (2000). *Manual of uniform traffic control devices (MUTCD): Millennium edition*. Washington DC: U.S. Department of Transportation. Retrieved Nov. 30, 2003, from http://mutcd.fhwa.dot.gov/kno-millennium_12.28.01.htm.

This Manual, which was first published in 1935 and since then undergone 21 revisions, sets a hierarchy of compliance regarding the use of traffic controls devices on streets and highways. This hierarchy consists of: standards (that must be satisfied), guidance (that should be followed), options (that may be applicable) and support. Traffic control devices are defined in the manual as "all signs, signals, markings, and other devices used to regulate, warn, or guide traffic, placed on, over, or adjacent to a street, highway, pedestrian facility, or bikeway by authority of a public agency having jurisdiction." The adopted MUTDC 2000 changes adopted by the Florida Department of Transportation can be electronically obtained from: http://www11.myflorida.com/trafficoperations/mutcd.htm.

Federal Highway Administration (FHWA). (2003). *Manual of uniform traffic control devices (MUTCD): 2003 edition*. Washington, DC: U.S. Department of Transportation. Retrieved Nov. 30, 2003, from http://mutcd.fhwa.dot.gov/kno-2003.htm.

MUTCD's 2003 Edition was published in November 2003 and becomes effective on December 22, 2003. However, states like Florida have until 2005 as a grace period for establishing compliance. A list of changes between the *2000* and *2003 MUTCD* editions is provided by FHWA at: http://mutcd.fhwa.dot.gov/HTM/2003/mutcd2003cl.htm.

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1.2: Bicycle-Oriented Considerations

This section presents a variety of sources associated with bicycle accommodation on transit and in multimodal environments. They range from a policy statement by the United States Department of Transportation recommending the integration of bicycling and walking into all mobility programs, to *TCRP Synthesis 4* by Doolittle (1994) reporting on best practices among transit agencies that successfully integrate bicycles to their operations. This section also includes research articles discussing the lessons—applicable to the U.S.—drawn from foreign experience with transit serving the bicycling community and often-cited bicycle design manuals issued by state transportation departments.

Overall the information in this section should be of interest to both transit agencies and bicyclists and should be useful to a diverse planning staff seeking to integrate bicycles and transit regarding: (1) bicycles on bus and/or rail, (2) bicycle parking, and (3) bicycle access design. The latter of the three includes such things as bicycle lanes on station and access roads, bicycle paths through park-and-ride lots, and bicycle-supportive station design and siting. Since many of these bicycle access design considerations occur on property not belonging to the transit agency and are generally part of larger bicycle programs, they are often based on administrative arrangements requiring interagency cooperation and development agreements. One such initiative (referenced in this section) is illustrated by the Regional Bikestations Project spearheaded by the Puget Sound Regional Council (2003) in collaboration with the local transit agencies and area jurisdictions.

City of Portland. (n.d.). *Portland bicycle design and engineering guidelines*. Retrieved Oct. 22, 2003, from http://www.trans.ci.portland.or.us/designreferences/bicycle/appenda.htm.

The design practices and standards outlined in this manual are based on the American Association of State and Highway Transportation Officials (AASHTO) manual "Guide for the Development of Bicycle Facilities 1991," with supplementary material from the 1996 Oregon Department of Transportation (ODOT) "Oregon Bicycle and Pedestrian Plan." Guidelines related to Portland's specific practices have been written by staff from the Portland Office of Transportation (PDOT). Abstract by the author.

Doolittle, J. (1994). *Integration of bicycles and transit* (TCRP Synthesis 4). Washington, D.C.: Transportation Research Board. Retrieved Oct. 25, 2003, from http://gulliver.trb.org/publications/tcrp/tsyn04.pdf

This report addresses the wide range of policy and operational decisions needed in order to provide bicycle-transit services. (Chapter 3 specifically deals with bikes on buses.) It identifies those program characteristics which are least disruptive to normal transit operations while extending transit services to bicyclists who are also transit riders. Design considerations focus on four performance characteristics: safety for the bicycle-transit rider, fellow passengers, bicycles, and buses; ease of use to encourage travel and allow for schedule adherence; capacity of the rack; and compatibility with existing equipment and servicing procedures. Operating procedures include issues such as fees and permitting, hours of permitted use, bicycle size and condition, loading and unloading procedures, storage instructions, and safety precautions. Abstract by the author.

Figure 4 - Bicycle rack.
Image from: Authors.

FDOT. (1999). *Florida bicycle facilities planning and design handbook*. Retrieved Oct. 18, 2003, from http://www.dot.state.fl.us/safetyped_bike/handbooks_and_research/bhtoc.pdf http://www.dot.state.fl.us/safety/ped_bike/handbooks_and_research/bhchpt1.pdf http://www.dot.state.fl.us/safety/ped_bike/handbooks_and_research/bhchpt2.pdf http://www.dot.state.fl.us/safety/ped_bike/handbooks_and_research/bhchpt3.pdf http://www.dot.state.fl.us/safety/ped_bike/handbooks_and_research/bhchpt4.pdf http://www.dot.state.fl.us/safety/ped_bike/handbooks_and_research/bhchpt5.pdf http://www.dot.state.fl.us/safety/ped_bike/handbooks_and_research/bhchpt6.pdf.

The purpose of this handbook is to provide guidelines and criteria for planning, design, construction, operation and maintenance of safe on-road bicycle facilities and shared use paths. This handbook is intended to serve as an aid to engineers, designers, planners, architects, landscape architects, citizens and others interested in improving Florida's bicycling environment. Information found in this handbook can be useful for private, local, state or federal projects.

Section 2 focuses on planning and "provides an

overview of planning considerations for bicycles, a discussion of the types of facility improvements, performance measures to the year 2005, and a description of factors to consider when locating a facility. Section 3, on safety, describes the customer's needs, behavior and problems. It provides background on crash causation, human performance, the design bicyclist and the design bicycle. Section 4 [looks] at on-road design and provides guidelines to follow when constructing or improving highways and streets. Section 5, on shared use paths, incorporates the needs of bicyclists to the maximum extent practicable. Section 6 on supplemental topics "provides information on parking, transit links, maintenance, traffic operations, and law." Abstract taken from author's introduction (p. 1-1 - 1-6).

Federal Highway Administration. ***(2003). Design guidance accommodating bicycle and pedestrian travel: A recommended approach*****. Retrieved Oct. 21, 2003, from http://www.fhwa.dot.gov/environment/bikeped/design.htm.**

This guide contains a policy statement adopted by the United States Department of Transportation. USDOT hopes that public agencies, professional associations, advocacy groups, and others adopt this approach as a way of committing themselves to integrating bicycling and walking into the transportation mainstream.

The Design Guidance incorporates three key principles: (1) a policy statement that bicycling and walking facilities will be incorporated into all transportation projects unless exceptional circumstances exist; (2) an approach to achieving this policy that has already worked in State and local agencies; and (3) a series of action items that a public agency, professional association, or advocacy group can take to achieve the overriding goal of improving conditions for bicycling and walking.

The Policy Statement was drafted by the U.S. Department of Transportation in response to Section 1202 (b) of the Transportation Equity Act for the 21st Century (TEA-21) with the input and assistance of public agencies, professional associations and advocacy groups. Abstract by the author

Figure 5 - Front bicycle carrier.
Image from: http://www.bikestation.org/seattle/location.asp

Puget Sound Regional Council. (2003). ***Regional bikestations project*****. Retrieved Oct. 11, 2003, from http://www.psrc.org/projects/nonmotorized/stationsproject.htm**

A bikestation is a facility designed to promote bicycle/transit commuting to work, as well as to encourage biking as a form of local mobility. Inspired by bikestations in Western Europe and California, the Puget Sound Regional Council, local transit agencies and jurisdictions in the region developed the Regional Bikestations Project. This project

offers “local transit agencies the tools they need to better accommodate bicycles at their bus and rail stations, ferry terminals and park-and-ride lots. Its findings will help them plan, design and build regionally coordinated bike-parking facilities, appropriately scaled for potential levels of use. The project also examines the feasibility of constructing commuter Bikestations, similar to those in California, at key transit stations in King, Pierce and Snohomish counties. Abstract taken from author’s introduction (p. 1).

Replogle, M. (1981). Role of bicycles in public transportation access. *Transportation Research Record, 959*, 55-61.

Bicycles play a vital role in access to rail and express bus services in Japan and northwestern Europe as well as in a growing number of communities in the United States. Suburbanization has been a driving force for the growth of bicycle -transit linkage. In many suburban towns in Japan, West Germany, Denmark, and the Netherlands, 25 to 50 percent of rail station access trips and up to 20 percent of egress trips are made by bicycle. The number of trips involving a combination of bicycles and public transportation has quadrupled since the early 1970’s. In the United States, high bicycle theft rates have restrained similar growth except for transit systems that have made special provisions for bicycle access. Significant use of bicycles for transit access is found only where bicycle theft rates are relatively low or where secure bicycle parking has been provided at transit stops. The evolution of transit access systems is discussed and park and ride versus bike and ride transit access re-compared with regard to capital and operating costs, air pollution, and energy use, impacts on transit ridership, implications for transit stop siting, and other factors. The article concludes that American transit agencies should substantially increase suburban transit use without increased operating costs by improving bicycle-transit integration. Bike and ride development is far more cost effective than park and ride development. Abstract by the author.

Replogle, M. (1993). Bicycle access to public transportation: Learning from abroad. *Transportation Research Record, 1396*, 75-80. Retrieved Nov. 11, 2003, from http://www.environmentaldefense.org/documents/2294_BikesJournal.pdf

In the face of traffic congestion, air pollution, and inadequate fiscal resources, American communities need to consider new, more cost-effective strategies to expand transit use and reduce automobile dependence. Worldwide experience suggests that improving bicycle access to transit in the United States may be the most promising but neglected low-cost strategy to enhance air quality while increasing the freedom of travelers to alternatives to the automobile. Bicycles are the fastest-growing and predominant mode of access to public transportation services in many European communities and Japan. Provision of secure bicycle storage at rail stations, development of bicycle friendly street networks, and the creation of a climate of community opinion supportive of bicycling are all important factors behind the success of bike and ride systems in these countries. U.S. transit access systems have increasingly relied on the automobile. However, park and ride systems have served only suburb to central city travel markets, which are of declining importance, while weakening transit system competitiveness in the growing suburb to suburb travel market. U.S. communities can learn valuable lessons from the foreign experience in creating balanced multimodal transit access systems that include the bicycle. Abstract by the author.

1.3: Pedestrian-Oriented Considerations

This compilation of sources encompasses pedestrian-oriented design principles, design guidelines, standards and recommendations. They focus on designing for transit accessibility to and from the *pedestrian realm*—the indispensable foundation of transit-friendly community planning and design. As Ewing (1999) remarks:

> Pedestrian-friendly features are also inherently transit-friendly. They set the context in which transit operates and, as transit operators are discovering, have as much to do with ridership as do service headways, fare levels, and other transit operating characteristics. (p. 2)

Three types of works are offered in this section: 1) model pedestrian guidelines from regional agencies (e.g., San Diego Association of Governments), state transportation agencies (e.g., Florida Department of Transportation), and city agencies (e.g., City of Portland, OR); 2) walkable environments and transit research-based recommendations; and 3) transit-supportive pedestrian retrofitting approaches for suburbs and central cities. Pedestrian design guidelines offer "best practice" strategies for integrating transit to the *pedestrian realm* and other off-street mobility networks. They identify key land-use pedestrian accessibility issues, differentiate between new development and infill or retrofit development, are responsive to the needs of riders of various disabilities and ages, and promote safe street crossing. As with planning and designing the *bicycle realm*, jurisdiction over the *pedestrian realm* often falls outside the transit agency's scope of responsibilities. Thus, successfully integrating transit with adequate pedestrian facilities and pedestrian mobility networks is not a simple task. It is a coordination-intensive activity requiring strong levels of both intra- and inter-agency cooperation.

Cervero, R. (2001). Walk-and-ride: Factors influencing pedestrian access to transit. *Journal of Public Transportation, 3* (4), 1-21.

The predominant means of reaching suburban rail stations in the United States is by private car. Transit villages strive, among other things, to convert larger shares of rail access trips to walk-and-ride, bike-and-ride, and bus-and-ride. Empirical evidence on how built environments influence walk-access to rail transit remains sketchy. In this article, analyses are carried out at two resolutions to address this question. Aggregate data from the San Francisco Bay Area reveal compact, mixed-use settings with minimal obstructions are conducive to walk-and-ride rail patronage. A disaggregate-level analysis of access trips to Washington Metrorail services by residents of Montgomery County, Maryland, shows that urban design, and particularly sidewalk provisions and street dimensions, significantly influence whether someone reaches a rail stop by foot or not. Elasticities are presented that summarize findings. The article concludes that conversion of park-and-ride lots to transit-oriented developments holds considerable promise for promoting walk-and-ride transit usage in years to come. Abstract by the author.

Chu, X., & Baltes, M. R. (2001). *Pedestrian mid-block crossing difficulty* (NCTR-392-09). Tampa, FL: National Center for Transit Research (NCTR). Retrieved Sept. 14, 2003, from http://www11.myflorida.com/planning/systems/sm/los/pdfs/Pedestrian.pdf

This report documents a research project that developed a model of mid-block crossing difficulty as perceived by pedestrians. Four aspects of the research are reported: research design issues, selection of potential determinants, data collection, and statistical analysis. This model was done through a statistical calibration and validation process involving collecting actual site characteristics and

Figure 6 - Easy pedestrian access to a bus shelter.
Image from: Authors.

stated level of crossing difficulty by a sample of persons at a sample of sites from Hillsborough and Pinellas Counties in Florida.

For traffic operations applications, this model may be used as a screening tool to determine whether pedestrian mid-block crossing difficulties, such as crosswalks or pedestrian signals, may be needed at particular locations. For planning purposes, this model has a number of applications: 1) It can be used as a measure of effectiveness for determining pedestrian level of service for mid-block crossing; 2) It could potentially be combined with those for pedestrian level of service for walking along a roadway segment and for crossing at intersections to determine the overall pedestrian level of service for an entire roadway segment; and 3) This overall level

of service at the segment-level could then be used as a direct input into transit level of service methodologies that take into account pedestrian street-crossing difficulty. Abstract by the authors.

City of Portland. (1998). *Portland pedestrian design guidelines*. Retrieved Oct. 30, 2003, from http://www.trans.ci.portland.or.us/DesignReferences/Pedestrian/.

The public right-of-way houses many transportation activities, including walking, bicycling, transit, freight movement, and automobile travel. It harbors the hardware, such as traffic signals and street lights, that supports those activities. In many cases the right-of-way also contains public utilities. Each of these functions has specific design needs and constraints. . . The purpose of Portland's Pedestrian Design Guide is to integrate the wide range of design criteria and practices into a coherent set of new standards and guidelines that, over time, will promote an environment conducive to walking. Abstract taken from author's introduction (p.1).

Ewing, R. (1999). *Pedestrian and transit friendly design: A primer for smart growth*. Washington, D.C.: Smart Growth Network. Retrieved Oct. 30, 2003, from http://www.epa.gov/smartgrowth/pdf/ptfd_primer.pdf

This primer is based on Pedestrian and Transit friendly Design, a manual prepared for the Florida Department of transportation and the American Planning Association. From the longer list of the 23 pedestrian and transit friendly features in the FDOT/APA manual, this primer highlights 12. [Of these the top ten are the following essential features: 1) medium to high densities, 2) mix of land uses, 3) short to medium length blocks, 4) transit routes every half-mile, 5) two- or four-land streets, 6) continuous sidewalks, 7) safe crossing, 8) appropriate buffering from traffic, 9) street-oriented buildings, 10) comfortable and safe places to wait wide enough for couples]. They are described in detail, and illustrated with photos from walkable places and with graphics reproduced from award-winning design manuals. The other 11 features are simply acknowledged by name. The 12 highlighted features seem to relate more to pedestrians than transit users. But since virtually all transit users are pedestrians at one or both ends of their trips, the distinction is illusory. Pedestrian-friendly features are also inherently transit-friendly. They set the context in which transit operates and, as transit operators are discovering, have as much to do with ridership as do service headways, fare levels, and other transit operating characteristics. Abstract taken from author's introduction (p.2).

FDOT. (1999). *Florida pedestrian planning and design handbook*. Retrieved Oct. 18, 2003, from http://www.dot.state.fl.us/safety/ped_bike/ped_bike_standards.htm#Florida%20Ped%20Handbook.

This manual provides guidelines, standards, and criteria for the planning, design, construction, operation, and maintenance of pedestrian facilities. It is a reference publication intended for engineers, transit planners, landscape architects, business leaders, politicians, citizens, and others interested in improving Florida's walking environment. It supplements the 1988 version of the Florida Manual of Uniform Minimum Standards for Design, Construction, and Maintenance for Streets and Highways with which design of projects for the Florida State Highway System must comply. This pedestrian planning and design manual contains 20 chapters that deal with principles and guidelines for planning and designing for: (1) pedestrian safety by taking into consideration pedestrian and motorist behavior and characteristics of pedestrian-motor vehicle crashes; (2) accommodating pedestrians with disabilities; (3) installing

sidewalks (i.e., width, setback distance, grades, and pavement surfaces); (4) regulatory signs, warning signs, and pavement markings; (5) pedestrian signalization (e.g., signal timing and phasing, push-button signals, and audible signals); (6) street crossing facilities (e.g., crosswalks, stop lines, curb ramps, and refuge islands); (7) one-way streets, intersections and mid-block crossings; (8) parking and safe access to buildings and schools; (9) traffic calming; (10) work-zone pedestrian safety and on street parking and a variety of other topics such as street lighting, grade-separated crossings, and boulevards.

Fruin, J. (1987). *Pedestrian planning and design*. Mobile, AL: Elevator World.

The intent of this book is to help fill the broad gap that exists in the planning and design of building and street spaces for comfortable and convenient human use. The beginning of the book establishes the importance of walking in urban design, and the problems of pedestrians in today's cities. There is a brief insight into some of the human physiological and psychological factors that affect the planning and design of pedestrian spaces. The traffic and space characteristics of pedestrians are developed in sufficient detail for an understanding of pedestrian traffic relationships. Supplementary written and pictorial descriptions of pedestrian traffic interactions at various human space occupancies provide a useful supplement for evaluating the environmental design quality of pedestrian building and street spaces. The book closes with a short review of some of the programs that are in progress for the improvement of the pedestrian environment. Abstract by the author.

Hodgson, G. D., Hunter-Zaworski, K., & Layton, R. D. (1999). *A preliminary assessment of the effects of access management on pedestrian, bicycles and transit* (No. WA-RD_._TNW 99-03). Seattle, WA: University Transportation Center (UTC), University of Washington. Retrieved Oct. 18, 2003, from http://www.wsdot.wa.gov/ppsc/research/CompleteReports/TNW99-03AccessMgtImpact.pdf

The project investigates the impacts of access management treatments on pedestrians and bicyclists, primarily on arterial streets, and identifies conflicts, accident and safety issues involving pedestrians and bicycles, associated with access management treatments, impacted groups of pedestrians and bicyclists. The project is an extension of a major access management project that is currently being conducted by Oregon Department of Transportation and the Transportation Research Institute at Oregon State University. The ODOT project is developing statues, policies and guidelines for Access Management for the state of Oregon, and suggests recommendations for solution strategies to resolve or mitigate for these conflicts.

Randall, T., & Baetz, B. (2001). Evaluating pedestrian connectivity for suburban sustainability. *Journal of Planning and Development. 127* (1), 1-15.

A crucial ingredient for achieving urban sustainability is reducing society's dependence on the automobile. Residents of suburban developments are often dependent on their cars for trips to destinations within the neighborhood because of circuitous street layouts, lack of sidewalks, and long travel distances. The term "pedestrian connectivity" is introduced as a measure of both the directness of route and the route distance for the pedestrian for each home-destination trip. The developed methodology for retrofitting pedestrian enhancements to an existing suburban neighborhood is coded as an ArcView GIS extension.

Improvements include the addition of sidewalks and access pathways to isolated cul-de-sacs to make for shorter and more direct routes. Reduced energy consumption, and therefore greater sustainability, may be achieved by having suburban neighborhoods retrofitted in such a way as to allow people to walk for some of their needs and to be well connected to a regional transit system. Modeled results from a neighborhood in Hamilton. Ont., Canada, show how the retrofitted improvements could lead to measurably improved conditions for pedestrians. Abstract by the authors.

SANDAG. (2002). *Planning and design for pedestrians. Model guidelines for the San Diego region*. Retrieved Oct. 21, 2003, from http://www.sandag.org/uploads/publicationid/oublicationid_713_1271.pdf.

This manual is intended to assist local governments and other interested entities in the creation and redevelopment of pedestrian areas and corridors throughout the San Diego region. It is also intended for transit agencies, specifically to be used "as a basis for planning access improvements to transit facilities and working with local jurisdictions to establish overlay districts around existing and proposed station areas" (p. 6). Pedestrian-oriented design principles, design guidelines, standards and recommendations are provided with direct reference to transit accessibility and as a the indispensable foundation for transit supportive environments.

Walk-Boston. (1999). *Improving pedestrian access to transit: An advocacy handbook*. Retrieved Oct. 16, 2003, from http://policy.rutgers.edu:16080/tpi/pedbike/infoclearing/infocollection/library/electronicdocuments/pedtransit.pdf.

This report funded by the by the Federal Transit Administration as a Livable Communities Project was designed for those who advocate for public transit and walking. It illustrates key steps that activists can take to ensure that mass transit supports community needs and creates livable communities through improved pedestrian access. The authors present their personal experiences in case studies that detail advocacy techniques and strategies. They also identify some failures or setbacks. The report discusses several public transit modes (e.g., bus, light rail, and subway) used in different kinds of communities (low-income urban neighborhoods, upper- and middle-income inner suburb). The authors are members of WalkBoston, a nonprofit organization that promotes walking and transit as means of transportation. Abstract by the author.

Zacharias, J. (1994). Planning for pedestrian networks in North American downtowns. *Journal of Advanced Transportation, 28* (2).

While North American urban regions are served by mechanical modes of transportation, downtowns are largely pedestrian environments. The growth and consolidation of office districts over the last twenty years have revived interest in developing coherent and efficient pedestrian networks, which can be coordinated with other transportation needs within the downtown. Ambitious plans for expansion of the downtown for offices, the retail and service industries as well as for housing and entertainment have been adopted in many North American cities during the 1980s. The successful integration of these large central areas depends to a considerable extent on the implementation of expanded pedestrian networks. This paper discusses certain spatial characteristics of North American cities which call for specific network designs and research into the walking environments of central areas. More knowledge is needed of the relative contributions to pedestrian regeneration of land use combination, the design of networks and of walking paths. Abstract by the author.

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1.4: Security and Crime Prevention

Perceived "lack of safety" has been identified as the most important deterrent to using public buses,[1] and although the problem is more prevalent in large cities than in small ones, there is a large body of literature that focuses on design aspects of bus stops that can help prevent crime in and around these facilities. These studies generally invoke CPTED (crime prevention through environmental design) principles pioneered by Oscar Newman and his "defensible space" ideas.[2] These principles are utilized to guide crime research in transit facilities—from bus stops to larger stations—and are also applied by transit facility designers in collaboration with transit managers and security personnel in the planning and design of new or retrofitted bus stop facilities. Another body of literature focuses on security and crime prevention through all types of preventive measures. Based on a national survey of transit agencies, *TCRP Synthesis 21* by Needle and Cobb (1997) finds that seven strategies are the most effective and most widely practiced among transit operators. Listed in order of importance these strategies include: (1) technological, such as video and TV facility monitoring, automatic ticketing, and security lighting; (2) uniformed officers on foot and bicycle; (3) employee involvement in conflict resolution and crime reporting; (4) education and information; (5) CPTED; (6) community outreach; and (7) nonuniformed officers. Lastly, since 2001, the threat of terrorism has spawned renewed interest in assessing security conditions of transportation facilities and systems, and *TCRP Report 86* by Rowshan and Simonetta (2003) provides the latest update regarding what transit systems are doing to implement post-September 11, 2001 security review protocols.

The sources assembled in this section can be classified in three groups: (1) architectural or CPTED-inspired research—with field research concentrated in the West Coast, particularly in Los Angeles, California; (2) transit-agency-based research that identifies best practices; and (3) post-nine-eleven assessment of security conditions. Improving security and safety perceptions at transit stops and facilities requires a combination of policing, increased surveillance and supervision, and the application of defensible space design to new and existing bus stations and other facilities. After September 11, 2001 transit agencies carried out important modification to their intrusion detection systems (IDS) and access control systems (ACS) involving additional fencing, gates, lighting, barriers, video surveillance and deployment of security personnel. However, research findings also point to transit agencies' cautious adoption of new IDS and ACS since the most sophisticated video surveillance technologies also require large investments in labor to interpret and monitor the information provided by these systems. Budget constraints, and rapid technological change stand in the way as obstacles to the adoption of the more costly security innovations.

Caylor, P. (1998). Translucent wind screens help reduce crime. *American City and County, 113* (5), 16. Retrieved Oct. 21, 2003, from http://www.americancityandcounty.com/ar/government_translucent_wind_screens/

In order to give a sense of security to users of park-and-ride and transit centers in Houston, Texas, translucent wind screens that discourage crime by maximizing visibility were included in the design. Edward Fanning, manager of architecture for the Metropolitan Transit Authority of Harris County, based his structural model for the transit centers on the principles of Crime Prevention Through Environmental Design. The translucent walls transmit 80 percent of available light, and the knowledge that people can see what's going on deters criminals and makes users feel safer. Abstract by the author.

Deka, D. (2002). *An assessment of the relationship between crime, security, and transit use in Florida using GIS and economic approaches*. Tallahassee, FL: Florida Department of Transportation.

This report tests whether there is a significant relationship between crime and transit use through statistical models with regard to both actual crime and perception of crime. The report also provides recommendations for improvement of transit services on the basis of the observed relationship between crime and transit use. Finally, the report gauges the threat of terrorism against transit and examines the preparedness of transit agencies to deal with such threats.

Jenkins, B. M., & Gersten, L. N. (2001). *Protecting public surface transportation against terrorism and serious crime: Continuing research on best security practices* (01-07). San Jose, CA: Mineta Transportation Institute, San Jose State University. Retrieved Oct. 21, 2003, from http://transweb.sjsu.edu/publications/terrorism_final.htm

Figure 7 - Security camera within a bus.
Image from: http://www.metrokc.gov/kcdot/news/thisweekarch/tw020415_d igitalvideo.htm

Terrorist activity was the initiator of this study. While air transport has increased its security measures against terrorism, public surface transportation still experiences terrorism without increased safety measures. The United Kingdom, France, Japan, and areas in the United States were assessed for the apparent terrorist threat that is posed for each station.

Security and crisis management that each station is currently taking were also assessed. Specific areas of assessment include design criteria and management criteria. Under design criteria are good lighting, up-to-date information, clear signs and clear lines of vision. Under management criteria are security staff presence, closed-circuit television surveillance, rapid response in emergencies, inspection and maintenance, and special training for staff. It was concluded that there are differences between the security measures that each station takes. Historical references, cultural values, and government arrangements all appear to be elements that differ for each place. They begin to suggest why some surface transportation terrorist efforts succeed and why some fail. Abstract by the authors.

Liggett, R. (2001). *Bus stop environment connection: Do characteristics of the built environment correlate with bus stop crime?* (Transportation Research Record 1760). Washington, D.C.: Transportation Research Board.

Can we understand why some bus stops are safe and others are crime-ridden? Can we predict which features of the bus stop environment are likely to encourage or discourage crime? Can we design safer bus stops? These questions are addressed by exploring the relationship between environmental variables and bus stop crime. An earlier study used crime data, along with environmental indicators, for a sample of 60 bus stops in downtown Los Angeles. Crime rates were higher for bus stops near alleys, multifamily housing, liquor stores and check-cashing establishments, vacant buildings, and graffiti and litter. In contrast, good visibility of the bus stop from its surroundings and the existence of bus shelters contributed to lower crime rates. This earlier study was indicative but not predictive of the elements that contribute to bus stop crime. With the geographic and temporal expansion of the data (covering a larger city part over a longer time span), a series of regression

Figure 8 - Installing security camera within a bus.
Image from: http://www.metrokc.gov/kcdot/aboutus/intransit/2001/it6-0 1p2.htm

models was generated that identify environmental predictors of bus stop crime. These models show that the most important predictor of crime is location. If the environment is controlled, undesirable facilities and litter result in higher crime rates, whereas visibility and many pedestrians lead to lower crime rates. The presence or absence of certain characteristics in the bus stop microenvironment can affect crime. Also, the appropriate design and layout of the physical environment can reduce opportunities for criminal actions. Abstract by the author.

Loukaitou-Sideris, A. (1999). Hot spots of bus stop crime: The importance of environmental attributes. *Journal of the American Planning Association, 65* (4), 395-411. Retrieved Oct. 15, 2003, from http://proquest.umi.com/pqdweb?Did=000000045717861&Fmt=4&Deli=1&Mtd=1&Idx=3&Sid=2&RQT=309

This study focused on bus stop crime and sought to identify the environmental attributes that can affect the bus rider's security while at the bus stop. Following the argument of criminologists that certain place characteristics can affect the incidence of crime, the study used direct

observation, mapping, interviews, and surveys to examine the physical and social environment around the 10 most crime-ridden bus stops in Los Angeles during 1994 and 1995. It found an abundance of 'negative' environmental attributes and a general lack of 'defensible space' elements. It also found that different types of crime tend to occur under different environmental conditions. The use of four control cases of low-crime bus stops in matched pairs with four high-crime bus stops in close proximity showed that the low-crime bus stops typically lacked 'negative' environmental attributes, while offering better surveillance opportunities from surrounding establishments. The article discusses design responses as an approach to crime prevention at bus stops. Abstract by the author.

Loukaitou-Sideris, A. (2001). *The environment - transit crime connection: Continuing study of the Metro Green Line and its vicinity*. Los Angeles, CA: University of California, Los Angeles.

This study is an in-depth examination of case study stations along a light rail line in Los Angeles. The study explores how environmental and social characteristics of the neighborhood affect crime at the station, and how, in turn, the existence of the station affects crime at the neighborhood. The study utilizes crime statistics, census and ridership data, and environmental data and uses a mix of qualitative and quantitative methodologies, including the compilation of environmental inventories, GIS and spatial analysis techniques, and block-group level correlation and regression analyses. Abstract by the author.

Loukaitou-Sideris, A., Liggett, R., & Hiroyuki, I. (2001). Measuring the effects of the built environment on bus stop crime. *Environment and Planning: Planning and Design, 28* (1), 255-280. Retrieved Oct. 21, 2003, from http://www.uctc.net/papers/419.pdf

Figure 9 - Security camera.
Image from: TCRP 86

There has been considerable interest in recent decades in the identification of the physical correlates of crime in different urban settings. This study focuses on bus stop crime and seeks to understand how different environmental attributes in the vicinity of a bus stop can affect the incidence of crime. The authors review evidence from the relevant literature to understand the impacts of the built environment on crime. This is followed by the presentation of empirical research. The study uses a stratified random sample of sixty bus stops in downtown Los Angeles to examine the effects of environmental and land-use attributes on crime rates. Using descriptive statistics, correlations, regression and discriminant

analyses, and matched-pair analysis, the authors find some relations between the existence or absence of certain environmental attributes and the incidence of crime.

Lusk, A. (2002). *The bus and bus stop designs related to perceptions of crime* (FTA-MI-26-7004-2002.1 and FTA-TRI-12-02.1). Ann Arbor, MI: FTA.

The author reviews research conducted to determine bus and bus stop designs that might lessen the perception of crime and increase personal security. The case study research is conducted in a small city (Ann Arbor, MI) and a large metropolis (Detroit, MI) with additional research for external validity conducted in Burlington, Vermont and Washington, D.C. The research methodology includes interviews, site visits, observations, literature review, surveys of riders on buses, picture preference surveys and focus group discussions. The research is conducted from September 1998 until December 2001 and is carried out in two phases. Phase I involves surveys distributed on buses in Detroit and Ann Arbor. The surveys ask the participants for their perceptions about the bus design features in relation to crime including windows, seating, and color. Phase I helps frame the methodology for Phase II which involves picture preference surveys. The results suggest that the appearance of the bus and bus stop could be altered to increase the perception of personal security for riders and potential riders.

Needle, J., & Cobb, R. (1997). *Improving transit security* (TCRP Synthesis 21). Washington, D.C.: Transportation Research Board. Retrieved Oct. 6, 2003, from http://gulliver.trb.org/publications/tcrp/tsyn21.pdf

The principle objective of this synthesis is to identify violence prevention and control practices deemed successful by transit agency professionals. Chapter 1 addresses the costs of transit violence, objectives of the synthesis, and the methodology employed. Chapter 2 discusses the dimensions of transit crime and violence. Chapter 3 presents strategies that transit professionals use to address crime and violence, singles out those that are most effective, and examines how strategies are evaluated. Chapter 4 outlines the combination of responses selected by four agencies to combat disorder and violence in their systems. Chapter 5 highlights current research and literature. Chapter 6 summarizes salient findings of the synthesis and suggests next steps that can help transit agencies cope with crime, violence, and fear. Abstract by the authors.

Rowshan, S., & Simonetta, R. J. (2003). *Public transportation security: Volume 4 intrusion detection for public transportation facilities handbook* (TCRP Report 86). Washington DC: Transportation Research Board. Retrieved Oct. 6, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_86v4.pdf

The Intrusion Detection for Public Transportation Facilities Handbook ("Handbook") addresses transit agencies' needs for evaluating and upgrading the intrusion detection systems applicable to the spectrum of their facilities including tunnels, bridges, buildings, power stations, transfer stations, rail yards, bus yards, and parking lots, as well as transit vehicles such as buses, trains, support vehicles, and special purpose vehicles. The Handbook provides guidance on assessing system needs; developing system designs; and estimating system costs, benefits, and risks. The systems discussed in the Handbook range from low-technology to more complex high technology systems, and directly support the deterrence and detection of intrusion into secure areas. The Handbook distinguishes Intrusion Detection Systems (IDS) and Access Control Systems (ACS). IDS are a set of technologies and systems that define, observe, control, and sense entry into a defined controlled or secure area. ACS

manage various combinations of entry, exit and/or movement through secure and controlled areas by the use of an identifiable token. In this Handbook, ACS are a subsystem that support IDS by enabling access by authorized personnel, preventing access by intruders, and interfacing with IDS to annunciate entry into controlled or secure areas. ACS over the spectrum from simple keys to highly integrated biometrics controls.

The information in the Handbook was compiled based on a comprehensive literature search of commercial intrusion-detection system specifications and costs; a survey of major U.S. and international transit agencies; and on-site visits and interviews with general managers, senior staff, and security chiefs of selected major metropolitan transit facilities. The information received from surveys and interviews found that IDS and ACS presently used in transit systems are generally functioning as intended and are viewed as having satisfied their originally designed purposes. Several transit systems reported that intrusion detection applications also produced purposes. Several transit systems reported that intrusion detection applications also produced secondary benefits in addition to their initial purpose. Cameras in facilities and vehicles have provided law enforcement agencies with evidence related to general criminal activity not necessarily related to the transit system. Transit employees have also become more aware of the role they can play to supplement and enhance intrusion detection and access control applications. Abstract by the authors.

Smith, M., & Clarke, R. (2000). Crime and public transport, *Crime and Justice, 27* (1), 169-233.

The writers discuss crime and public transport, noting that such crime covers a vast array of offenses committed in various forms of transport. The targets of crime in public transport can be the system itself, employees, or passengers. A distinction needs to be drawn between crimes facilitated by overcrowding and those made possible by lack of supervision; both of which are the result of financial constraints faced by all forms of public transport. Although some measures have been successful in dealing with specific crimes in public transport, much crime could be "designed out" of new subway systems and existing train and bus stations; and order maintenance might be an effective transit policing strategy. The issue of whether transit systems spread crime from high- to lower-crime areas and whether some forms of transport are safer than others has not been successfully determined. Abstract by the authors.

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Ewing, R. (1999). *Pedestrian and transit friendly design: A primer for smart growth*. Washington, D.C.: Smart Growth Network. Retrieved Oct. 6, 2003, from http://www.epa.gov/smartgrowth/pdf/ptfd_primer.pdf

Notes

[1] Loukaitou-Sideris, A. (1994). Reviving transit corridors and transit riding. *Access*, 4, 27-32.

[2] Newman, O. (1972). *Defensible space: Crime prevention through urban design.* New York: MacMillan.

2: Building Bus Transit Facilities

The most basic passenger facility for all transit agencies, great and small, is the bus stop. It is the point where the passenger and bus service meet. The bus stop acts as portal and node, connecting bus service with all other mobility networks in the city and region. As mentioned in chapter I, bus stops—from signs on the road to sophisticated intermodal stations—depend on good and safe handicapped, pedestrian, bicycle, and automobile accessibility in order to provide quality bus service that enhances non-auto mobility. Hence the location, design, spacing, and operation of bus stops are critical in transit system performance and customer satisfaction.

Two major overriding considerations affect customer satisfaction. First, facility siting considerations stress safe and convenient accessibility to the bus stop for the bus patron (i.e., facilities must be adequately incorporated into the existing fabric of roads, pedestrian infrastructure, and public rights of way) while balancing the need for efficient bus operation and service schedule (i.e., facility placement should facilitate efficient service provision). Second, facility design considerations underscore amenitizing patrons' waiting time at the bus stop. Facility waiting time—a function of bus headways—and passenger volume strongly influence success in designing for passenger convenience, comfort and security.

Since the 1980s a heightened interest in integrating transit with development—often originating from outside transit agencies—has ushered a flurry of trendy transit-community design concepts including transit-oriented development (TOD), transit-focused community design, transit-village planning, transit-friendly communities, and transit-supportive development, etc. These ideas have coalesced under the umbrella of the TOD movement. This movement emphasizes the planning and design of transit facilities as core components of new development and redevelopment projects. Some TOD proposals urge for growth management policies that place transit at the forefront of guiding new development (see Chapter III in this review for more details).

BUS TRANSIT FACILITY DESIGN GUIDELINES

In this section, the literature on designing and siting bus passenger facilities comes from three main sources: (1) transit facility design guidelines and studies commissioned by federal agencies such as the Federal Transit Administration—the sponsor of the Transit Cooperative Research Program (TCRP)—and the Transit Development Corporation. These are generally publications of the Transportation Research Board (TRB) published as TCRP reports; (2) state transit facility guidelines developed by state transportation departments; and (3) regional and city transit facility guidelines elaborated for in-house use by city and regional transit agencies as well as by city departments.

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2.1: Transit Facility Design Guidelines

NATIONAL AND TCRP-REPORT-BASED GUIDELINES

Inspired by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and its sequel the Transportation Equity Act for the 21st Century, TEA-21 (1998), post-1990 transit design guidelines underscore the principle of designing for intermodality at every stage of bus passenger facility planning and design. In fact, the Transit Cooperative Research Program (TCRP), proposed by the U.S. Department of Transportation and authorized in 1991 in the ISTEA, has compiled and made available a large body of information of special concern to the transit community. In the area of locating and designing bus stops, *TCRP Report 19* by Kittelson and Associates (1996), *TCRP Web Document 6, Part 4* by the Texas Transportation Institue (1999), and on evaluation of bus bulbs *TCRP Report 65* by Fitzpatrick et al. (2001) collectively stand out as very useful comprehensive reference publications representative of this influential national transportation initiative.

Table 1. Location and Design of Bus Stops
(From *TCRP Report 19*, 1999)

Street-Side Factors	Curb-Side Factors

• Stop spacing
• Bus stop placement
• Bus stop types & dimensions
  o Curb-side
  o Bus bay
  o Open bus bay
  o Queue jumper bus bay
  o Nub
• Vehicle characteristic types & dimensions
  o Turning radii
  o Wheelchair lift
  o Bikes on buses
• Roadway intersection design
• Safety
	• Pedestrian access
	  o Patron access
	  o Bus stops & sidewalk connections
	  o Access to commercial and business development
	  o Access to residential development
	  o ADA Accessability
	• Waiting & accessory pads
	• Shelters
	  o Inclusion & sizing
	  o Configuration & orientation
	  o Advertising
	  o Artistic & thematic design
	• Amenities

TCRP Report 19, drawing substantively from a selection of four city and transit agency facility design handbooks and field visits to transit agencies across the nation, contributes an important bus passenger facility design concept: The separation between *street-side* and *curb-side* factors which affect both on-street bus operations and off-the-roadway bus patrons' comfort and safety (see Table 1).

Bus Capacity and Quality of Service. Part 4 of the *Transit Capacity and Quality of Service Manual* (TCRP Web Document 6, 1999) focuses on bus capacity conceived as a function of the flow of both bus passengers and buses. The manual's sizing and design procedures of passenger facilities closely follow the Highway Capacity Manual's (HCM) methodology based on pedestrian levels of service analysis. Based on this methodology it provides procedures for sizing passenger waiting areas at bus stops and the provision of passenger amenities at these venues. For bus stations and terminals it provides sizing calculations for both inside and outside terminal components. The former include walkways, stairways, escalators, elevators, turnstiles, ticket machines, and platforms; while the latter refer to transfer facilities, such as bus transfer, park-and-ride, and kiss-and-ride areas.

Inspired by the HCM, this manual offers a comprehensive facility design approach related to smooth and swift bus and passenger flows. It takes into account not only the size of the buses and service schedules, but also the interaction between passenger traffic and vehicle flow. This "swift flow" philosophy to passenger facility design stresses siting and design principles that optimize the overall levels of service of bus routes, bus lanes, and bus terminals. It identifies bus vehicle and person capacity factors and suggests how each one can be improved to attain additional capacity (see Table 2) and how in certain instances, this may also require a trade-off with quality of service. Complete applicability of all procedures contained in this manual may be limited by data availability—particularly among bus transit systems—operating in small- and medium-sized urban areas.

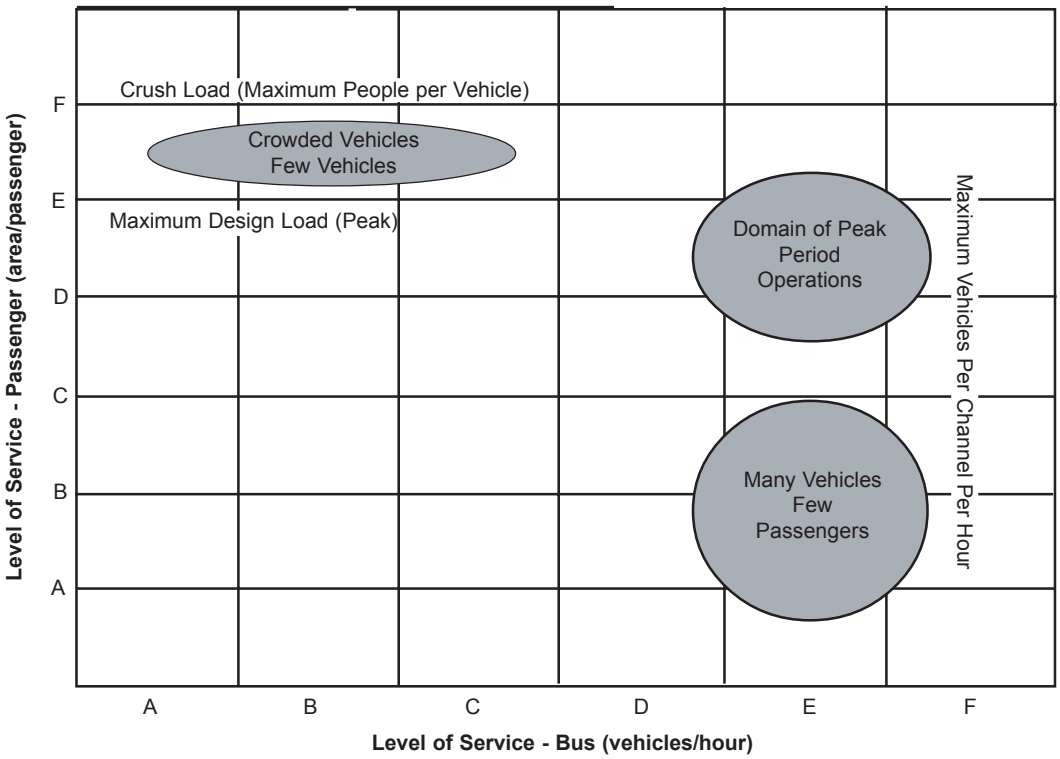

Figure 1 - Relationship between passenger and vehicle capacity.
Image from: *TCRP Web Document 6 (*http://gulliver.trb.org/publications/tcrp/tcrp_webdoc_6-a.pdf)

Table 2. Factors Influencing Bus Capacity
(From *TCRP Web Document 6*, 1999, *Transit Capacity and Quality of Service Manual*)
http://gulliver.trb.org/publications/tcrp/tcrp_webdoc_6-a.pdf

Item	Ways to Improve Each Item
CAPACITY FACTORS	
Dwell Time	• Greater use of pre-paid fares • Use low-floor vehicles • Encourage one-way door flows on two-door buses • Provide multiple-stream doors for boarding and alighting • Increase bus frequency to reduce the number of standees • Implement proof-of-payment fare collection
Clearance Time	• Use on-line stops* • Enact and enforce laws that require cars to yield to buses re-entering a street • Implement queue jumps at traffic signals
Coefficient of Variation	• Generally constant for a given area
Failure Rate	• Increase the number of loading areas at a stop • Schedule fewer buses per hour using the stop**
CALCULATED RESULTS	
Loading Area Capacity	• Reduce dwell time • Implement transit priority treatments • Increase the accepted failure rate*
Bus Stop Capacity	• Increase loading area capacity • Use off-line loading areas* • Use sawtooth or pull-through loading areas • Increase the number of loading areas
Bus Lane Capacity	• Increase the capacity of the critical stop • Reserve lanes for buses • Platoon buses • Implement skip-stop operation • Prohibit right turns by automobiles
Bus Speeds	• Reduce dwell time • Implement transit preferential treatments • Balance number of stops with passenger convenience and demand • Implement skip-stop operation

*Measure that may negatively affect other items in the list if implemented.
**Measure that improves the failure rate, but decreases capacity.

Bus bulbs are perhaps the greatest examples of how the bus stop is a portal and connection to bus mobility in the city. They facilitate smooth bus movement and alighting and boarding operations on the street-side as well as off-roadway pedestrian accessibility and bus passenger comfort and security. The additional space that they bring to the bus stop permits the inclusion of bus patron amenities, particularly in areas with tight public right-of-way, where installing bus shelters would be prohibitive. Reducing congestion on sidewalks, eliminating bus-weaving maneuvers into bus-bay stops, and reducing traffic blockage caused by stopping buses are a major rationale for providing these facilities.

According to TCRP Report 65 *Evaluation of Bus Bulbs* by Fitzpatrick et al. (2001), the most appropriate locations for bus bulbs are downtowns and high pedestrian activity areas with curb-side parking on arterials conveying two-lane travel on both directions. Based on research carried out in San Francisco, Portland, Seattle, and Vancouver, Canada, the report provides a useful review of supportive and limiting conditions to bus bulb construction including community attitudes, pedestrian infrastructure conditions, and on-street bus movement consideration (see Table 3).

Figure 2 - Nearside bus bulb on Portland's north Sandy Boulevard at northeast 67th Avenue (eastbound).
Image from: *TCRP 65.*

Figure 3 - The 16th Street bus mall in Denver, CO.
Image from: *TRCP Web Document 6* (http://gulliver.trb.org/publications/tcrp/tcrp_webdoc_6-a.pdf)

Table 3. Opportunities and Barriers to Bus Bulbs Construction
(Adapted from *TCRP Report 65*, 2001)

Opportunities	Barriers
Community Conditions • Communities that give high priority to transit • Local business owners interested in the bulbs *Off-the-Roadway Pedestrian Conditions* • High pedestrian activity on sidewalk • High levels of bus patronage at bus stop or within the corridor *On-Street and Bus Movement Conditions* • Lower operating speeds on the roadway • Two travel lanes per direction (to allow passing of stopped buses) • Difficulties for buses in re-entering the traffic stream usually because of high traffic volumes • Facilities with very high traffic volumes • Presence of on-street parking	*Community Conditions* • Citizen and business concerned about changes in traffic patterns. *Off-the-Roadway Pedestrian Conditions* • *Sites with low pedestrian activity* • *Sites with low transit ridership* *On-Street and Bus Movement Conditions* • Facilities with high operating speeds (e.g., 40 to 45 mph) • Two-lane streets (i.e., traffic cannot pass a stopped bus) • High bicycle traffic on roadway • Sites where 24-hr curbside parking is not available • Facilities that are served by vans that deploy wheelchair lifts or where the majority of buses are lift-equipped (e.g., where wheelchair lift operation can take up to 10 min) • Layover locations • Complex drainage patterns

Fitzpatrick, K., Hall, K., Farnsworth, S., & Finley, M. (2001). *Evaluation of bus bulbs* (TCRP Report 65). Washington, D.C.: Transportation Research Board. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_65-a.pdf

This report will be of interest to individuals and groups with a stake in the location and design of bus stops. These groups include public transportation organizations, public works departments, local departments of transportation, developers, and public and private organizations along or near bus routes. The research evaluated bus bulbs, an innovation in the design of bus stops found in several major North American cities. A bus bulb is a section of sidewalk that extends from the curb of a parking lane to the edge of a through lane. They are also known as curb extensions, nubs, and bus bulges. Chapter 1 introduces the research objectives, scope, and approach. Chapter 2 presents the findings from the site visits, the curbside and roadway before-and-after studies, and the traffic simulation program. Chapter 3 presents the conditions that support the Construction of bus bulbs and the conditions that would not support the use of bus bulbs. Chapter 4 summarizes the findings from the research and suggests further research. The report's Appendix A is a review of selected cities' practices. Abstract by the authors.

Kittelson & Associates Inc. (1999). *Transit capacity and quality of service manual* (TCRP Web Document 6). Washington, D.C.: Transportation Research Board. Retrieved Oct. 21, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_webdoc_6-a.pdf http://gulliver.trb.org/publications/tcrp/\tcrp_webdoc_6-b.pdf

The Transit Capacity and Quality Service Manual [TCQSM], intended to be the transit companion for the Highway Capacity Manual, is "a fundamental reference document for public transit practitioners and policy makers. The manual contains background, statistics, and graphics providing orientation to the various types of public transportation and it introduces a new framework for measuring transit availability and quality of service from the passenger point of view. The manual contains qualitative techniques for calculating the capacity of bus and rail transit services, terminals, and platforms" (p. ix). Part 2 of this manual focuses on bus transit capacity determination including: bus capacity guidelines and calculations related to operations, busways' and freeways' high occupancy vehicle lanes, bus lanes in exclusive arterials and mixed traffic conditions and demand response services. Part 4 is devoted to terminal capacity design including bus stops, transfer facilities, and park-and-ride and kiss-and-ride facilities. Each transit facility and amenity discussed includes subsections on design factors, capacity standards and evaluation procedures.

National Transportation Safety Board. (1997). *Federal Safety Commission highway accident summary report. Bus collision with pedestrians Normandy, Missouri June 11, 1997*. Washington, DC: National Transportation Safety Board. Retrieved Dec. 3, 2003, from http://www.ntsb.gov/Publictn/1998/har9801s.pdf.

On June 11, 1997, a transit bus collided with seven pedestrians at a "park and ride" transit facility in Normandy, Missouri. The bus was being operated by a driver trainee who had just completed a routine stop at the station. After allowing the passengers to debark from the bus, the driver trainee began to move the bus forward to provide clearance for another bus to pass. The driver trainee, who was reportedly unable to stop the bus, allowed it to surmount the curb and continue onto the station platform. The resulting encroachment onto the platform resulted in the deaths of four pedestrians and injuries to three others. The safety issues discussed

in this report are the sufficiency of pedestrian protection provided by the saw-tooth parking bay design and the need for positive separation between the roadway and pedestrian areas of parking bay facilities. Abstract by the author.

Rabinowitz, H. Z., Beimborn, E. A., Lindquist, P. S., & Opper, D. (1989). *Market based transit facility design* (DOT-T-89-12). Washington, D.C.: U. S. Department of Transportation, Office of Technical Assistance and Safety.

The purpose of this report is to provide guidelines for the planning and design of transit stations, stops and terminals. These guidelines have been prepared from a market-based point of view. Design elements are suggested that directly relate promoting the success of development activities and transit services. The report discusses general development policies and provides design guidelines for six transit station types through a range of design phases.

Guidelines are given for the planning and design of six station types—CBD rail stations, neighborhood rail, park and ride stations, transit malls, transfer centers and local stops. These station types are explored through four phases of planning and design —systems planning, site planning, station design and operations/management. Among the topics discussed for each station type are location, market, connections, access, information, image, user comfort, safety and security, operations and management. Abstract by the authors.

Texas Transportation Institute, & Texas A&M Research Foundation. (1996). *Guidelines for the location and design of bus stops* (TCRP Report 19). Washington, D.C.: Transportation Research Board. Retrieved Oct. 8, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_19-a.pdf

This report will be of interest to individuals and groups with a stake in the location and design of bus stops. This includes those associated with public transportation organizations, public works departments, local departments of transportation, developers, and public and private organizations along or near bus routes. The primary objective of this research was to develop guidelines for locating and designing bus stops in various operating environments. These guidelines will assist transit agencies, local governments, and other public bodies in locating and designing bus stops that consider bus patrons' convenience, safety, and access to sites as well as safe transit operations and traffic flow. The guidelines include information about locating and designing bus stops and checklists of factors that should be considered. The research began with a literature review and the identification of stakeholders' concerns through mail-out and telephone surveys and face-to-face interviews. A review of 28 transit agency manuals on bus stop design and location provided the basis for an appraisal of current practice. Observations made at more than 270 bus stops during regional visits to Arizona, Michigan, and California were supplemented with traffic field studies conducted at 14 bus stops and pedestrian field studies conducted at 10 bus stops. Computer simulation of bus stops on suburban highways was also used to develop the findings. The guidelines include three sections: the big picture, street-side design, and curb-side design. The guidelines also include two appendixes that present the results of the street-side and curb-side studies. Abstract by the authors.

STATE, REGIONAL, AND LOCAL GUIDELINES

The many manuals and handbooks produced by state and local transportation departments and regional and city transit agencies can be broadly divided into before and after ISTEA (1991) and before and after ADA (1990). During the 1980s a strong interest in including public transit in land use planning emerged as transportation professionals acknowledged, that American cities had rapidly decentralized over the last twenty years; activities traditionally concentrated in central business districts (CBDs) had followed suburban populations to the periphery of cities. The new polycentric urban form comprised of many suburban subcenters was accompanied by suburb-to-suburb regional travel patterns, which were more diverse and less focused on the CBD. Calls to reorient transit to serve the new suburban centers and to capture a share of the already largely suburban travel market emphasized the design of transfer centers in timed-transfer bus service networks. In these transit center-based systems, major regional activity centers, such as shopping malls, airports, medical centers, universities, etc., were—and still are—strategic locations for transit malls and transfer centers. These transit regional nodes would connect three route types: radial routes stretching to the CBD with rapid bus service, circumferential routes linking the transfer center to other suburban centers, and local routes conveying bus patrons from their home to the transit center.[1] In the 1980s, so called "market-based approaches" to passenger facility design focused on three types of facilities: transit malls, transfer centers, and local stops and provided planning and design guidelines comprehensively on five topics:[2]

1. Joint development opportunities–integrating transit to surrounding commercial development
2. Systems planning–locating transit to serve existing activity centers or to redirect urban development to new activity areas
3. Site planning–site designing in context with surrounding neighborhood and/or with development of retail on site, plus proper siting of bus shelters and amenities.
4. Station design–design for safe bus patron access and movement
5. Operations management–combination and coordination of retail management (push cart regulations, leasing of private space for public use) with transportation management (parking regulations, maintenance of transit schedules, information booths, etc.).

Also in the 1980s, some transit facility design guidelines played an important marketing role in exposing local governments and developers to the benefits of integrating transit and development. Proactive regional transit agencies in the West Coast developed transit guidelines to acquaint local governments with the transit agency's policies regarding land use planning and transit, and to encourage local governments to include transit in their general or comprehensive plans. Additionally, these guidelines encouraged cities and developers to coordinate with the transit agency in designating and locating bus stops, and to build transit-compatible projects with adequate pedestrian access through the existing permitting process. They also encouraged cities to impose transit amenity requirements or transit fees whenever development adversely impacted the transit system or service.[3]

Post-ISTEA (1991) and post-ADA (1990) bus passenger facility design guidelines incorporate many of the former concerns but add further detail about ADA accessibility specifications. With the advent of digital and desk-top publishing technology, these guidelines offer richer graphic depiction of design principles with illustrations of best practices in designing for intermodality. Moreover, these guidelines reflect the changes in metropolitan planning

brought about by the ISTEA, which the U.S. Department of Transportation in a guide to MPO planning explains as consisting of:

> a more integrated planning process to better meet the needs of all constituencies. . . . [The Act] places significant emphasis on broadening participation in transportation planning to include key stakeholders who have not traditionally been involved, including the business community, members of the public, community groups, and other governmental agencies.[4]

The ISTEA's intent to make transportation planning more responsive to local needs by broadening public participation has challenged transportation professionals to engage nontraditional stakeholders in metropolitan transportation planning. In response to this challenge transit facility guidelines have evolved to serve both technical audiences and new diverse, nontechnical audiences, providing two types of information. The first relates to bus facility design standards and technical specifications such as bus vertical and horizontal clearances, turning radii, berthing and bus stop dimensions, bus stop spacing and placement, and bus shelter standards, etc. The second offers recommendations for land use decisions and urban design principles supportive of transit-friendly development. Typically, these are directives such as "give priority to pedestrian facilities," "encourage a mixture of land uses," "orient building frontage to the pedestrian," and "interconnect street network," that encourage the user to adopt a transit-friendly community design philosophy.

Figure 4 - A public charrette for the Leon County Florida Bicycle and Pedestrian Master Plan.
Image from: http://talgov.com/citytlh/planning/trans/bikeped/masterplan/bppdf/tally_news.pdf

The first set of "hard" standards and guidelines generally prescribe metrics related to street-side factors that affect safe bus operations and traffic flow (e.g., bus stop spacing, placement, bus bays, bulbs, etc.), as well as off-street or curb-side factors that affect accessibility, safety and convenience of bus riders (e.g., ADA accessibility, shelter design and placement, and amenities that enhance bus patrons' comfort). These norms, typically under the administrative purview of transit agencies, are contained in the majority of transit facility design guidelines (see Tables 4 and 5). They are also the most widely used and routinely consulted by transit operators and planners. On the other hand, the second set of "soft" guidelines normally require several layers of interagency coordination and urge transit agencies to join efforts with elected officials, city administrators, engineers and planners, developers, and neighborhood groups in incorporating transit-supportive policies into the land development review process. These guidelines are advisory and illustrative of best development practices that other agencies and stakeholders can emulate or adapt. More recently however, county-based transit regional authorities such as Pinellas Suncoast in Florida are starting to include in their manuals suggestive regulatory language that local jurisdictions may incorporate in their land development regulations in order to implement transit-friendly development. Other regional transit agencies like Lynx in Central Florida provide

schematics of the land development review process and the stages in the process to which the design guidelines apply.

With the exception of a few handbooks, one significant gap in the literature is the scant attention that the biking community receives. Fortunately, the latest handbooks make an effort to incorporate biking design considerations both on the street and at the curb-side. As already mentioned, more recently produced guidelines give more importance to pedestrian access, sidewalk connectivity, and land-use aspects than their predecessors. However, there is a substantial shortage of case studies documenting lessons learned regarding successful and unsuccessful attempts at integrating bus transit and land use planning from the point of view of the social capital and institution-building deemed necessary to bring transit-friendly development to fruition.[1] Despite this shortcoming, many transit planners welcome "soft" guidelines for integrating transit and land-use as public relations and communication tools useful in post-ISTEA metropolitan transportation planning context and for negotiating and advocating for bus transit in the local development review process.[2]

Tables 4 and 5 provide a selection of frequently cited transit facility design guidelines from Florida and outside Florida.

Figure 5 - Bus shelter from Tampa, FL.
Image from: Authors.

Table 4. Florida-Based Guidelines	Street-Side									Curb-Side			Other			
	Bus Stop			Vehicle		Roadway		Pedestrian								
	Spacing	Location	Types & Dimensions	Types & Dimensions	Bicycle	Intersection & Street Geometrics	Bicycle	Ped Crossings	ADA & Access	Shelters	Transfer & Other Facility Types	Amenities	Land Use or TOD	CPTED	ITS	Quality of Illustration
District Office of Modal Development. (2002). *District 4 transit facilities guidelines*. Fort Lauderdale, FL: District 4, Florida Department of Transportation.	✓	✓	✓			✓		✓	✓	✓		✓				Good
Hillsborough Area Regional Transit. (1995). *Transit-friendly planning and design handbook and technical manual.* Tampa, FL: Hillsborough Area Regional Transit (HARTline).	✓	✓	✓	✓	✓				✓	✓		✓	Cursory			Fair
Jackson, G. (1994). *Central Florida mobility design manual.* Orlando, FL: Central Florida Regional Transportation Authority, LYNX. Retrieved October 6, 2003, from http://www.golynx.com/pdfs/pubs_mdm.pdf	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			Very good
Halback, H. (2000). *Customer amenities manual.* Orlando, FL: Central Florida Regional Transit Authority - Lynx. Retrieved October 6, 2003, from http://www.golynx.com/pdfs/pubs_Amenities_Manual.pdf		✓			✓				✓	✓	✓		✓	✓	✓	Very good
Jacksonville Transportation Authority. (2003). *JTA mobility access program workbook*. Jacksonville, FL	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓			Very good
Science Applications International Corporation. (1999). *Transit friendly design guidelines*. St. Petersburg, FL: Pinellas Suncoast Transit Authority.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			Good

Table 5. Selected Out-of-State Guidelines (in historical order)	Street-Side									Curb-Side			Other				
	Bus Stop			Vehicle		Roadway		Pedestrian		Shelters	Transfer & Other Facility Types	Amenities	Land Use or TOD	CPTED	ITS	Maintenance	Quality of Illustration
	Spacing	Location	Types & Dimensions	Types & Dimensions	Bicycle	Intersection & Street Geo-metrics	Bicycle	Ped Crossings	ADA & Access								
Tri-County Metropolitan Transportation District of Oregon. (1996). *Planning and design for transit handbook: Guidelines for implementing transit supportive development.* Portland, Oregon.	✓	✓	✓	✓		✓		✓	✓	✓		✓	✓		BPS*		Very
Metropolitan Transit Development Board. (1993). *Designing for transit*. San Diego, CA.	✓	✓	✓	✓		✓				✓		Cursory	✓				Very
Valley Metro. 1993. *Bus stop handbook.* Phoenix, AZ: Regional Public Transportation Authority.	✓	✓	✓	✓	✓	✓	✓		Access	✓							Very
Seattle Metro. (1991). *Metro transportation facility design guidelines.* Seattle, WA: Municipality of Metropolitan Seattle. http://dnr.metrokc.gov/WTD/library/mr4358-01.htm	✓	✓	✓	✓					✓	✓	✓		✓			✓	Fair
Denver Regional Transportation District. (1987). *Transit facility design guidelines.* Denver, CO: Regional Transportation District.	✓	✓	✓	✓						✓	✓						Very
Mass Transit Administration 1988. *Access by design: transit's role in land development. A developer's manual.* Baltimore, MD: Maryland Department of Transportation.	✓	✓	✓	✓					✓	✓	Cursory	✓					Good
Yazhari, David H. (1983). *Transit Facilities Standards Manual*. Alameda-Contra Costa Transit District. Oakland, CA.		✓		✓						✓	✓	Cursory					Fair

*BPS Bus Priority Signal

City of Eugene Public Works Transportation Department. (1999). *Design of transit facilities in arterial collectors street plans*. Retrieved Oct. 29, 2003, from http://www.ci.eugene.or.us/PW/trans/ACSP/77_94.pdf.

These guidelines are part of the City of Eugene's Arterial Collector Street Plans. They were developed by the local transit authority Lane Transit District. The specific aim of this chapter is to: facilitate the planning and design phase of development in which the inclusion of transit facilities is either mandated or encouraged; avoid costly and time consuming delays from adding transit amenities to developments; ensure that transit facilities are safely accessible to bus riders and pedestrians; ensure safe and convenient transit operation; and promote use of transit by providing highly visible, convenient areas for riders. Abstract taken from author's introduction (p. 79).

Denver Regional Transportation District. (1987). *Transit facility design guidelines*. Denver, CO: Regional Transportation District.

Metropolitan Denver depends upon public transit to ensure its citizens uninterrupted mobility. This document is intended to provide guidance to local officials, developers, planners, and engineers so they may plan adequate collector streets, access walkways and bus stops for new developments and subdivisions. The guidelines provide a framework for site selection and site planning. The guidelines cover the following: bus stops, bus passenger shelters, transfer stations and park-and-ride.

District Office of Modal Development. (2002). *District 4 transit facilities guidelines*. Ft. Lauderdale, FL: District 4, Florida Department of Transportation.

This manual, designed by FDOT District IV, is intended for engineers to use during the construction of bus stop facilities. It includes detailed drawings of various treatments of bus stops, bus bays, bus shelters, and pedestrian crossings. It also includes a transit design review checklist intended for developers and designers of new developments.

Florida Department of Transportation Design Office. (1989). *Green book: Manual of uniform minimum standards for design, construction & maintenance for streets & highways*. Tallahassee, FL: Florida Department of Transportation. Retrieved Oct. 2, 2003, from http://www11.myflorida.com/rddesign/Florida%20Greenbook/2002%20FLORIDA%20GREENBOOK.pdf.

The purpose of this manual is to provide uniform minimum standards and criteria for the design, construction and maintenance of all public streets, roads, highways, bridges, sidewalks, curbs, curb ramps, crosswalks (where feasible), bicycle facilities, underpasses, and overpasses used by the public for vehicular and pedestrian traffic as directed by Sections 334.044(10)(a) and 336.045, Florida Statutes. Specific policies governing the activities of planning, design, construction, reconstruction, maintenance and operation of streets and highways are listed throughout the manual. The manual presents land development principles and guidelines and geometric design principles which are very critical for an efficient transit service planning by transit agencies. The second section of the manual presents engineering details on roadside design, pavement design and construction, roadway lighting, rail highway design grade crossings, pedestrian and bicycle facilities. The final section presents guidance on maintenance of the facilities, work zone safety, construction of facilities, transit components, design exceptions, traffic calming measures and residential street design principles.

Fuhs, C. (2002). *Geometric design guide for transit facilities on highways and streets—Phase I interim guide*. Houston, TX: American Association of State Highway and Transportation Officials (AASHTO).

Many agencies are required to plan, design, and/or modify highways and streets to accommodate public transportation vehicles or facilities. Currently, there is no single publication to which an agency can refer for guidance on the design of highways and streets to accommodate transit services and facilities (AASHTO). This interim document is intended to function as a comprehensive reference of current practice in geometric design applications for transit facilities on urban highways and streets. The first section of the report presents general guidelines which are common to all transit facilities like functional planning, bus transit capacity and design controls and criteria. The second section provides design guidelines for transit facilities on highways, which include transit vehicle facilities and highway transit passenger facilities. The third section provides design guidelines for off-street and on-street transit facilities and recommended amenities associated with it.

Grand Junction Mesa County Metropolitan Planning Organization. (2003). *Transit design standards and guidelines*. Grand Junction, CO: Grand Junction/Mesa County Metropolitan Planning Organization. Retrieved Oct. 8, 2003, from http://www.gjcity.org/CityDeptWebPages/PublicWorksAndUtilities/TransportationEngineering/TEFilesThatLINKintoDWStoreHere/TEDS/TRANSITREGS.pdf.

This is a small guidebook that consists of two chapters. The first chapter provides information on bus stop spacing and location. The second chapter includes design guidelines on off street turnouts, on street stops, facility access and transit stop amenities.

Halback, H. (2000). *Customer amenities manual*. Orlando, FL: Central Florida Regional Transit Authority—LYNX. Retrieved Oct. 8, 2003, from http://www.golynx.com/pdfs/pubs_Amenities_Manual.pdf.

This manual intends to provide the reader with a clear means of identifying, analyzing and proposing solutions to LYNX transit facilities' design questions. The manual has been organized into sections from the broad to the specific. The first section describes the specific planning and physical properties of each of the five mobility stations within the LYNX system: the Local Transit Stop, the Primary Local Stop, the Superstop, the Transit Center and the Park and Ride. The second section deals with design standards influenced by the Americans with Disabilites Act, crime prevention through environmental design, green building materials, advertising, wayfinding devices, and public art. The third section describes other passenger amenities and site furnishings such as shelters, benches, lighting, bike storage, specialty paving, drinking fountains, restrooms, and newspaper stands.

Hillsborough Area Regional Transit. (1995). *Transit friendly planning and design handbook and technical manual*. Tampa, FL: Hillsborough Area Regional Transit (Hartline).

This handbook is intended to be used by planners, designers, developers, local city, county and state agencies as a guideline to the standards promoted by Hillsborough Area Regional Transit Authority (HART) within Hillsborough County. The handbook is a result of research of local, regional and federal requirements, as well as reviews of other research and surveys. The first section of the report deals with land use regulations and transit improvement measures that can significantly influence land use patterns and neighborhood revitalization. The second

section of the report addresses technical and engineering details of bus operations and maintenance. It provides design standards for bus facilities ranging from smaller to large sized facilities.

INCA Engineers. (2002). *MAG park-and-ride site selection study, design criteria: Revised draft report prepared for the Maricopa Association of Governments*. Retrieved Oct. 8, 2003, from http://www.mag.maricopa.gov/archive/PUB/Park-Ride/Report%20-%20Design%20Criteria%20Draft%205-%202-2000.pdf http://www.mag.maricopa.gov/archive/PUB/Park-Ride/design/Presentation%20-%20Design%20Criteria%20-%205-%202-2000_files/frame.htm.

The purpose of this document is to provide information concerning the guidelines and standards used by the RPTA [Regional Public Transportation Authority], and other agencies in the design of transit and ridesharing facilities. These guidelines are intended for use by state agencies, public works and planning departments, developers, and interested individuals. The study objective in providing this information is twofold. The primary objective is to encourage the inclusion of transit and ridesharing facilities in the initial design stages of freeway, roadway and new development. A secondary objective is to inform agency staffs how to site and design its facilities. Rather than presenting detailed engineering specifications for a park-and-ride facility, this document endeavors to provide an overview of the facility, including characteristics, basic dimensions, design criteria, and accepted standards. The dimensions presented in this document are intended as recommended standards. They may need to be modified in individual cases to meet site constraints or applicable local, state, and federal land use and permit requirements. Abstract taken from the author's introduction (p. 1).

Jackson, G. (1994). *Central Florida mobility design manual*. Orlando, FL: Central Florida Regional Transportation Authority, LYNX. Retrieved Oct. 8, 2003, from http://www.golynx.com/pdfs/pubs_mdm.pdf.

The *Central Florida Mobility Design Manual* is intended to be a working document illustrating basic mobility design actions to be considered at the design and review level of individual projects. The mobility actions present basic planning and design guidelines which are the foundation of a strategy that can influence the form of new growth and redevelopment in Central Florida.

The design manual is divided into two sections. The first section introduces basic design guidelines and functional requirements which illustrate how the physical design features of a project can help balance the overall transportation network. This includes pedestrian circulation, bicycle circulation, vehicular circulation, transit circulation, transit stops and terminals, building location, and building design.

The final section of the design manual demonstrates how specific guidelines for each design element can be successfully integrated into a comprehensive development review process. This section also documents the importance of revising transportation elements and land development regulations, and additional revisions to concurrency requirements, design standards, impact fees, and incentive programs that will ensure effective implementation of the mobility design guidelines. Abstract taken from author's introduction (p. 14).

Jacksonville Transportation Authority. (2003). *JTA mobility access program workbook*. Jacksonville, FL: Jacksonville Transportation Authority.

The handbook provides design guidelines for transit stops throughout Jacksonville's service area via Jacksonville's Transportation Authority's (JTA) Mobility Access Program (MAP). This program

contains two types of guidelines. The first standardizes certain design criteria in accordance with transit stop functional classifications. The second are flexible guidelines that permit adaptability of facility design criteria to specific community "sense of place" and contexts. The intended use for the guidelines are for local governments as part of their planning and zoning process, for developers needing to meet growth management requirements, and for communities seeking better transit accessibility and mobility. As part of MAP, the guidelines form the basis for neighborhood and transit joint development programs and for JTA's capital improvement process. Abstract by the author.

KFH Group Inc. (2001). *Arlington county bus stop design standards*. Arlington, VA: Arlington Transit. Retrieved Oct. 8, 2003, from http://www.commuterpage.com/pdfdocs/designstandard.pdf.

This is a draft copy of the Arlington County Bus Stop Design Standards. It presents design guidelines for bus stop design, location and amenities. It addresses specific details of designing bus stops like curb clearance, relationship to roadway, signage, right-of-way consideration, pedestrian connection, etc.

Maryland Department of Transportation. (1988). *Access by design: Transit's role in land development*: Mass Transit Administration.

This document has been published under the Access by Design program of Maryland DOT, which was initiated to promote better understanding of the transit industry. The manual explains the significant benefits of transit accessibility. It also reviews the goals and standards used by MTA (Mass Transit Administration) to make new service decisions. Finally, the manual provides important operational and design standards for specific transit facilities. It is intended for use by developers, planners, and engineers who recognize that designing for transit from project inception leads to better transit service in the future.

Metropolitan Transit Development Board. (1993). *Designing for transit*. San Diego, CA: Metropolitan Transit Development Board (MTDB).

Transit-oriented land development policies have led to a focus on integrating land development with proper transit planning. This handbook presents ways to design transit-oriented communities like changing the land mixes, integrating transit to community, proper design of street system, providing better pedestrian facilities, etc. It also outlays transit-oriented land development policies, which could be implemented by the local government to create better communities that provide a wide range of transportation options to its residents. It also provides engineering details and design standards for bus and light rail facilities. The handbook concludes that urban form is the primary determinate of whether transit is a desirable alternative to the automobile. For this reason the planning process must include the comprehensive consideration of transit, from policy through implementation.

North San Diego County Transit District Planning Department. (n.d.). *Design outlines for bus facilities*. Ocean Side, California: North San Diego County Transit District.

The purpose of this document is to provide a uniform guide for the design and placement of various bus related facilities and amenities. The guidelines are intended to provide individual design considerations for certain transit facilities rather than specify the complete engineering design of each element. The guidelines provide the criteria, dimensions, requirements, typical layouts and designs for the following types of transit improvements: bus stops, bus turnouts, bus layover areas, benches, shelters, park-and-

ride lots, transit centers, transfer terminals, bus turning radii and road grades.

Regional Public Transportation Authority. (1993). *Bus stop handbook–Street improvements for transit*. Phoenix, AZ: Regional Public Transportation Authority.

The intent of this manual is to provide the reader with accurate, authoritative and general guidelines as opposed to site-specific engineering, architectural, construction, legal or other information. The reader must adjust the information contained in the handbook to site-specific needs, constraints and applicable law, regulations and codes. The manual has been organized into sections from broad to specific issues. The first two sections describe the specific engineering details regarding the bus and the allowance to be provided in the sites and routes that will be catered by transit with land use recommendations. The next section deals with elaborate suggestions for passenger amenities and facilities essential to bringing about successful transit that complies with design standards influenced by the Americans with Disabilities Act, crime prevention through environmental design, advertising, way-finding devices, and public art. The last section describes other street priority treatments and the impacts of construction on bus operations. The report concludes with specific city requirements for bus transit.

Regional Transportation Commission of Clark County. (1999). *Citizens area transit bus stop guidelines*. Nevada: Regional Transportation Commission of Clark County.

This guidebook was adopted by the Regional Transportation Commission of Clark County on July 8, 1999. It presents approaches that might be undertaken by transit agencies to mitigate the impacts of construction or street closure during special events on bus stops. It also provides engineering details on bus stop and pad design, bus benches and bus shelters. The guidebook also presents cost details for bus stop and shelter construction and relocation.

Sacramento Regional Transit District. (1988). *Design guidelines for bus and light rail facilities*. Sacramento, CA: Regional Transit.

This guidebook provides placement and design guidelines for all of the following: bus stops, bus turnouts, bus shelters, bus benches, bus layover areas, bus berths, bus turnarounds, bus turning radii, roadway grades, exclusive bus lanes, bus priority traffic signals, park-and-ride facilities, transit centers, light rail track right-of-way, light rail stations, bicycle storage facilities, and information signs. It also gives project guidelines for placement of the transit facility in terms of access, location and density.

Seattle Metro. (1991). *Metro transportation facility design guidelines*. Seattle, WA: Municipality of Metropolitan Seattle. Retrieved Oct. 19, 2003, from http://dnr.metrokc.gov/WTD/library/mr4358-01.htm.

This document provides information concerning the guidelines and standards used by the Municipality of Metropolitan Seattle in the design of transit and ridesharing facilities. The guidelines intended users are state agencies, public works and planning departments, developers, and interested individuals. The document provides an overview of each facility, including a definition of facilities, methods of operation, basic dimensions, design criteria and accepted standards.

Sound Transit. (2003). *Sound transit online*. Retrieved Oct. 19, 2003, from http://www.soundtransit.org/stbusiness/facts/staccess/facilityDesign/stacsFacilityDsgn.htm.

Sound Transit is a public transit agency delivering a mix of rail and regional bus routes, as well as new transit facilities to the citizens of urban King, Pierce and Snohomish counties. The website provides guidelines on bus stop design, bus shelters, bus pads and bus berths along with illustrations of current and past transit projects within the agency's service area.

Tri-County Metropolitan Transportation District of Oregon. (1996). *Planning and design for transit handbook: Guidelines for implementing transit supportive development*. Portland, OR: Tri-County Metropolitan Transportation District of Oregon.

This handbook provides guidelines for implementing transit supportive land use and transportation plans, development projects, and street improvement projects in the Portland region. The handbook is presented in three sections.

The first section contains guidelines for land use and transportation plans that are more transit supportive. The second section contains guidelines for site and building design and provides guidance for the planning and design of development projects to maximize the effectiveness of pedestrian related project investments. The third section has guidelines for the design of bus related facilities on multimodal streets. It offers design standards for bus facilities on streets that accommodate the needs of pedestrians, bicycles, automobiles, trucks and transit vehicles.

Figure 6 - An outside waiting area at Central Plaza in St. Petersburg, FL.
Image from: Authors

BOOKS AND ARTICLES ON TRANSIT FACILITY DESIGN

The books and articles in this section provide two kinds of information: (1) fundamentals of transit planning and design from engineering and urban transportation perspectives, including facility design considerations, and (2) journal articles accounting for research and modeling results of the effects of specific design features (e.g., bus stop spacing, passenger waiting time, busways, etc.) on overall system performance.

Books by V. R. Vuchic (1981) and G. A. Giannopoulos (1989) are excellent sources of definitions, description and technical and engineering analyses of transit systems. Vuchic treats the subject with detailed descriptions of different transit modes while Giannopoulos devotes his entire book to urban bus planning and operations. Although Edwards' (1997) book on architectural design of modern stations focuses on rail, many aspects covered in this book are applicable to large bus station design, especially those related to site choice, station core and peripheral areas, security and public safety, route and timetable information, customer facilities, lighting, and environmental standards.

Books

DeChiara, J. (1975). *Urban planning and design criteria (2nd ed.)*. New York: Van Nostrand Reinhold Company.

Intended as a working guide, this volume is primarily graphical and pictorial, and supplements theoretical and critical writings on design through graphic reference of current standards, design details, analytical methods, and design procedures. This second edition volume adds material on urban design and environmental planning primarily to give basic or general standards of particular aspects of the urban scene. The standards are presented to assist in establishing general concepts or direction and to furnish a basis for further analysis and development in the complex planning process.

Edwards, B. (1997). *The modern station: New approaches to railway architecture*. London: E & FN SPON.

This book is a guide for the design, commission and management of railway stations. It attempts to set out the principles of good station architecture drawing upon recently built stations, others still on the drawing board, and those that have become classic models from the past. Although the book focuses on rail stations, many aspects of station design presented are applicable to bus stations, especially those related to site choice, station core and peripheral areas, security and public safety, route and timetable information, customer facilities, lighting, and environmental standards. The book balances technical and functional components with aesthetic aspects through ample drawings and diagrams complemented with concise text. The text ranges from siting a station within the urban context to the role of the smallest structural detail.

Giannopoulos, G. A. (1989). *Bus planning and operation in urban areas: A practical guide*. Vermont: Gower Publishing Company.

This volume is intended as "an easy-to-use guide" for bus transport planning and operations in urban areas, and examines major areas of bus operation by presenting main characteristics and current practices for such operation. The material is derived from two main resources: the author's own field of experience and an eighteen-month study dealing with the characteristics and proposed standards for bus operations in urban areas in Greece. Special emphasis is given to operations in developing countries where physical and human resources are limited. The volume

includes chapters on (1) organizational structure, (2) guidelines for service and operation planning processes, (3) service standards and evaluation processes, (5) networks and rolling stock specifications, (6) measuring demand and necessity, and (7) marketing and public information.

Mass Transit Administration. (1988). *Access by design: Transit's role in land development. A developer's manual*. Baltimore, MD: Mass Transit Administration, Maryland Department of Transportation.

This manual is intended to impart a transit perspective to land development. It's intended audience is local governments, developers, engineers and planners. It explains the significance of transit accessibility, reviews the goals and standards that the agency uses to make new service decisions, and provides operations and design standards for specific transit facilities.

Science Applications International Corporation. (1999). *Transit friendly design guidelines*. St. Petersburg, FL: Pinellas Suncoast Transit Authority.

This manual's objective is to assist the local metropolitan organization and local governments in implementing transportation decisions regarding transit, pedestrian, and bicycle mobility and accessibility. The design guidelines in this document intend to provide local design guidance to better integrate these modes of travel into the built environment. Section 2 provides roadway design standards for bus transit. Section 3 offers guidelines for auto, pedestrian, and bicycle access to transit stops. Section 4 includes a discussion of policies related to better land use and transit integration. Finally, Section 5 devotes attention to ways on how the manual guidelines can be implemented with suggestive regulatory language that local jurisdictions can adopt in their comprehensive plans and land development regulations.

Valley Metro. (1993). *Bus stop handbook*. Phoenix, AZ: Regional Public Transportation Authority.

The handbook was designed to respond to nine problem areas obtained from field observations and surveys of cities served by the Regional Public Transportation Authority. They are intended to be used by planners, designers, developers and agency officials and citizens. The purpose of the handbook is to promote convenient, comfortable and safe bus stops for bus patrons. "It is not intended to provide detailed engineering solutions. Rather, it serves as a general guideline or goal for redevelopment. Design solutions may need to be adjusted to fit site specific constraints and applicable codes. Abstract from the author's introduciton (p. 2).

Vuchic, V. (1981). *Urban public transportation*. Englewood Cliffs, New Jersey: Prentice Hall.

This book places a major emphasis on systematic description of the basic concepts, terms, and relationships, illustrated through the use of practical examples and applied models. The book is intended to serve transportation professionals working in academia, government or the transit industry.

Chapter 1 presents the historical development of transit and its impact on urban development. Chapter 2 offers the definitions and the theory of urban passenger transport modes. Chapter 3 covers theory of traction, characteristics of diesel and electric propulsion, analyses of vehicle motion, travel times, and energy efficiencies of different modes. Several chapters present detailed description and analyses of different transit modes focusing on their technical/ operational complexities and their roles in urban transportation. Of particular interest for this bibliography is Chapter 4 which covers bus and trolleybus

modes.

Yazhari, D. H. (1983). *Transit facilities standards manual: Alameda-Contra Costa Transit District*. Oakland, CA: Research and Planning Department, Alameda-Contra Costa Transit District.

The intended users of this manual are “local elected officials, civic and traffic engineers, city and transportation planners, developers and other citizens concerned with good transit services” (p. 1). The manual offers guidance in the design of facilities rather than technical engineering specifications with the expectation that the guidelines will encourage states, counties, cities and developers to include transit related facilities in their projects. The Transit District expects that the manual will assist in the incorporation of transit services in roadway and development plans. Thus, it includes criteria, dimensions, requirements and drawings with typical layouts for transit vehicle standards, geometric standards, operational and structural standards.

Figure 7 - Ottawa Transitway Station.
Image from: http://www.cutr.usf.edu/research/nuti/busway/Busway.htm

Journal Articles and Reports

Fitzpatrick, K. (2002). Alternative bus stop configuration: An analysis of the effects of bus bulbs. *Journal of Public Transportation, 5* (1), 19-37.

Bus bulbs are sections of sidewalk that extend from a curb of a parking lane to the edge of a through lane. A major advantage of using bus bulbs is the creation of additional space at a bus stop for shelters, benches, and other bus patron improvements when the inclusion of these amenities would otherwise be limited without the additional space. Several large cities on the West Coast have begun to explore bus bulbs as one of the many strategies used in developing a transit preferential program. Researchers visited four transit agencies that use bus bulbs (San Francisco, Portland, Seattle, and Vancouver) to observe and document existing and planned bus bulbs. Before and after studies were conducted to determine if there was a change in pedestrian traffic operations after the installation of the bus bulbs. The bus bulb design was clearly an improvement in pedestrian space as compared to the bus bay design. The average amount of available space for pedestrians and transit patrons alike, improved form 19 to 44 square feet per pedestrian after the bulb was constructed. The replacement of a bus bay with a bus bulb improved vehicle and bus speeds on the block. The block with the far side stop saw a statistically significant increase in vehicle travel speed during both non-peak and peak periods. Abstract by the author.

Fitzpatrick, K., & Nowlin, R. L. (1997). Effects of bus stop design on suburban arterial operations. *Transportation Research Record, 1571*, 31-41.

When choosing the location and design for a particular bus stop, several alternatives are available. These alternatives include nearside, farside, or mid-block locations, and curbside or bus bay designs. Several studies have focused on choosing the optimal location of a bus stop for given situations; however, few have investigated the effects of bus stop design. The objective is to use computer simulation to determine how bus stop design influences traffic operations around a bus stop. Bus stop designs analyzed included curbside, bus bay, open bus bay, and queue jumper. The results can be used to aid in the selection of a preferred bus stop design for a given location and traffic volume. The analysis was divided into two separate studies: curbside versus bus bay/open bus bay, and queue jumper versus non-queue jumper. The analysis consisted of investigating the relationships between variables such as travel time, speed and traffic volume for given bus stop designs and locations. The bus stop locations investigated in the curbside-bus bay/open bus bay study included mid-block and farside. Results indicated that the bus bay design provided the greatest benefit at traffic volumes of approximately 350 vehicles per hour per lane and above; however, notable advantages in vehicle speeds were also observed at 250 vehicles per hour per lane. Results from the queue jumper design provided significant benefits at volumes above 250 vehicles per hour per lane. Abstract by the authors.

Martinelli, D. R. (1996). A systematic review of busways. *Journal of Transportation Engineering, 122* (3), 192-199.

Busways are controlled-access facilities dedicated for bus service separated from general traffic. The concept of busways was first given serious consideration in the 1960s; however, only a few of them have been constructed in North America. This paper examines the potential of busway transit in providing urban environments with cost-effective mobility. The review makes the case that there are some misconceptions concerning the cost and level-of-service characteristics of busways. In the final

section, a comparison is made between busways and their most prominent competitor, light rail. The comparison is done in the framework of the four most cited advantages of light rail, and concludes that busways, in most cases, are likely to be a superior mode of transit to light rail. Abstract by the author.

Saka, A. (2001). Model for determining optimum bus stop spacing in urban areas. *Journal of Transportation Engineering, 127* (3), 195-199.

This paper proposes a model that can be used to determine effectively a sub-optimal policy for bus-stop spacing in urban areas. Transit users are usually interested in minimizing their out-of-vehicle travel time. Conversely, transit operators are interested in minimizing their fixed operating cost. Often, transit operators are required to make transit highly accessible to their patrons, because they operate under stringent budgets. This paper demonstrates, from a sensitivity analysis, that proper spacing of stops can significantly improve the quality of transit service, and decrease travel time, headway, and fleet size (i.e., number of buses). The Highway Capacity Manual, which contains a library of formulas for analyzing various transit performance measures, does not adequately address transit-stop spacing as a primary operational parameter. It is postulated in this report that optimal spacing of bus stops can reduce operating costs by minimizing the required number of buses in service. The proposed model is derived from the fundamental relationships that exist among velocity, uniform acceleration /deceleration, and displacement, and among the average bus operating speed, headway, required fleet size, and potential system capacity. The model can serve as a valuable decision support tool for transit planners in determining suitable spacing of bus stops for prevailing network and traffic conditions. Abstract by the author.

Salek, M.D., & Machemehl, R. B. (1999). *Characterizing bus transit passenger wait times* (SWUTC/99/167211-1). Austin, TX: University of Texas.

Mathematical models are developed to predict bus passenger waiting time components. A statistically significant quantity of waiting time data, including related passenger attributes, transit system characteristics and bus frequency, were collected by direct observation and video taping. The experimental data were collected a six-month period at several bus transfer centers and bus stations in the city of Austin, Texas. Measured wait time was decomposed into two components: “wait time before scheduled departure time” and “wait time after scheduled departure time”. The effects of bus frequency and reliability, as well as other potential predictors on wait time components, were examined by performing Analysis of Variance (ANOVA) and regression. Traditional and conceptual waiting time models were evaluated using this data set and compared to the new developed models. Abstract by authors.

Shen, D. L., Elbadrawi, H., Zhao, F., & Ospina, D. (1998). *At-grade busway planning guide* (NUTI95FIU1.2). Miami, FL: Florida International University. Retrieved Oct. 19, 2003, from http://www.cutr.usf.edu/research/nuti/busway/Busway.htm.

At-grade busways can be a major component of strategies designed to make better use of existing transit facilities with relatively low capital expenditures. The objective of at-grade busways is to attract auto drivers or other transit users from major traffic corridors by improving comfort, economy, travel time, and quality of transit services and providing express services that collect transit riders from residential neighborhoods and parking facilities. The main advantages of an at-grade busway transit system include flexibility, self-enforcement, incremental development, low construction costs, and implemen-

tation speed.

While it is important that the general public understands the technical aspects of at-grade busways, it is even more important that the potential users become aware of the enhanced quality of services provided by a busway system and its attractiveness in terms of shorter commuting time and minimal environmental impact. This report presents to transportation officials a guideline for planning and design consideration for at-grade busway systems. The report reviews planning procedure for selected busway systems in North and South America, Europe, and other developing countries. Design issues to assure a safer operation of at-grade busway systems are also presented in this report. The information presented in this report in general and it can be modified according to the needs of each transit agency. Abstract by the authors.

Figure 8 - A median, at-grade busway in Curitiba, Brazil
Image from: http://www.cutr.usf.edu/research/nuti/busway/Busway.htm

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2.2: Intelligent Transportation Systems (ITS)

Because the transportation system of many US cities is nearing capacity limitations, the National ITS Program expects intelligent transportation systems (ITS) to play a key role in improving congestion, transit ridership, mitigate the environmental impacts of transportation systems, and help save energy. This is a tall order indeed, and the U.S. Department of Transportation has commissioned many studies to monitor progress in the adoption and diffusion of ITS and to document the benefits and costs to transit agencies associated with the adoption of these technologies.

Two major publications in the 1990s, *TCRP Synthesis 24* by Board (1997) and USDOT-FTA's *Advanced Public Transportation the State of the Art Update '98* by Casey et al. (1998) described the extent of adoption of intelligent transportation (ITS) and advanced public transportation (APTS) systems by transit agencies. These systems have been incorporated into a variety of applications including (1) fleet management, (2) traveler information systems, (3) electronic fare payment, and (4) transportation demand management applications. However, as technological change is rapid and unpredictable, continuous updating and accounting of APTS evolution and their adoption by transit agencies seems to be constantly underway. A number of TCRP reports, TCRP syntheses, U.S.DOT publications, and journal articles have been produced since 2000. These generally focus on a specific APTS application (e.g., real-time bus arrival information systems, traveler information and way-finding systems, and bus signal priority systems.) and on documenting the experience of the transit industry regarding deployment, operational and organizational obstacles and costs and benefits associated with the specific application.

The summary below highlights general aspects of the most widely used ITS applications in transit systems.[1]

- ***Fleet Management***—for more effective vehicle and fleet planning, scheduling and operations.

  - Geographical information systems (GIS) applications in special request and special needs transportation.
  - Automatic vehicle location systems (AVLS)—vehicle tracking systems that use computers and satellite-based global positioning systems (GPS) technology to measures the real-time position of each vehicle and to relay the information to a central location.
  - Automatic passenger counters (APC) collect data on passenger boardings and alightings by time and location. In the 1990s transit agencies were installing new APCs integrated to AVL systems.
  - Transit operations software include a variety of applications such as dispatching and service monitoring integrated into fleet management software. These computer programs are designed to process the data provided by the APTS and

some of the most salient applications include: enhancing the effectiveness of operations, dispatching, scheduling, planning, and customer services.

- Traffic signal priority treatment (TSP). This technology holds green at an intersection so as to give priority to a bus passing through the intersection. Although TSP treatment has been in use for quite some time, it has run against traffic engineers' concerns with the delaying effect on overall traffic. New TSP treatment combined with AVL technology gives priority to only buses running behind schedule and have met with more acceptance from traffic engineers.

- ***Traveler Information Systems***—provide bus patrons with information before and during their trip. This information may be provided through the internet, in transit terminals, wayside stops on buses. Real time information about arrival and departure times and delays is typically the information more often offered by transit agencies.

  - Pre-trip information supports itinerary planning via the internet, hand-held-devices, and kiosks in terminals.
  - In-terminal and wayside transit information for bus patrons already en-route, includes real-time arrival and departure as well as the traditional static signs.
  - In-vehicle transit information, via automated annunciators and in-vehicle displays, has been provided to disabled passengers and to comply with the ADA. These systems provide audible and visual next-stop, major intersection, and transfer-point information. These innovations have been made possible by the use of AVL technology.

- ***Electronic Fare Payment***—transit authorities are using three types of fare payment media: magnetic stripe cards, credit cards, and smart cards. Consumers will embrace these technologies as e-commerce becomes more prevalent. However the lack of standardization resulting from the variety in electronic payment media, still poses an obstacle to regional transit fare coordination.

- ***Transportation Demand Management***—technologies aim to maximize the ability of transit and road networks to accommodate increased transportation demand. This is accomplished through various means as noted below.

  - Organized dynamic or real-time ridesharing (in which individuals request a ride to a ride-matching organization, with unsuccessful results) and casual car-pooling (in which informal carpooling networks have been more successful).
  - Automated service coordination utilizes APTS technologies to coordinate the service of multiple transportation providers in a region. Many transit agencies have added this technology to enhance their coordinating efforts . Thanks to this technology small transit agencies have been able to network with other transit providers in the region.
  - Transportation management centers (TMC) are (often virtual) facilities that function as communication and control centers of transit and traffic operations. These may include monitoring of traffic signal priority systems. In general most successful TMCs are found in the same building.

Technology	Deployment Level	Limiting Factors	Comments
Automatic vehicle location	Moderate Deployment	Cost, fleet size, service type, staff technological competence	**Successful–**use continues to grow, new systems principally use GPS technology but usually augmented by dead reckoning
Operations software	Widespread Deployment	N/A	**Successful**
Fully automated dispatching for demand response	Research & Development*	Still in research and development stage	**Jury is still out**
Mobile data terminals	Moderate Deployment*	Most frequently deployed with automatic vehicle location systems	**Successful**–reduces radio frequency requirements
Silent alarm/covert microphone	Moderate Deployment*	Most frequently deployed with automatic vehicle location systems	**Successful**–improves security of transit operations
Surveillance cameras	Limited Deployment*	Cost	**Holds promise**–enhances on-board security, deters vandalism
Automated passenger counters	Limited Deployment	Cost	**Holds promise**–provides better data for operations, scheduling, planning, and recruiting at lower cost
Pre-trip passenger information	Widespread Deployment	N/A	**Successful**–improves customer satisfaction
En-route and in-vehicle passenger information	Limited Deployment	Cost, lack of evidence of ridership increases	**Jury is still out**
Vehicle diagnostics	Limited Deployment	Cost, lack of data on benefits	**Jury is still out**
Traffic signal priority	Limited Deployment	Institutional issues, concerns about impacts on traffic flows	**Holds promise**–reduces transit trip times. May reduce required fleet size
Electronic fare payment	Limited Deployment	Cost	**Holds promise**–increases customer convenience

*Quantitative deployment tracking data not available. Deployment level determined by expert judgment

Figure 9 - Advanced Public Transportation Technologies Evaluated
From: Casey, R. A. *What have we learned about advanced public transportation systems?* (Chapter 5) Washington DC : U.S. Department of Transportation

- High occupancy vehicle (HOV) facility monitoring.

Perhaps the most useful ITS deployment studies for the small transit agency are those reports generally by large transit agencies that synthesize transit practices such as TCRP syntheses, and those that review lessons learned, about APTS implementation. Table 6 summarizes what has been learned about advanced public transportation systems for twelve technology applications.[2] These are evaluated according to deployment level, limiting factors and attained level of success. Of these, operations software and pre-trip passenger information technologies have been widely deployed, while surveillance cameras, automated passenger counters, en-route and in-vehicle passenger information, traffic signal priority and electronic fare payment have encountered limited adoption for a variety of reasons. Common among these are high cost, absence of clear benefits (e.g., no evidence of increased ridership), and institutional issues.

In this section we grouped the annotated literature in three general areas: (1) reports and articles devoted to the assessment of various ITS technologies adopted by transit agencies; (2) reports and articles dedicated to the evaluation of traveler information systems—including real-time bus arrival and web-based itinerary planning; and (3) articles and reports on transit accessibility and operations applications such as ITS related to pedestrian and ADA applications and bus signal priority systems.

GENERAL STUDIES OF ITS ADOPTION BY TRANSIT AGENCIES

Blythe, P., Rackliff, T., Holland, R., & Mageean, J. (2000). ITS applications in public transport: Improving the service to the transport system user. *Journal of Advanced Transportation, 34* (3), 325-345.

This paper examines all the disparate technologies and techniques capable of smoothing the integration of public transport modes and services at both the urban and interurban scale. The paper focuses on the application of information technology and telematics solutions which have been designed to create as seamless a journey as possible from the point of view of the transport system user. The scope of the paper is therefore deliberately wide-ranging and includes an examination of measures as apparently unconnected as smartcard ticketing, bus priority systems, automatic vehicle locationing, trip planning and on-board information systems as well as new public transport services offering demand responsive travel and integration with taxi services. The paper intends to show how such technological solutions can be used to increase the attractiveness and competitiveness of fixed public transport networks in comparison to the door-to-door flexibility of the private car. Abstract by the authors.

Board, T. R. (1997). *AVL systems for bus transit* (TCRP Synthesis 24). Washington, DC: Transportation Research Board. Retrieved Oct. 6, 2003, from http://www.fta.dot.gov/research/pdf/s24.pdf.

This synthesis focuses on AVL [automated vehicle location] issues related to the workhorse of the transit fleet, the bus, and examines the range of implementations, benefits, and institutional issues associated with planning, designing, implementing, operating, and maintaining AVL systems for fixed-route bus transit. Since 1969, more than 20 U.S.

transit agencies have implemented AVL systems for fixed-route bus transit, and many more agencies are investigating the possibility of bringing in AVL to assist in managing their fleets. Interest in AVL for fixed-route bus transit is not limited by transit agency size or community type, although a majority of respondents to a survey of transit agencies in the United States and Canada conducted for this project operate in an urban environment. . . . As costs for GPS receivers declined, GPS has become the most popular technology for AVL applications. . . .Respondents indicated that the primary objective for procuring AVL was to improve customer service. Through increased service reliability, improved safety and security, and use of bus status information, agencies are using AVL to attract new riders, disseminate real-time information to their customers, improve their operations, and maximize use of performance data throughout their organizations. Abstract taken from author's introduction (p-1-2).

Casey, R. F., Labell, L. N., Carpenter, E. J., LoVecchio, J. A., Moniz, L., Ow, R. S., et al. (1998). *Advanced transportation systems. The state of the art, update '98*. Cambridge, MA: Volpe National Transportation Systems Center. Retrieved Oct. 9, 2003, from http://www.fta.dot.gov/research/pdf/aptssoa98.pdf.

This report describes the extent of adoption of new technologies in the public transportation industry. It is the latest in a series of State-of-the-Art reports, the last of which was published in January 1996. It contains the results of an investigation of the extent of adoption of advanced technology in the provision of public transportation service in North America. It focused on some of the most innovative or comprehensive implementations, categorized under four types of services/technologies: Fleet Management, Traveler Information, Electronic Fare Payment, and Transportation Demand Management. The objective of this effort was to increase the industry's knowledge of successful applications of advanced technologies with the expectation that this will lead to their widespread adoption. Abstract by the authors.

Casey, R. F. (2000). What have we learned about advanced public transportation systems? *What have we learned about ITS?* (pp. 88-105), Retrieved Oct. 9, 2003, from http://www.itsdocs.fhwa.dot.gov/jpodocs/EDLBrow/@@101!.pdf.

This paper discusses advanced public transportation systems (APTS) technologies, assesses the extent of their deployment, and judges their degree of success. It covers advanced APTS technologies in use by bus and demand-response service operations. The primary source of deployment-level information is a 1998 survey by the John A. Volpe National Transportation Systems Center (Volpe Center) that encompassed 525 transit agencies operating fixed-route bus and/or demand-response services.

In spite of the lack of quantified benefits, transit agencies that have deployed or will soon deploy APTS technologies have concluded that potential benefits of the added functions and services that these technologies provide outweigh the capital and operating expenses. Several transit agencies have stated that a principal reason for installing APTS technologies is to help them provide better service for customers and safer service for both customers and vehicle operators.

Despite measured benefits and other benefits realized but not measured, many agencies are not considering APTS technologies. Possible reasons include cost (although some less sophisticated, low-cost APTS systems are available), a lack of awareness of benefits, small fleet size, type of service provided, resistance to change, and absence of personnel knowledgeable about APTS. Nevertheless, APTS technology deployments increased substantially

between 1995 and 1998. Deployments are expected to continue to increase faster for those making up the more basic elements of APTS deployments (e.g., automatic vehicle location, operations software, mobile data terminals, silent alarms, and covert microphones). Also, greater use of AVL data is expected in the areas of real-time service adjustments, scheduling changes, route planning, and customer information. Abstract by the author.

Hickman, M., & Jeong, R. (2001). *Economic evaluation of transit bus design standards* (SWUTC/01/167407-1). College Station, TX: Texas A&M University System. Retrieved Oct. 10, 2003, from http://swutc.tamu.edu/Reports/167407-1.pdf.

The research in this report investigates the perceptions of ITS standards for the public transit industry. The public transit industry has a rather colorful past in standardization, and this experience is reviewed with an eye toward lessons that might be applied to transit ITS standards today. Particular examples of standardization include the PCC car from the 1930's, the Transbus program of the 1970's, and the subsequent White Book. To complement this historical review, a survey of transit agencies regarding recent transit standards was conducted. In particular, transit agency experience with the J1708/J1587 standard for on-board electronics, and with the recent Standard Bus Procurement Guidelines, was investigated. Both the historical review and the survey results suggest that there are some primary factors that affect whether transit design standards are successful; i.e., whether they improve technical compatibility and reduce costs. Based on these factors, recommendations for the current transit ITS standards efforts are suggested. Abstract by the authors.

Khattak, A. J., Noeimi, H., & Al-Deek, H.M. (1996). A taxonomy for advanced public transportation systems. *Journal of Public Transportation, 1* (1), 39-64.

This study explores the development and availability of APTS (Advanced Public Transportation Systems) technologies. APTS technologies can revitalize transit by directly improving service, increasing transit efficiency and reducing operating costs, as well as by producing direct benefits for travelers such as reduced travel times, increased safety and security, and reduced stress in dealing with transit unreliability. To understand APTS impacts, this study develops a taxonomy of transit technologies and uses it to explore the availability of new technologies and their impacts. The taxonomy is based on defining the features, functions, and performance characteristics of transit technologies. Further, the implementation of new technologies can be described by their spatial, temporal, and user dimensions, i.e., where, when, and for whom is the technology implemented. These dimensions, along with the implementation context, determine the impacts of APTS technologies. To explore the availability of APTS technologies, technology suppliers were surveyed. They were asked about the features, functions, and performance of transit technologies, their testing and deployment in transit agencies, and their potential impacts on travelers and transit operators. The survey results suggest a trend toward transfer of data in real-time through electronic media and increased automation. It was found that about a dozen APTS technologies queried in the survey were commercially available for field testing. From a policy perspective, there is a need to develop a strategy that considers the individual and joint testing of two or more APTS technologies and facilitates synthesis of the resulting information. Individually, the benefits of APTS technologies may be limited, but, collectively, APTS technologies may have significant benefits. Cases of joint APTS technology implementations need to be

designed, implemented and synthesized. Abstract by the authors.

Krouk, D. (2002). Don't stop that bus. *Planning, 68,* 12-17.

GPS technology is increasingly being used for Automatic Vehicle Location (AVL) in public transit. Its positional information provides a foundation for a wide range of technologies benefiting both transit systems and the traveling public. This article describes some of the exciting applications of GPS technology in public transit and what it means as more and more agencies adopt these systems. We will look in particular at transit systems in Denver; Portland, Oregon; Chicago; and Rehoboth, Delaware. Abstract by the author.

Maccubbin, R. P., Staples, B. L., & Mercer., M. R. (2003). *Intelligent transportation systems benefits and costs: 2003 update* (FHWA-OP-03-075). Washington DC: Federal Highways Administration, U.S. Department of Transportation. Retrieved Oct. 9, 2003, from http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/13772.html

The increasing demand for travel by highway and public transit in the United States is causing the transportation system to reach the limits of its existing capacity. Intelligent Transportation Systems (ITS) can help ease this strain through the application of modern information technology and communications. This report is a continuation of a series of reports providing a synthesis of the information collected by the United States Department of Transportation's ITS Joint Program Office on the impact that ITS projects have on the operation of the surface transportation network. New in this 2003 report is the inclusion of cost information for representative ITS deployments; previous reports contained only benefits information. Information in this report is drawn from the ITS Benefits and Unit Costs Database, a regularly updated repository of such information, available on the Internet at http://www.benefitcost.its.dot.gov/. The report presents material from the database that describes the impacts and costs of the intelligent transportation infrastructure as well as intelligent vehicle applications. Abstract by the authors.

Sussman, J. M. (2000). What have we learned about ITS? A synthesis. *What have we learned about ITS* (pp. 1-20)? Washington DC: U.S. Department of Transportation. Retrieved Oct. 21, 2003, from http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/@9w01!.pdf

This study is concerned with what we have learned about ITS. But ITS is composed of many technologies and applications, some of which are more successful than others. So, in a disaggregate manner, this study examines which ITS technologies and applications have been successful, which have not, and for which more information is needed to make a judgment. Of further interest are the characteristics that distinguish successful from unsuccessful applications in the ITS world. If they can be identified, then we can more effectively plan the future of the National ITS Program, building on that knowledge.

The areas included within the scope of this study are as follows:

- Freeway, Incident, Emergency Management, and Electronic Toll Collection (ETC)
- Arterial Management
- Traveler Information Systems
- Advanced Public Transportation Systems
- Commercial Vehicle Operations (CVO)
- Cross-Cutting Technical Issues
- Cross-Cutting Institutional Issues.

Abstract by the author.

ELECTRONIC PAYMENT SYSTEMS
Electronic payment systems employ various communication and electronic technologies to facilitate commerce between travelers and transportation agencies, typically for the purpose of paying tolls and transit fares.

Benefits

Evaluation of the smart card electronic payment system in Ventura, California, indicated potential savings of $9.5 million per year in reduced fare evasion, $5 million in reduced data collection costs, and $990,000 in transfer slip elimination.

Costs

System Costs	The Ventura County Transportation Commission, in California, implemented an electronic fare payment system on its buses. The "Go Ventura" card allows transit riders to use a smart card for fare payment. The card can be used on buses run by the county's six transit systems.	Project cost: **$1.7** million (2001)

From: Maccubbin et al. (2003). *Intelligent Transportation Systems Benefits and Costs: 2003 Update.* http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/13772.html

Figure 10

TRANSIT MANAGEMENT SYSTEMS

Transit ITS services include surveillance and communications, (such as automated vehicle location (AVL) systems), computer-aided dispatch (CAD) systems, and remote vehicle and facility surveillance cameras, (which enable transit agencies to improve the operational efficiency), safety, and security of the nation's public transportation systems.

Benefits

The GPS-based AVL system in Denver, Colorado rated very well with Regional Transportation District (RTD) dispatchers. Operators and dispatchers were able to communicate more quickly and efficiently. Approximately 80% of dispatchers found the system "easy" or "very easy" to use, and about 50% of operators and street supervisors felt likewise. The system succeeded in improving bus service by decreasing the number of passenger late arrivals by 21%.

Costs

System Costs	The Denver RTD installed the AVL system on its 1,355-vehicle fleet. Capital costs include system software, dispatch center hardware, in-vehicle hardware, field communication equipment, initial training, and planning and implementation.	Capital cost: **$10.4** million (approx.) Annual Operations & Maintenance (O&M) cost: **$1.9** million (approx.) (1997)

From: Maccubbin et al. (2003). *Intelligent Transportation Systems Benefits and Costs: 2003 Update.* http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/13772.html

Figure 11

TRAVELER INFORMATION SERVICES

Real-time Bus Arrival

Schweiger, C. L. (2003). *Real-time bus arrival information systems: A synthesis of transit practice* (TCRP Synthesis 48). Washington DC: Transportation Research Board. Retrieved Oct. 9, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_syn_48.pdf.

This synthesis describes the state of the practice in real-time bus arrival information systems, including both U.S. and international experience. The panel for this project chose to focus on bus systems, rather than all transit modes, and on the following six key elements of these systems:

- Bus system characteristics;
- Real-time bus arrival information system characteristics, including information about the underlying technology and dissemination media;
- System prediction, accuracy, and reliability;
- System costs;
- Customer and media reactions; and
- Institutional and organizational issues associated with the system.

This report includes a review of the relevant literature, in addition to the results of a survey that was conducted as part of this project. The survey covered items from the six key elements listed previously, including the technical capabilities of the systems, agency experience, cost, and bus rider reactions to these information systems. This synthesis also contains the results of interviews with key personnel at agencies that have implemented or are in the process of implementing these systems . . . .The survey covered the following most fundamental elements of deploying a real-time bus arrival information system: characteristics of the underlying AVL system, type of media distributing the real-time information, how real-time information is predicted, relative costs of the system, customer and media reaction to the system, and institutional and organizational issues associated with the system. Surveys were received from 18 transit agencies from around the world, including 9 from the United States. The U.S. responses represented agencies that carry a total of more than 428 million fixed-route bus passengers annually. Abstract by the author.

Strathman, J., Callas, S., Kimpel, T., Dueker, K., & Gerhart, R. (2002). Dynamic bus arrival time prediction with artificial neural networks. *Journal of Transportation Engineering, 128* (5), 429-438.

Transit operations are interrupted frequently by stochastic variations in traffic and ridership conditions that deteriorate schedule or headway adherence and thus lengthen passenger wait times. Providing passengers with accurate vehicle arrival information through advanced traveler information systems is vital to reducing wait time. Two artificial neural networks (ANNs), trained by link-based and stop-based data, are applied to predict transit arrival times. To improve prediction accuracy, both are integrated with an adaptive algorithm to adapt to the prediction error in real time. The bus arrival times predicted by the ANNs are assessed with the microscopic simulation model CORSIM, which has been calibrated and validated with real-world data collected from route number 39 of the New Jersey Transit Corporation. Results show that the enhanced ANNs outperform the ones without integration of the adaptive algorithm. Abstract by the authors.

Internet-based Itenerary Planning

Multisystems Inc., & Coogan, M. E. (2003). *E-transit: Electronic business strategies for public transportation volume 4: Advanced features of transit websites* (TCRP Report 84). Washington DC: Transportation Research Board. Retrieved Oct. 23, 2003, from http://www4.trb.org/trb/onlinepubs.nsf/web/tcrp_report_84v4toc.

The objective of this report was to identify and document lessons learned regarding the potential of incorporating advanced web features into the transit industry. The focus is on automated itinerary planning systems, real-time transit information, e-mail notification, and the application of customer relationship management concepts to theses services. The web features were reviewed in the context of customer relationship management. The report provides an overview of the implementation, technology, value creation, lessons learned, and best practices associated with web-based advanced features. The study findings reveal that an investment in advanced website features offers the potential to provide significant benefits to the customer and the transit industry. Abstract by the authors.

Multisystems Inc. (2003). *Strategies for improved traveler information* (TCRP Report 92). Washington DC: Transportation Research Board. Retrieved Oct. 9, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_92.pdf.

The objective of this research was to identify strategies for using information technology to improve individual mobility related decision making. The project's focus was on how public transportation providers can most effectively provide [traveler transportation information] (TTI), specifically, on how public transportation agencies can take maximum advantage of new and emerging technologies to better inform travelers about mobility choices. The research identified traveler information needs, assessed the state of the art in TTI systems, and developed a number of case studies in the area of improved traveler information.

To fulfill the primary objective of this research, this report presents a summary of existing practice in the area of improved traveler information. Examples are given of how public transportation providers can become part of region based and/or community-based information dissemination systems that include-but are not limited to-hand-held, vehicle-mounted, kiosk-based, and web-based communications.
The [report] provides information on the following:

- The demand for TTI,
- The state of the art in providing TTI,
- Examples of providing customer information in related industries,
- TTI as part of community information systems, and
- New directions for transit in providing traveler information. Abstract by the author.

Smith, B. L. (2000). Using geographic information systems and the world wide web for interactive transit-trip itinerary planning. *Journal of Public Transportation, 3* (2), 37-50.

Providing high-quality service information is important in attracting and retaining public transportation passengers. Currently, information provided to support transit-trip itinerary planning is either difficult to use or to access. Furthermore, after obtaining the information, passengers are required to perform a fairly complex search process to extract an itinerary. Two technologies that are becoming commonly used in public transportation, Geographic Information Systems (GIS), and the World Wide Web (WWW), offer capabilities to

provide an easily accessible, highly functional tool for trip itinerary planning. This research effort investigated the feasibility of integrating these emerging technologies to produce a transit-trip itinerary planning tool. Abstract by the author.

TRANSIT ACCESSIBILITY AND OPERATIONS

Pedestrian and ADA ITS Application

Bentzen, B. L. (1999). Wayfinding system for transportation services: Remote infrared audible signage for transit stations, surface transit, and intersections. *Transportation Research Record, 1671*.

Results show that remote infrared audible signage provides effective way-finding information for using transit stations, surface transit, and intersections, thereby enhancing independent use of public transit by people who have visual impairments or cognitive disabilities.

Boyce, P., & Derlofske, J. V. (2002). *Pedestrian crosswalk safety: Evaluating in-pavement, flashing warning lights*. New Jersey: Rensselaer Polytechnic Institute. Retrieved Oct. 9, 2003, from http://tid1s0.engr.ccny.cuny.edu/utrc/CrosswalkSafety.pdf

This study...demonstrates that both crosswalk striping and flashing lights enhance the noticeability of a crosswalk and both reduce the conflict of pedestrians and vehicles. The difference between the two methods lies in the mean speed at which vehicles approach the crosswalk. The lights reduced this speed, but there was no reduction of speed when approaching a conventionally striped crosswalk. The study concludes with recommendations for the use of in-pavement, flashing warning light signals at crosswalks. Abstract by the authors.

Sarasua, W., Awuah-Baffour, R., Fawley, M., Byars, C., & Orton, J. (1997). Design and development of a bus stop inventory to support an intelligent transportation system: The MARTA experience. *Journal of Public Transportation, 1* (4), 61-80.

Bus stops are a critical element in any transit system. The advent of Intelligent Transportation System (ITS) technologies in the area of transit has developed a need for transit agencies to keep an up-to-date inventory of bus stop data. Unfortunately, most transit agencies do not have a bus stop inventory that can adequately support Advanced Public Transportation System (APTS) applications, and many other transit agencies do not have an inventory at all. The design, development, and maintenance of a bus stop inventory that will support an array of available APTS applications is described in this paper. Procedures used in the development of the Metropolitan Atlanta Rapid Transit Authority bus stop inventory are highlighted. The lessons learned from MARTA's experience should be valuable to other transit agencies that are planning to or are in the process of implementing an APTS. Abstract by the authors.

Bus Signal Priority

Chada, S., & Newland, R. (2002). *Effectiveness of bus signal priority final report* (NCTR-416-04). Tampa, FL: National Center for Transportation Research, University of South Florida. Retrieved Oct. 9, 2003, from http://131.247.19.1/bus%20signal%20priority/css/bus%20signal%20priority%5F3.htm

Effectiveness of Bus Signal Priority (BSP) study evaluates BSP's impact on traffic operations. The goal was to examine how different situations, such as the level of congestion, placement of bus stops, presence of express bus service, and number of transit vehicles on route, require different techniques of BSP such as real-time or fixed-time based control. Those techniques also utilize a variety of different control strategies such as phase suppression, synchronization, compensation, and green recall. In order to guide transportation agencies in this decision-making process, a framework for an ideal bus priority system was developed. Based upon that information, the "Pre-Implementation Checklist" was designed. The checklist focuses on the most critical factors in BSP and recommends pursuing BSP if an area has enough characteristics in place to make BSP effective. A set of "Operational and Design Guidelines" for BSP were developed to assist an agency in choosing the most appropiate BSP method that complements the area characteristics. To establish how BSP can be most effective, ten transit professionals (planners and engineers) involved in installing BSP projects were interviewed. Five agencies utilizing BSP around the country were studied to determine which types of priority are used in certain conditions and what technology is being implemented. Abstract by the authors.

Garrow, M., & Machemehl, R. (1999). Development and evaluation of transit signal priority strategies. *Journal of Public Transportation, 2* (2).

Research describing the effectiveness of providing signal priority to transit vehicles is presented. Results from previous studies indicate that the effectiveness of transit signal priority depends on a number of factors, including the type of transit route, the transit usage level, and the time of day. This research describes and evaluates several transit signal priority provision methods during both peak and off-peak times. Results indicate that providing signal priority during off-peak times is often justified, due to excess capacity available within the transportation network. However, during peak times, transit signal priority use is justified only when the transit usage level is high.

Vuchic, V. R., & Stanger, R. M. (2001). Urban transit at the beginning of the 21st century. *Journal of Advanced Transportation, 35* (1). Retrieved Oct.12, 2003, from http://www.advanced-transport.com/Millennium_Vuchic_Stanger.htm

The paper reviews the development of urban public transit over the 20th century. The trends from the last decades are used to forecast the direction of transit and its likely role in the new century.

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2.3: Bus Passenger Facilities

This section offers brief information about bus terminal and station facilities that have been highlighted in the media or that have been recently featured in the Internet. Thy are illustrative of the size and type of discrete facility projects that generally fall outside the scope of most transit facility design guidelines and for which the literature generally combines rail and bus station design considerations. The purpose of this selection is to be illustrative and offers no specific evaluation or endorsement of the quality of design represented by the facilities. In this respect, the reader is referred to the publication (included in this section) *Neighborhood Intermodal Transfer Facilities* by Land and Foreman and published by the National Center for Transit Research (CUTR). This study offers a six-case-study evaluation of neighborhood-scale intermodal facilities and their requirements for effectiveness.

City of Montpelier. (2003). *Carr lot redevelopment project: Multi-modal transit center and confluence park*. Retrieved Oct. 6, 2003, from http://www.montpelier-vt.org/wip/carrlot/vision.htm.

The new multi-modal transit center will include many comforts for the transit user including bicycle storage racks, lockers, visual access to the Winooski river, and protected platform areas. Also included will be office space and access to van pools and taxis. The building design fits with the current style of downtown Montpelier, and half of the building site is reserved for park space with walking paths, benches, and tables.

City of Sacramento Downtown Development Department. (2001). *Preliminary concept*. Retrieved Oct. 6, 2003, from http://www.racestudio.com/sdepot.html.

The Preliminary Concept for the 37.5 acre Intermodal Station Area balances the community's preservation, economic development and transportation objectives. The Concept uses the historic depot as its centerpiece; provides for a long range and phased solution for transit; and creates a new accessible address that complements downtown. Abstract by the author.

Doncaster City Government. (2003). *Frenchgate Interchange Doncaster*. Retrieved Oct. 6, 2003, from http://www.frenchgateinterchange.co.uk/enhanced/main.htm.

This website includes detailed, computer-generated walkthroughs of the development of the Frenchgate Interchange and information on its benefits to passengers, specifically disabled passengers. The Interchange will be the main bus terminal for the city.

Figure 12 - Frenchgate Interchange, Doncaster, England.
Image from: http://www.frenchgateinterchange.co.uk/enhanced/plan.htm

Figure 13 - Quincy Street Station, Topeka, KS.
Image from: http://www.cjnetworks.com/~toptrans/

Henrikson, A. (2002, September 24). Bus service creates transfer hub. *Topeka Capital Journal*. Retrieved Dec. 15, 2003, from http://www.cjonline.com/stories/092402/inv_bustransfer.shtml

The new terminal for the Topeka Metropolitan Transit Authority is under construction at S.E. 9th and Quincy. With a stone structure and columns, the Quincy Street Station could be seen as just a bus transfer station. But Topeka Metropolitan Transit Authority General Manager Ron D. Butts sees the new bus transfer station as a stabilizer for the bus service. The station should open sometime in late February or early March. Construction on the bus transfer station began Dec. 18, 2002.

Cost of the project is about $3.7 million. Eighty percent of the cost has been covered by a grant from the Federal Transit Administration. Topeka Transit, which is a taxing entity, has been able to do the 20

Figure 14 - Marion Transit Center, Tampa, FL.
Image from: http://www.hartline.org/

Figure 15 - Fisher's Landing, Clark County, FL.
Image from: http://www.nctr.usf.edu/pdf/Intermodal%20Facility.pdf

percent local match primarily from property taxes. Bus stops for Topeka Transit's routes have been located at several spots around 8th and Kansas Avenues. Passengers transferring from one bus to another sometimes have to walk two blocks between buses. Butts considers the journeys people have to make from bus to bus unfriendly and unsafe for riders. The transfer facility will put all connecting routes in one place.

Bus transfers currently occur at the intersection of S.W. 8th and Kansas. If the area is under construction or a parade is scheduled, the location of the transfers has to change slightly. That can be inconvenient for riders and delay buses, Butts says. Another benefit of the station is that buses will take up less room in the intersection of S.W. 8th and Kansas. The space used for buses along Kansas Avenue has been a complaint of downtown merchants because they take up areas that could be used for parking.

Hillsborough Area Regional Transit. (2003). *Customer amenities at the Marion Transit Center*. Retrieved Oct. 6, 2003, from http://www.hartline.org/.

The Marion Transit Center offers many amenities. For transit users, there are trellis-covered walkways to the bus bays, garden areas outside of the building, and customer service amenities including information kiosks and customer service representatives. The design of the building incoporates historical architectural details and displays of public art.

Land, L., & Foreman, C. (2001). *Neighborhood intermodal transfer facilities* (NCTR-392-16). Tampa, FL: National Center for Transit Research. Retrieved Oct. 6, 2003, from http://www.nctr.usf.edu/pdf/Intermodal%20Facility.pdf.

This report contains specific examples of intermodal transfer facilities of various types and scales. The facilities were evaluated on how well each was developed with regard to coordination of modes, physical location, design, and safety. Other factors that were considered were service reliability, user satisfaction, physical attractiveness, community acceptance, and costs. The facilities' attributes are described and advantages and disadvantages of each are discussed. The facility types that are relevant to the bus study are:

1) Local stops: Margate Terminal in

Margate, Fl and the Washington Shores Superstop in Orlando, FL.

2) Park-and-Ride Facilities: GI Joe Tri-Met Park-and-Ride Facility in Portland, Oregon
3) Transit Centers: Fisher's Landing in Vancouver and Columbia Station in Wenatchee, Washington.

LYNX. (2003). *LYNX central station*. Retrieved Oct. 6, 2003, from http://golynx.com/whatshappening/central_station.htm.

A new facility being built to function as the Downtown Orlando Bus Station will incorporate many improvements from the former building. Included in the plans are walkways to increase safety for passengers accessing the bus bays and over 2,400 square feet of retatil space for restaurants and shops. The design will also include an increased number of bus bays to increase on-time departures and eliminate inefficiency.

Project for Public Spaces. (2003). *Staples Street Bus Station*. Retrieved Oct. 6, 2003, from http://www.pps.org/gps/one?public_place_id=113.

Corpus Christi's Regional Transportation Authority (RTA) found that by making people-friendly improvements to such transit centers, it is able to reach beyond the boundaries of building typical bus stops to the larger goal of helping to reshape communities. The Staples Street station brings more passengers to the area, thereby encouraging economic activity. Inside, it provides enhanced passenger services, greater comfort, and a sense of safety and community among users and staff, as well as further opportunities for retail development. The Staples Street Bus Station was well-received throughout the city, and acclaimed around the U.S. as the embodiment of a groundbreaking approach to the design of transit facilities. Abstract by the author.

Figure 16 - LYNX Central Station, Orlando, FL.
Image from: http://www.downtownorlando.com/pdf/new_dev/lynx.pdf

Figure 17 - Staples Street Bus Station, Corpus Christi, TX.
Image from: http://www.pps.org/gps/one?public_place_id=113#

Rochester-Genesee Regional Transportation Authority. (2003). *Rochester Central Station.* Retrieved Oct. 6, 2003, from http://www.rochestercentralstation.com

The Rochester Central Station seeks to provide a comfortable environment for teh transit user by offering a climate-controlled indoor area that is safe. The building includes retail space, underground bus bays, and free direct shuttle service to the airport, Amtrak, and the Fast Ferry.

Rosenberg, E., & Araki, G. (2003). *The bus stops here. Why the bus stop?* Retrieved Nov. 3, 2003, from http://www.the-bus-stops-here.org/why.html http://www.the-bus-stops-here.org/index.html.

The authors of this website have worked or are currently working for public transit agencies. This website features a great variety and number of transit agencies, located primarily in the West Coast, with photos of their bus stop facilities.

One of the objectives "of this page is to show the variety of amenities chosen by different districts so that people can use it as a reference when looking for new shelters, benches, etc. It is hard to find pictures of what they look like in the field. Most of the sales brochures show them in perfect condition in ideal lighting. We are attempting to show them as they look after they have been installed. We are also trying to show how each district chooses to represent itself to the riders. This will include the type of bench they use, what trash cans they choose, the shelters, info signs, and what their buses look like."

Saunders, M. (2003). *Reading the road signs.* Retrieved July 11, 2003, from http://www.pointssouth.net/the_woods/000216.htm.

This journal article published by Points South, of the the Poynter Institute in St. Petersburg, FL describes Pinellas Suncoast Transity Authority's Central Plaza new bus transfer facility and the experience of bus riders from the nearby neighborhood of The Woods. For bus riders, the author declares, "bad weather and traffic jams translate into slow buses and missed transfers that create a complicated commute."

Wisconsin Department of Transportation Research Board. (2003). *Milwaukee intermodal station.* Retrieved Oct. 6, 2003, from http://www.pmainc.com/pdf/pma_intermodal.pdf.

The new intermodal station will serve as a "one stop shop" for all area public transportation needs including rail, inter-city bus, public transit, taxi and shuttle vans; and will additionally feature an extensive range of top national brands of retail products and services. Interactive ad displays, kiosks and tourist information on local venues and attractions will also be incorporated into the facility. Abstract by the author.

Figure 18 - Rochester Central Station, Rochester, NY.
Image from: http://www.rochestercentralstation.com/

Figure 19 - Pinellas Suncoast Transit Authority Central Plaza, St. Petersburg, FL.
Image from: http://www.pointssouth.net/the_woods/000216.htm.

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2.4: Green Design Considerations

Environmentally friendly construction, or "green" building and design considerations, aim to conserve natural resources and improve environmental quality throughout a building's life-cycle via the application of principles, techniques and materials.

Many green building techniques and concepts like energy and material efficiency, air quality, ecosystem protection, solar and wind power, and designing with climate have become part of our common vocabulary and are no longer perceived as experimental. Thus, as the building and design professions and building industry have slowly adopted and applied green building concepts. Communities across the nation, with the aid of the Environmental Protection Agency (EPA), the U.S. Green Building Council, and the U.S. Department of Energy, have developed sustainable or green building regional action plans aimed at making green building and design a more mainstream practice.

Transit agencies, which have generally lagged behind, are just starting to join these efforts. For instance, *Sustainable Transit Leadership* (EPA 2002) notes that although transit construction projects receive federal funding, transit officials are often "unaware of existing federal requirements under the Resource Conservation and Recovery Act (RCRA) section 6002 for the procurement of construction and landscaping materials used on these projects."[9] For this reason, the pilot project featured in *Sustainable Transit Leadership* (EPA 2002) , a joint effort between a large transit authority in California and the U.S. EPA Region 9, with assistance from the U.S. Green Building Council, is implementing green technologies and building practices to reduce waste and to promote sustainable building among public transit agencies.

THE U.S. GREEN BUILDING COUNCIL (USGBC) AND LEED

The U.S. Green Building Council (http://www.usgbc.org/LEED/LEED_main.asp) is a national coalition of leaders from across the building industry working to promote buildings that are environmentally responsible, profitable, and healthy. The council has developed the Leadership in Energy and Environmental Design (LEED) Green Building Rating System. This is a market-driven rating system for designing and constructing environmentally friendly facilities. The LEED-NC program for rating new and existing commercial and institutional buildings was launched in 2000 and the council expects to develop criteria for evaluating other project types.

As consumer awareness of green building benefits spreads, the demand for environmentally sensitive design of bus passenger facilities is likely to increase. Transit agencies contemplating new construction or renovation of bus passenger facilities should "[emphasize] state of the art strategies for:

- sustainable site development
- water savings
- energy efficiency
- materials selection, and
- indoor environmental quality."[10]

LEED 2.1's check list[11] provides a good synopsis of the areas and states that a project can score for obtaining different levels of "green" certification.

Solar Powered Bus Shelters and Amenities

Examples of green building techniques applied to bus passenger transit facilities in the U.S. are not as rare as it is generally believed. To date, solar-power and solar photovoltaic devices (PVs) has been the technology receiving the most attention from public transit agencies. A few large transit authorities such as Pace in Chicago have bought off-the-shelf solar powered bus stop lights known as i-Stop, manufactured by Carmanah Technologies of Canada. The equipment "attaches to bus stop poles and includes built-in solar panels to charge batteries that power the lights, which can run for about 200 hours on a 90-minute charge of daylight." [12] Each device costs $1,000 and addresses the concerns of riders passed by by bus drivers that were unable to see them. They can now activate a flashing light that alerts bus drivers to their presence. Other U.S. transit agencies that have adopted this technology are Pinellas Suncoast Transit Authority, FL and City of Flagstaff, AZ. There are a substantial number of solar powered lighted bus shelters and stops commercially available (see Commercially Available Solar-Powered Bus Stops and Shelters on next pages)

Figure 20 - i-Stop by Carmanah Technologies, Inc. A fully self-contained, solar-powered transit stop offering TranSignal™ bus flagging capability, security lighting and on-demand schedule illumination.
Image from: http://www.carmanah.com/

Some agencies and cities such as SunTran in Tucson, AZ have organized design competitions for bus shelters that incorporate green design considerations.

Figure 21 - Bus shelter design concept.
Image from: http://www.theacaciagroupinc.com/PDFs/bus%20shelter%20c_s.pdf

Solar and Wind Powered Bus Shelters

European public transit authorities and local governments have been very active in adopting green design ideas and in applying them to bus shelter design. Advertising companies have also joined in and partnered with bus shelter manufacturers using green techniques. This is the case of ClearChannel and Adshel, who have developed a new bus shelter that uses the latest solar and wind technology to power the shelter's interior light and advertising panel. In addition to the green source of energy and associated reduced energy costs, other claimed benefits by the North Lanarkshire Council in the UK—the first place where they are being installed—include more safety in generally unlit areas and happier customers that should hopefully encourage more use of bus transit.[13]

Figure 22 - The Adshel wind and solar powered bus shelter.
Image from: http://www.clearchannel.co.uk/adshel/news/Adshelwindsolarshelternorthlanarkshire/index.cfm?view=print&

Transit Agencies that have Adopted Solar Powered Bus Stops and Shelters

Clear Channel International. (2003). *Adshel and North Lanarkshire Council launch the UK's first wind and solar powered bus shelter.* Retrieved Dec. 5, 2003, from http://www.oaa.org.uk/News%5Cadshel2.pdf.

The new bus shelter uses the latest solar and wind technology to power the interior courtesy light in the shelter and to illuminate the advertising panel requiring a power supply of 200 watts. The solar panel is located on the roof of the shelter while the 5m high wind turbine pole is discretely positioned in foliage two metres from the shelter. The wind and solar technology was developed at Adshel's Research and Development Centre in London. Abstract by the author.

Groark, V. (November 27, 2003). Pace installs solar-powered bus stops*. Chicago Tribune Online Edition*. Retrieved Dec. 5, 2003, from http://www.carmanah.com/index.asp?cartNum=32139_21127&a=iv&m=media&s=nov27_03

Pace introduced new solar-powered illuminated bus stops at 13 locations. The hi-tech equipment, which attaches to existing bus stop poles, provides on-demand lighting for the passenger waiting area, and a flashing beacon to notify bus drivers that a rider is waiting at the stop. Abstract by the author.

Resources and Protection Technology. (n.d.). *KMB's innovative solar powered bus shelter: PV case study in Hong Kong*. Retrieved Dec. 5, 2003, from http://www.rpt.com.hk/kmb_pve.htm.

To best utilize limited natural resources and protect the environment, Kowloon Motor Bus has decided to construct Hong Kong's first solar powered bus shelter. Apart from providing protection against ultraviolet radiation through a special material on its roof, the solar powered bus shelter will be equipped with adjustable Photovoltaic Panels, which will generate sufficient electrical power for the shelter's electronic information system and advertising panels. Abstract by the author.

Solarcentury. (2003). *World's largest solar powered bus shelter network reaches 100 mark*. Retrieved Dec. 5, 2003, from http://www.solarcentury.co.uk/news/newsitem.jsp?newsid=347.

The ongoing installation of the world's largest network of solar-powered bus shelters, in Plymouth, reached a key landmark today with the unveiling of the 100th in the network. The installation programme is set to reach completion, with 300 shelters, by end of 2003. Abstract by the author.

Figure 23 - Exterior lighting improves security, enhances safety, and directs pedestrians and vehicles. A wide selection of new lamps, ballasts, fixtures, and controls are available to lighting designers to replace traditional inefficient exterior lighting systems. With any exterior lighting design, it should be a high priority to avoid light pollution (upward transmission of light) and light trespass (glare obnoxious to neighbors)—careful luminaire and lamp selection minimize these problems. Photo by Warren Gretz.
Image and caption from: http://www.nrel.gov/data/pix/searchpix.cgi?getrec=1413141&display_type=verbose&search_reverse=1

Figure 24 - Solar powered bus shelter in Hong Kong.
Image from: http://www.rpt.com.hk/kmb_pve.htm.

Figure 25 - Photovoltaics provide power to this comfort station at Hillsdale Lake, a popular recreation area south of Kansas City, Kansas. This comfort station is a small part of a nationwide effort to design public buildings that reduce consumption of non-renewable energy resources by taking advantage of alternatives such as solar energy. Photo by Solar Electric Systems of Kansas City.
Image and caption from: http://www.nrel.gov/data/pix/searchpix.cgi?getrec=2710107&display_type=verbose&search_reverse=1

Figure 26 - At a bus stop in West Palm Beach, Florida, this solar-powered safety light offers riders an illuminated area as they sit in comfort waiting for their transportation. The light is adequate for reading, and allows drivers to spot riders in areas where they are often not seen. Solar Outdoor Lighting has installed similar systems throughout the United States. Photo by Solar Outdoor Lighting.
Image and caption from: http://www.nrel.gov/data/pix/searchpix.cgi?getrec=2727445&display_type=verbose& search_reverse=1

Commercially Available Solar-Powered Bus Stops and Shelters

Note: The list of manufacturers of solar-powered bus shelters and other amenities is provided below solely as a source of information. No warranties or endorsement of any of these products is intended or offered.

***National Solar Technologies* - EN-R-LIGHT™ parking lot lighting system.**

The EN-R-LIGHT Parking Lot Lighting System was designed to provide free-standing lighting for parking areas such as commuter parking lots, commercial parking lots and public parking areas. NST's EN-R-LIGHT Parking Lot Lighting System is the ideal choice for locations where connection to the electrical grid is difficult, unavailable, unreliable or expensive. Image and information from: http://www.nationalsolaronline.com/lighting/parking_lot.html

***OkSolar* - Solar bus stop lighting**

Each system includes a charge regulator with built-in, adjustable timers. The lighting load attached to this system is operated for six hours per night, starting at dusk. Image and information from: http://www.oksolar.com/stl/bus_shelters.htm

***Solar Electric Power Company (SEPCO)* - Miscellaneous lighting systems for bus shelters**
(No picture available)

SEPCO™ systems have proven their long-term reliability in nearly all areas of the world; and their products meet or exceed all applicable codes and standards including utility requirements for performance, reliability and safety. Information from: http://www.sepconet.com/main.htm

Solar Outdoor Lighting, Inc. **- OmniLight™**

The OmniLight™ is a stand-alone, solar-powered light designed specifically to enhance bus stop safety by providing light where electricity is not available or would be prohibitively expensive. Waiting passengers activate the light with a simple push of an illuminated, highly visible button. The solar-powered light stays on for 15 minutes, providing a safe environment for the waiting bus rider. When light is needed for more than 15 minutes, riders can push the button again. The OmniLight™ is vandal resistant, easy to install and requires virtually no maintenance. Image and information from: http://www.solarlighting.com/htmlsite/busstop.ihtml

Tolar Manufacturing Company **- Model 13NALD-WG**

This model is a 13 foot, dome roof, non-advertising bus shelter with decorative wire grid facia at the roofline perimeter. It includes a solar security lighting system in the roof. Image and information from: http://www.tolarmfg.com/pro02.htm

Notes

[1] Schneider, J.B. (1980) *Planning and designing a transit center based transit system: Guidelines and examples from case studies in twenty-two cities.* Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation.

[2] Rabinowitz, H.Z., Beimborn, E.A., Lindquist, P.S. & Opper, D. (1989). *Market based transit facility design* (DOT-T-89-12). Washington, DC: U.S. Department of Transportation, Office of Technical Assistance and Safety.

[3] Alameda-Contra Costa Transit District. (1983). *Guide for including public transit in land use planning.* Oakland, CA: AC Transit.

[4] U.S.Department of Transportation (U.S.D.O.T.) (1991). *A guide to metropolitan transportation planning under ISTEA—How the pieces fit together.* Washington, D.C.: U.S.D.O.T. Retrieved Dec. 18, 2003, from: http://ntl.bts.gov/DOCS/424MTP.html

[5] The National Center for Transportation Research has started to devote some attention to this issue. See Volinski, J. (2001). *Conditions that promote creativity at transit agencies* (NUTI-USF-02). Tampa, FL: University of South Florida.

[6] Higgins, H & Audirac, I. (2003). *Bus passenger facility design guidelines for small Florida transit agencies: Needs assessment,* Technical Memorandum to the Florida Department of Transportation, Public Transit Office. Tallahassee, FL: Department of Urban and Regional Planning, Florida State University.

[7] The summary is drawn from Casey, R.F., Labell, L.N., Carpenter, E.J. LoVecchio, J.A. Moniz, L., Ow, R.S., Royal, J.W., & Schwenk, J.C. (1998). *Advanced transportation systems. The state of the art, update '98.* Cambridge, MA: Volpe National Transportation Systems Center.

[8] This table was obtained from Casey, R.A. (2000). What have we learned about advanced public transportation systems? *What have we learned about advanced public transportation systems?* (pp. 88-105) Washington, D.C.: U.S. Department of Transportation. Retrieved Dec. 15, 2003, from http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/@9w01!.pdf

[9] Environmental Protection Agency (EPA) (2002). *EPA OSWER innovations pilot. Sustainable transit leadership*. Washington, D.C.: EPA. Retrieved Dec. 01, 2003 from http://www.epa.gov/oswer/docs/iwg/SustainableTransit.pdf, (p.1).

[10] *Leadership in energy and environmental design (LEED).* Retrieved Dec. 03, 2003: http://www.usgbc.org/LEED/LEED_main.asp

[11] This checklist can be found online at http://www.usgbc.org/Docs/LEEDdocs/LEED-NC%20checklist-v2.1.xls

[12] Groark,Virginia. (2003). *Pace installs solar-powered bus stops.* Chicago Tribune, On-Line Edition. November, 27, 2003. Retrieved Dec. 3, 2003 from http://www.carmanah.com/index.asp?cartNum=32139_21127&a=iv&m=media&s=nov27_03

[13] Clear Channel (2003). *Adshel launch the UK's 1st wind and solar powered bus shelter.* News Release 04/09/2003. Retrieved Dec. 01, 2003 from http://www.clearchannel.co.uk/adshel/news/Adshelwindsolarshelternorthlanarkshire/index.cfm?view=print&

3: Transit-Oriented Development (TOD)

INTRODUCTION

Transit-oriented development is an umbrella term for a variety of urban, suburban and redevelopment projects built around or along transit stops. They go by a variety of names such as “transit villages,” transit-friendly” and “transit-focused” development or “transit-supportive development.” These projects generally involve improvements to the walking and bicycling infrastructure connecting development to the transit stop, a mixing and densification of commercial, office and residential land uses, and provision of substantially amenitized public space (e.g., landscaping, street furniture, and ample street and station lighting). Peter Calthorpe and Robert Cervero are well known for their work in this area (see annotations in the “Influential Books” section).

Calthorpe, a New Urbanist architect from the West Coast, is credited for being the originator of the TOD concept and for developing the planning principles and detailed physical design guidelines contained in his book *The Next American Metropolis* (abstracted in this section).These ideas can also be found in various TOD design guidelines and studies that his consulting group, Calthorpe Associates, has developed for various cities and transit authorities across the nation, including studies for San Diego and Sacramento, California and for Tri-Met in Portland, Oregon. Robert Cervero, coauthor of *Transit Villages in the 21st Century,* is another influential author, who has championed the “transit village” version of TOD. Along with Michael Bernick he defines a transit village as:

> A compact, mixed-use community, centered around a transit station that, by design, invites residents, workers, and shoppers to drive their cars less and ride mass transit more. The transit village extends roughly a quarter mile from a transit station, a distance that can be covered in 5 minutes by foot. The centerpiece of the transit village is the transit station itself and the civic and public spaces that surround it. The transit station is what connects village residents to the rest of the region . . . . the surrounding public space serves the important function of being a community gathering spot, a site for special events, and a place for celebration—a modern-day version of the Greek agora.[1]

This definition is emblematic of the physically compact, highly walkable, and intensely civic orientation associated with TOD imagery. Development that deviates from this vision in the sense that it is only physically near a transit stop, but misses all the other TOD elements (i.e., walkable, dense and mixed-land-uses with civic spaces) has been labeled transit adjacent development (TAD). A large portion of the literature devoted to station-area redevelopment projects outlines the experience and lessons learned regarding the transformation of TADs into TODs through the application of transit-joint development (TJD) strategies.

Transit-joint development refers to the set of land-use zoning strategies, real-estate and financial transactions, and public-private agreements between transit agencies and the private sector regarding

development associated with transit stations or other transit facilities. In its broadest sense, TJD is considered to be the mechanism for implementing TOD projects of any type—urban, suburban, new development or redevelopment. In terms of TJD public-private partnership arrangements Cervero and Associates[2] differentiate TJD on the basis of revenue-sharing and cost-sharing arrangements. On the revenue side they include land leases, air rights development, station connection-fee programs, concession leases, and benefit assessment districts, which generate revenues for the transit agency. On the other hand, cost-sharing TJD—geared to reducing the transit agencies' share of facility construction, maintenance, or redevelopment costs—include such practices as sharing facility construction or maintenance expenses and incentive-based programs, whereby the developer trades off a greater share of construction costs for density bonuses or air rights acquisition. Of the two TJD agreements, cost-sharing was found to be the most prevalent form of TOD implementation in the U.S.[3]

A very comprehensive study of 19 rail-based TOD cases by Porter (1997) entitled *Transit Focused Development* (TCRP Synthesis 20) stresses the institutional barriers that impede TOD and TJD success. These include lack of cross-jurisdictional cooperation, particularly between local governments and transit agencies, and the priority that auto-oriented development receives even from transit agencies. However, a variety of governmental policies and actions supporting TOD often coexist at all levels of government, including state departments of transportation, regional planning councils and metropolitan planning organizations (MPOs), local governments, and transit agencies. Although state departments of transportation rarely have policy statements in support of TOD, there is a great deal of variation at the regional and local level concerning the types of instruments used to implement TOD and TJD. The most successful TOD and TJD implementation occurs where strong support for TOD at all levels of government results in strong TJD action frameworks. This has been the case among public agencies in MPOs that had adopted TOD policies and whose constituent cities and/or counties, where transit is provided, have also adopted policy and enacted regulations in support of station-area development. Additionally, in these cases transit agencies were also actively involved in implementing JTD and TOD. Some of the most salient activities that transit agencies undertake include:

- Design Guidelines—TOD design guidelines incorporating standards and illustrations for meshing development with transit service. In 1993 about 38 agencies throughout the United States and Canada had published or were in the process of publishing guidelines for rail and bus transit.
- Joint Development—Adoption of procedural and design guidelines for joint development around transit stations. For instance, "those used by Miami's transit agency indicate[d] the range of development opportunities being pursued as follows:

    - long-term lease of air rights above and around stations;
    - private sector dedication of property and other contributions to construction of transit improvements;
    - integration of stations into planned and existing developments; and
    - creation of direct access links between stations and adjoining developments."[4]

- Other joint development transit agency activities included:

    - the leveraging of ownership of land used for parking facilities at stations to promote private development opportunities;

- marketing of agency's excess properties for transit-oriented development;
- marketing campaigns for specific station sites; and
- scouting for development interest in station sites.

- Educational Activities—organizing of community meetings to build support and understanding of TOD.[5]

The literature documenting the TOD and TJD experience in the U.S. has been reviewed by Cervero et al. (2002) in *Transit-Oriented Development and Joint Development in the United States* (TCRP-Research Results Digest 52). To date the results of this experience remains very mixed with a seemingly unimpressive record. TOD via TJD implementation in many cities has remained embryonic or has failed in large part due to a variety of reasons including: sluggish real estate markets, lack of public sector champions with a stead-fast commitment to station area development, and novice knowledge from both public and private partners about TJD complexities.

A few well known TOD examples like the Hazard Center in San Diego's Mission Valley trolley line, Orenco Station in Portland's light rail, and the highly profitable Metrorail's Bethesda Metro Center in downtown Bethesda, Maryland have set a trend that has been difficult to replicate elsewhere. However, some transit agencies in association with very proactive communities have leveraged developers' funding in hot real estate markets. In these instances, commuter rail TOD station projects and park-and-ride lots conversion into TOD stations has been abetted by Smart Growth policy and redevelopment grants.

BUS-BASED TRANIST-ORIENTED DEVELOPMENT

It must be pointed out that rail takes the lion's share of TOD implementation in the U.S. and that in contrast with other countries, bus-based TOD is still in its infancy. Cervero et al. (2002) list Denver's RTD-Transitway Mall, the Santa Ana Transportation Center in Orange County, California and the Corpus Christi, Texas, Staple Street Transit Center as recently implemented bus-based TODs and San Diego's Uptown District and Charlotte's BRT corridors as bus-based TODs that are currently on the drawing board. However, it seems that these efforts are primarily concentrated on and around downtown central bus terminals and that air right leasing has been the primary source of revenue sharing for TJD agreements. For example, the Ground Transportation Center in Cedar Rapids, designed as the central terminal for intercity and city bus service, has strong pedestrian connectivity to nearby office towers and retail, and a new residential apartment building was added by leasing the air rights over the terminal. Similarly, the Santa Ana Transportation Center had office buildings erected over the station through leased air rights, and Tucson's downtown bus terminal TJD consists of public building and a child-care center. As small and medium sized transit agencies continue to promote downtown multimodal bus transfer facilities, it seems that these locations will be prime sites for bus-based TOD.[6]

LITERATURE ORGANIZATION

The literature compiled in this chapter is organized into four groups. The first consists of nationally influential books on TOD and research studies and reports related to best practices on TOD adoption and implementation commissioned by national organizations such as the Federal Transit Administration, the U.S. Department of Transportation, and the Transportation Research Board. The second section collects works related to TOD studies and design guidelines carried out by state and regional agencies. The third section gathers studies, design guidelines and land use policies developed by county and city governments and local transit agencies in support of transit-oriented development. Lastly, the fourth section is made of articles appearing in planning and transportation professional and academic journals and magazines.

Figure 1 - The Charlotte/Mecklenburg, NC area has focused transit-oriented-development along five major corridors. Image from: http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_PTO/FDOT_BC137_38_TOD_rpt.pdf

3.1: TOD Planning Strategies

NATIONAL STUDIES AND GUIDELINES

As mentioned in the introduction, two influential books, *The Next American Metropolis* by Peter Calthorpe and *Transit Villages in the 21st Century* by Michael Bernick and Robert Cervero have had strong sway in the way transportation planners and urban designers think of transit-area-station development. The Transit Cooperative Research Program's reports and research digests collectively have added to the body of knowledge regarding transit-oriented development. Among these, *The Role of Transit in Creating Livable Metropolitan Communities,* (TCRP Report 22) by the Project for Public Spaces (1997) proclaims a new era for transit. Community groups are recognizing the importance of transit in enhancing the livability of downtowns and neighborhoods. At the same time, public officials view transit as a vehicle for economic development and for building a broader constituency of support. Although TOD can accrue direct economic benefits to the transit agency, space leases and commercial concessions like post offices, stores and cafes, routine among rail service providers, are "often overlooked by the nation's bus operators who handle most of today's transit riders" (p. 8).

The report divides TOD approaches into design-oriented and service-oriented strategies. Design-oriented strategies emphasize the bus or transit stop as the centerpiece of the development or redevelopment project. With the proper physical design and economic incentives, bus station area development can attract a combination of uses like retail, office, special events, etc., and become the catalyst for overall neighborhood improvement. "Service-oriented strategies include transit shuttles and connectors, which link residential neighborhoods with commuter rail and rapid transit stations and circulators and trolleys, which enable shoppers, visitors and office workers to move more freely about downtown areas" (p. 36). Six livability themes are used to examine eleven transit-oriented development cases located across the nation and each case is profiled in terms of the planning process, TOD strategy, funding and issues associated with overcoming implementation obstacles.

In terms of bus-based TOD, the implementation experience is scarce and the number of exemplary cases are relatively small. The literature often mentions Staples Street Station in Corpus Christi, Texas which was designed to accommodate future small-scale retail, and the Rondstadt Downtown Bus Transit Center in Tucson, Arizona, which has become a popular twice-a-month stage for a community wide "Downtown Saturday Night" event.

While many of the TCRP publications in this section provide relatively optimistic assessments of TOD opportunities and planning processes, some studies have raised a cautionary note about the market and real-estate viability of the TOD prototype—a compact, mixed-use station area consisting of small-scale retail, office and residential land uses, where pedestrian accessibility is emphasized with concomitant reduction in automobile parking. *A New Planning Template For Transit-Oriented Development* by Nelson

(2001) suggests that the rise in nonwork travel is a direct consequence of technological change and rising incomes which have greatly expanded the scope of business opportunities and consumer choice. This in turn questions the assumptions that given that TOD residents will be closer to work and non work activities, TOD will induce more pedestrian and transit trips in lieu of auto trips. According to this study, the success of TOD measured as less automobility cannot be taken for granted, particularly when transit cannot effectively serve the regional distribution of retail and other non work activities which are rapidly changing location and scope. For these reasons, some academic research suggests that albeit desirable, the neotraditional TOD prototype will not have a significant impact on personal travel habits.

From a legal perspective, the authors of TCRP Legal Research Digest 12, *The Zoning and Real-Estate Implications of Transit-Oriented Development* argue that given their recent history, there has been no reported litigation associated with TOD and TJD. However, even though "the United States Court of Appeals for the Eleventh Circuit has affirmed that the use of traditional neighborhood development principles is a legitimate use of the police powers" (p. 16), mixed-land uses, flexible zoning, and the use of eminent domain and financial incentives to encourage joint development have been litigated in court. Hence, policy tools applied to the implementation of TOD strategies, such as those included in Table 1, may present potential legal issues that require well crafted comprehensive planning policies and careful drafting of new TOD ordinances in order to avoid court challenges.

Table 1. Techniques Used by Transit Agencies to Encourage TOD

From *TCRP Legal Research Digest 22* (2001), p. 43
http://gulliver.trb.org/publications/tcrp/tsyn20.pdf

	Mixed Use	Density Bonus	Density Increase	Density Transfer	TDR	Streets Standards	Uses	Impact Fee	Con-currency
Culver City	✓	✓	✓						
Broward Co. Mass Transit								✓	✓
Washington WAMETA									
Snohomish Co. Public Transp.							✓		
Santa Clara Co.	✓		✓				✓		
Champaign, Urbana, Mass Transit									
City Utilities of Springfield, MO									
Sacramento Regional Transit District	✓		✓			✓	✓		
Tri-County Metro Transp.	✓		✓		✓	✓	✓	✓	
King Co. DOT	✓	✓	✓	✓	✓				
Triangle Transit Authority	✓	✓	✓	✓	✓	✓	✓	✓	

Books

Bernick, M., & Cervero, R. (1997). *Transit villages in the 21st century*. New York: McGraw-Hill.

This book presents a vision of transit villages as compact urban communities centered around rail transit stops. Using examples from the San Francisco Bay area, Washington D.C. and other cities, the book offers ideas and lessons learned about: (1) integrating issues of land use and transportation planning with community development and redevelopment; (2) reinvigorating rail transit as a response to traffic gridlock, urban sprawl and environmental pollution; (3) best practices for creating pedestrian access to mixed-used communities that enjoy a sense of place, diversity of housing opportunities, and community safety.

Calthorpe, P. (1993). *The next American metropolis*. New York: Princeton Architectural Press.

In this book Peter Calthorpe, a leading New Urbanist architect and urban designer, sets forth the planning and design principles for building communities that are more suited to the new realities of post-industrial society. The notion of transit-oriented development (TOD) based on public transit is at the center of Calthorpe's regional vision which is also partly a manifesto against urban sprawl and conventional suburban development. There are three parts to this book. The first presents the author's guiding principles and philosophy. The second provides detailed design guidelines, and the third offers a number of TOD case studies from various U.S. cities.

Publications by National or Regional Transportation Centers

American Public Transit Association. (1987). *Building better communities*. Washington, D.C.: American Public Transit Association.

The authors favor integration of land use and transit planning which requires changes to local ordinances, regulations, building codes and procedures. They explain efficient strategies for developers like subdivision and activity design strategies, travel demand strategies, and transportation management associations. They also suggest a host of land use strategies that allow public agencies and developers to integrate the impact of mass transit investments and private sector financial participation. They include designing policies, working with the investment community, ordinances and regulations, urban design considerations, master planning, developer-furnished improvements, adequate public facilities, etc. Thus they conclude that if the land use planning is transit supportive then it can bring about an increase in transit ridership.

American Public Transportation Association (APTA). (2003). *Transit-oriented development resource guide, revised November 8, 2003*. Retrieved Nov. 30, from http://www.apta.com/research/info/briefings/briefing_8.cfm.

This is a printable web-based guide to sources related to transit oriented development produced by APTA. In its introduction APTA states that: "transit-oriented development (TOD) is compact, mixed use development near new or existing public transportation infrastructure that serves housing, transportation and neighborhood goals. Its pedestrian-oriented design encourages residents and workers to drive their cars less and ride mass transit more. Some TOD projects are a significant source

of non-farebox revenue for the participating transit agency. This Resource Guide comprises a collection of internet-based documents that provide background resources and tools on TOD as well as examples of successful TOD in U.S. urban communities."

Beimborn, E. (1991). *Guidelines for transit sensitive suburban land use design*. Washington, D.C.: U.S. Department of Transportation.

Transit agencies have witnessed a decline in ridership and have been very unsuccessful in capturing riders in the suburbs. The most significant deterrent of successful transit operations in suburbs is the land use pattern that exists there. This guidebook introduces elements of successful transit and criteria for transit-sensitive suburban land use design. It presents a list of transit-oriented and transit-compatible land uses to be included in an area served by transit and which should be located elsewhere. It presents guidelines for land use policies, access policies and transit policies under two major frameworks, namely system planning and district planning. It further outlines administrative and policy guidelines for transit agencies and local government. It also presents implementation methods as well as a case study wherein the guidelines were applied to develop a successful transit-oriented development in an emerging suburban area in the City of Milwaukee.

Beimborn, E., & Rabinowitz, H. (1991). *The new suburb: Guidelines for transit sensitive suburban land use design*. Center for Urban Transportation Studies and the School of Architecture and Urban Planning, the University of Wisconsin-Milwaukee. Retrieved Oct. 22, 2003, from http://ntl.bts.gov/data/1370.pdf.

This report provides guidelines for the planning and design of land use patterns that are sensitive to the needs of public transit. These guidelines are meant to create an efficient environment for future growth in suburban areas, and were prepared from a market-based point of view. Design elements are proposed that directly address the success of development activities and transit services. The report discusses requirements for successful transit and provides design guidelines for land use, access systems and transit service types through a range of scales.

Transit-sensitive land use design can be developed through the designation of Transit Corridor Districts (TCDS) which would separate transit- and auto-oriented land uses. Such areas would have a mix of land uses with higher densities located near a transit route. A high quality access system for pedestrians and bicyclists would be provided to permit easy connections between buildings and transit vehicles. Guidelines are offered for the overall administrative and policy issues, systems planning considerations and specific designs of individual districts where transit service is provided. Steps to implement the guidelines are also included. Abstract by the authors.

Goodwill, J., & Hendricks, S. (2002). *Building transit oriented development in established communities* (473-135). Tampa, FL: Center of Urban Transportation Research, University of South Florida. Retrieved Oct. 20, 2003, from http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_PTO/FDOT_BC137_38_TOD_rpt.pdf.

This report provides a synthesis of the steps that established car oriented communities have taken to transform into transit oriented communities. The report identifies several approaches, such as the use of transit oriented design, focusing transit oriented development (TOD) around park-and-ride lots, making changes to land development regulations, parking management, offering development incentives, coordinating stakeholders, incorporating transit into future development/redevelopment,

crafting TOD design guidelines, predesignating transit corridors, ensuring pedestrian and bicycle access, adapting transit services to the needs of suburban style communities, offering location efficient mortgages and ideas for dealing with community resistance toward applying transit friendly measures to car oriented communities. This report presents a literature review with conclusions, an annotated bibliography and five case studies of communities that have taken steps to become transit oriented. These communities include Atlanta, Charlotte, Orlando, the Central Puget Sound Region in Washington and Denver. Abstract by the authors.

Morris, M. (1996). *Creating transit-supportive land-use regulations* (PAS 468). Chicago: American Planning Association.

This guidebook illustrates how transit supportive policies and land use regulations can bring about a compact, pedestrian friendly community that offers a wide choice of transportation for its residents and reduces the negative externalities associated with the use of the automobile. It offers guidelines and advantages for transit and pedestrian friendly site design like providing continuous, direct and convenient linkages, improving the pedestrian environment, and providing public spaces. It illustrates the effect of reduction of parking spaces or of limiting parking according to transit patronage volumes. It also presents the effect of mixed-use development on the promotion of public transportation in cities and suburban communities. It encourages planners and local government to adopt policies that increase urban densities that support transit. It concludes that if transit supportive policies and regulations are included in the local government planning process then it can greatly benefit transit agencies and also encourage people to use transit as an alternative to the automobile.

Nelson, R. (2001). *A new planning template for transit-oriented development.* San José, CA: Mineta Transportation Institute, San José State University. RetrievedOct. 22, 2003, from http://transweb.sjsu.edu/TODHTML/TOD_v2.htm.

The Mineta Transportation Institute (MTI) at San José State University assigned a project team to design a planning template for transit-oriented development (TOD) that incorporates an understanding of nonwork travel, that is, trips for shopping, eating out, and engaging in recreational and cultural activities. Nonwork trips are growing in significance and now account for four of every five trips. At the same time, TOD has become a popular planning response to the impacts of metropolitan growth. Some planners believe that TOD will induce more pedestrian and transit trips and will reduce the average length and frequency of household auto travel. This effect is assumed to result from improved accessibility to employment and nonwork venues located in compact, mixed-use centers. Planning professionals in many MPOs also suggest that if multiple centers are linked by high quality transit, such as light or heavy rail, access is enabled to the broad range of nonwork activities.

The project arrived at these essential findings: (1) Venues for nonwork activities are very numerous and geographically dispersed. (2) The spatial environment for nonwork activities is the result of growing prosperity, technical innovation, and a dynamic, competitive marketplace. (3) The consumer marketplace will provide many more places to go than mass transit can cost-effectively serve. (4) Current metropolitan planning methods and modeling tools focus on the work trip and do not adequately account for the complexity of nonwork trips and their linkage to work trips.

These findings support the need for a new regional planning process to complement current methods. One

recommended approach is that metropolitan communities establish a Nonwork Travel Improvement Planning Process using a multidisciplinary expert advisory group interacting with a core, Internet-enabled, professional transportation planning staff. An iterative interaction across varied but relevant skill sets could be achieved through a Backcasting Delphi process. The focus of the interaction would be on understanding the ramifications of consumer and retail industry behavior for TOD and other new transportation strategies, and then assessing the available strategies for cost-effectiveness in reducing the impacts of growth and automobility in a complex and uncertain metropolitan market. Abstract by the author.

Reconnecting America. (2003). Retrieved Nov. 30, from http://www.reconnectingamerica.org/html/TOD/index.htm

This website is produced by Reconnecting America a national transit-oriented development advocacy center whose mission and programs include: "Removing the barriers that prevent our different transportation modes—planes, trains, autos and buses, as well as walking and bicycling—from functioning as one convenient interconnected network. We will also focus on reinventing the planning and delivery system for building regions and communities around transit and walking rather than solely around the automobile. Toward this end, Reconnecting America has undertaken three programs:

Reconnecting America's Transportation Networks, which seeks to integrate our separate aviation, rail and intercity bus systems into an integrated network in order to improve economic productivity, enhance consumer choice and value, and improve environmental performance and energy efficiency. http://www.reconnectingamerica.org/html/RATN/index.htm

The Center for Transit-Oriented Development, which seeks to use transit investments to spur a new wave of development that improves housing affordability and choice, revitalizes downtowns and urban and suburban neighborhoods, and provides value capture and recapture for individuals, communities and transportation agencies. http://www.reconnectingamerica.org/html/TOD/index.htm "

National TCRP Reports

Cervero, R., Ferrell, C., & Murphy, S. (2002). *Transit-oriented development and joint development in the United States: A literature review* (TCRP Research Results Digest 52). Washington, DC: Federal Transit Administration. Retrieved Oct. 12, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rrd_52.pdf.

This digest summarizes the literature review of TCRP Project H-27, *Transit-Oriented Development: State of the Practice and Future Benefits*. This digest provides definitions of transit-oriented development (TOD) and transit joint development (TJD), describes the institutional issues related to TOD and TJD, and provides examples of the impacts and benefits of TOD and TJD.

Kuzmyak, J. R., Pratt, R. H., & Douglas, G. B. (2003). *Traveler response to transportation system changes: Chapter 15—land use and site design* (TCRP Report 95). Washington, DC:Transportation Research Board. Retrieved Oct. 9, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_95c15.pdf.

Rather than focusing on the impact of transportation decisions on land use and on the development potential of specific areas, the focus of this report is on the impact that land use decisions have on transportation outcomes. It examines land use and site design options as "transportation strategies." The report assesses what is known or "surmised about the relationships between land use/site design and

travel behavior . . . [through an examination of]: (1) objectives of land use and site design strategies, summarizing key reasons why planners and decision makers view the land use-transportation connection as important; (2) types of land use and site design strategies characterizing the types of strategies of concern to transportation analysts, and relating them to the elements of land use and site design around which this chapter is structured; (3) analytical considerations, identifying analytic approaches that have been used to examine the transportation-land use link, and offering guidance as to their reliability; and (4) traveler response summary, providing a condensation of key travel behavior findings. In this study, transit-oriented development (TOD) is one among eight land use and site design strategies. It applies the TOD designation to "growth focused or intensified in the immediate vicinity of a transit route, station or other service node," and differentiates it from traditional neighborhood and pedestrian friendly development strategies in that the latter, unlike the former, does not necessarily require high densities. (p. 15-1). The chapter also presents case studies illustrating these strategies and the assessment of traveler response associated with them.

Porter, D. (1997). *Transit-focused development* (TCRP Synthesis 20). Washington, D.C.: Transportation Research Board. Retrieved Oct. 12, 2003, from http://gulliver.trb.org/publications/tcrp/tsyn20.pdf.

This synthesis describes planning and implementation processes leading to development at and near transit stations. It is based on a summary of research and on nineteen agency profiles which are found in Appendix A. Much of the research is based on rail stations, but the policies and planning tools could be applied to bus and multi-modal stations as well. (See table 3 pp. 14-19.) Aspects covered in this synthesis include: 1) the extent and character of development around rail transit stations, with some examples of similar developments at bus transfer stations or other multi-modal centers; 2) the benefits of transit-focused development, potential obstacles to overcome and recommended procedures for achieving them; 3) policies and planning tools adopted by transit agencies, MPOs and local governments to encourage transit focused development are identified and evaluated; and 4) findings and conclusions concerning the conditions conducive to transit focused development and the tools that public agencies can use to encourage it.

Project for Public Spaces. (1997). *The role of transit in creating livable metropolitan communities* (TCRP Report 22). Washington, D.C.: Transportation Research Board. Retrieved Oct. 7, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_22-a.pdf.

This report combines guidelines and case studies to provide a comprehensive approach for improving community livability and transit ridership in the United States. It is directed toward a broad range of individuals and groups in the public and private sectors associated with community, business, and civic organizations, including public transportation providers, local and metropolitan governments, community groups, and private businesses. The report's twelve chapters are divided into three major parts. Part I, Overview and Context, defines the concept of livability and the impact of transportation on livability. It also describes federal support for transit and livable community initiatives, the place-making approach to livability, and transportation strategies that impact livability. Part II, Roles of Transit in Creating Livable Communities, contains Chapters 3 through 9, which document and present diverse examples of how public transportation supports and enhances community livability. The examples which briefly summarize the experience of the individual communities

and the more lengthy case studies are organized by the following topics: creating places for community life; using transit as a catalyst for downtown and neighborhood renewal; creating opportunities for entrepreneurship and local economic development; improving safety and amenity; making communities accessible and convenient; and shaping community growth. Part III, Implementation, contains Chapters 10 through 12, which provide a guide to implementation. These chapters describe the importance of community-based process for creating livable communities, then describe specific planning, design, and management strategies for livable places.

Project for Public Spaces. (1998). *Transit-friendly streets: Design and traffic management strategies to support livable communities* (TCRP Report 33). Washington, D.C.: Transportation Research Board. Retrieved Oct. 22, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_33.pdf.

This report will be of interest to individuals seeking to improve the livability of their communities and to those concerned with the role that local streets and public transportation can play in pursuing this goal. The report presents 10 strategies used in both the United States and Europe to create transit-friendly streets. The strategies are followed by case studies of five communities that have pursued different initiatives to improve their livability by making their streets more transit-friendly. The report culminates with lessons learned from the case studies. The report is very practical and will be useful to transit professionals, transportation planners, engineers, city officials, and local communities.

White, M. (1999). *The zoning and real estate implications of transit oriented development* (TCRP LRD 12). Washington, D.C.: Transportation Research Board. Retrieved Oct. 18, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_lrd_12.pdf.

Local government officials, including attorneys, planners, and urban design professionals, are seeking new approaches to land use and development that will address environmental impacts of increased automobile traffic and loss of open space around cities and towns, and that will alleviate financial pressures on governments and their constituents. Among these approaches is the urban design concept of transit oriented development, which emphasizes that where transit facilities are in place, or planned to be put in place, there should be a mix of commercial, retail, residential, and civic uses within close proximity to the facilities designed for the best possible interface. The highest density would be closest to these fixed gateways or other transit facilities. This research produced information on legal and other issues associated with transit-oriented development. The report should be useful to transit and development attorneys, financial officials, planners, development officials, and anyone interested in transit-oriented development.

STATE AND REGIONAL STUDIES AND GUIDELINES

This selection of studies and guidelines encompasses several states: Oregon, California, Florida, and Washington State. Not surprisingly, TOD studies in California out number all other states. Among the various TOD studies commissioned by the California Department of Transportation (Caltrans), the *Statewide Transit-Oriented Development Study: Factors for Success in California* by Parsons Brinkerhoff (2002), provides the most comprehensive state-wide analysis of the state of the art TOD practice in California and the U.S. In terms of bus-based TOD, the experience in California as well as in the rest of the country is somewhat mixed. With the aforementioned exceptions of successful bus-based TOD in San Diego, Corpus Christi, and Tucson, bus-based TOD is more difficult to build because bus has several disadvantages when compared to rail, particularly in terms of attracting real estate investment. For instance, factors that favor rail over bus include the more permanent nature of rail; the higher status that rail has as a travel mode for choice riders; the different transit markets that each one serves (i.e., rail serving the more affluent downtown-suburban markets); and the larger number of stops that are typically found along bus transit corridors (see Table 2).

The conventional wisdom related to bus-based TOD is that in order to capitalize on its cost advantages it should be built around bus rapid transit (BRT) service. Los Angeles Metropolitan Transportation Authority (LA MTA) has a successful BRT demonstration project with state-of-the-art bus priority signal, low-floor buses, and intelligent traveler information signals. Bus-based TODs in California which are not served by BRT include a variety of examples with varying levels of inter-agency coordination. For instance, at the lowest level of coordination, there is a sheltered bus stop in West Davis' Aspen Neighborhood that was not originally conceived as a suburban TOD by the transit agency YoloBus, but that evolved into one serving the local university residential market. In contrast, at the highest level of inter-agency coordination we find the NoHo bus-based TOD in the North Hollywood Arts District. This project was the result of a community partnership with the Los Angeles Neighborhood Initiative (LANI), the L.A. Community Redevelopment Agency (CRA) and the L.A. Metropolitan Transit Authority (LA MTA), "which has promoted economic development, increased pedestrian activity, and improved the general attractiveness of the area."[7] Similarly, a well known example of city-initiated TOD and TJD is San Diego's Uptown District bus-based TOD located in the site of a former Sears store nested within a 14-acre mixed-use development. The redevelopment project, spearheaded by the city, was completed in 1989 with an average density of 43 units per net acre and 145,000 square feet of retail and commercial space. The Uptown project has been showcased as a "good example of how to accommodate the needs of the automobile and create a well designed, pedestrian-friendly mixed use transit-oriented development,"[8] since the developer chose to provide more parking than that recommended by the city, and the project does not provide parking for transit patrons. Nonetheless, transit ridership, which was substantial before the TOD project, increased significantly after the project's completion.

According to the Caltrans' report and other studies in this literature review, where local governments or transit agencies have been reluctant partners TOD initiatives have failed; but when cities and transit agencies have jointly embraced the idea and worked together implementing it, TOD has flourished.

Other studies and guidelines in this collection include Caltrans' TOD searchable

database and the Mineta Transportation Institute's (2001) website containing the *Envisioning Neighborhoods with Transit Oriented Development Potential.* This study offers transit planners, developers, and designers tools for the analysis of the area surrounding transit stops within pedestrian, bicycle and automobile catchment areas. It also provides detailed examples that apply the envisioning tools to several rail TOD station areas in the San Francisco Bay Area.

Table 2. Examples of Bus-Based TOD Implementation

Adapted from: Parsons Brinckerhoff (2002). *Statewide transit oriented development study: Factors for success in California*. Chapters 4 and 5
http://www.dot.ca.gov/hq/MassTrans/doc_pdf/TOD/Divided/TO D%20Study%20Final%20Report%20-%20Section%202.pdf

Aspen Neighborhood, West Davis *Developer*: West Davis Associates *Jurisdiction*: City of Davis *Transit Agencies*: Unitrans, Yolo County Transit Authority *Transit Service*: 5 bus routes, 5 to 25-minute frequency
'NoHo' (North Hollywood) Arts District, Los Angeles Developer: Los Angeles Neighborhood Initiative (LANI) North Hollywood Community Forum Jurisdiction: Los Angeles Urban Renewal Agency: L.A. Community Redevelopment Agency (CRA) Transit Agency: L.A. County Metropolitan Transit Authority (MTA) Transit Service: 4 bus lines, 20- to 40-minute frequency
Uptown District, San Diego *Developer*: Oliver McMillan / Oldmark & Thelan *Jurisdiction*: City of San Diego *Transit Agency*: Metropolitan Transit Development Board (MTDB) *Transit Service*: 5 bus routes, 15-minute frequency

Figure 2 - Bus stops serve students & commuters in the Aspen Neighborhood of West Davis, CA.
Image from: CA Department of Transportation.

Figure 3 - A pedestrian arcade connects a bus stop on University Avenue to the core of the neighborhood (San Diego, CA).
Image from: Parsons Brinckerhoff and the CA Deptartment of Transportation.

Figure 4 - Metro Rapid Bus demonstration project in Los Angeles.
Image from: Los Angeles MTA.

Figure 5 - The NoHo (North Hollywood) bus TOD has promoted economic development, increased pedestrian activity, and improved the general attractiveness of the area.
Image from: Parsons Brinckerhoff and the CA Deptartment of Transportation.

Table 3. Bus and Rail TOD

Adapted from: Parsons Brinkerhoff. (2002).
Statewide Transit-Oriented Development: Factors for Success in California.
http://www.dot.ca.gov/hq/MassTrans/doc_pdf/TOD/Divided/TOD%20Study%20Final%20Report%20-%20Section%202.pdf

Bus TOD	Rail TOD
Can increase ridership	Can increase ridership
More efficient service provision	More efficient service provision
More ubiquitous and flexible than rail	Fixed and more expensive than bus
Lack of fixity increases investment attraction	Permanent stops provide less risks for investment
Larger number of bus stops along a transit corridor	Fewer bus stops along a transit corridor
Stigmatized as second-rate transportation	More culturally accepted than bus
Low-income riders	Higher income and choice riders
Urban service market	Urban & suburban service markets
Less influential constituencies	More influential constituencies
Construction process provides fewer opportunities for joint development	Construction process provides more opportunities for joint development
Requires more leadership than rail	Requires less leadership than bus
Few successful examples	Proven track record

1000 Friends of Oregon. (1997). *Making the connections–a summary of the LUTRAQ project, volume 7*. Portland, OR: 1000 Friends of Oregon. Retrieved Oct. 22, 2003, from http://www.friends.org/resources/lut_vol7.html.

The report presents illustrations of high prices of suburban sprawl with a case study of Portland, and explains how the LUTRAQ alternative can overcome all the problems and lead to efficient transit service. It explains in detail the LUTRAQ alternative, which focuses on three general types of transit-oriented development: mixed-use centers, urban TODs and neighborhood TODs. It explains the transportation link established between the different modes of transportation thus offering a wide modal choice to citizens. It recommends design guidelines and zoning regulations to the local government to encourage, or at least make possible, transit-oriented development. Then it provides a comparison of the LUTRAQ alternative with other traditional approaches to addressing transportation needs. Finally it presents case studies from different states that have adopted other transportation alternatives, pricing road use, new forms of land development, regional planning, and grassroots involvement. It concludes with the advantages offered by transit supportive LUTRAQ alternative.

Bossard, E. G. (2002). *Envisioning neighborhoods with transit-oriented development potential* (FHWA/CA/OR-2001-25). San Jose, CA: Norman Y. Mineta International Institute for Surface Transportation Policy Studies, San Jose State University. Retrieved Oct. 5, 2003, from http://transweb.sjsu.edu/publications/envisioning/Envisioning.pdf.

The Mineta Transportation Institute (MTI) at San José State University conducted this study to review the issues and implications involved when seeking to Envision Neighborhoods with Transit Oriented Development (TOD) Potential. The Envisioning Neighborhoods with Transit Oriented Development (TOD) Potential project seeks to introduce planners, developers, and urban analysts to information design techniques and digital computer tools that can be used to undertake and study TOD. A basic premise is that effective TOD requires thoughtful planning to be successfully integrated into the metropolitan fabric. The primary focus of this project is intra-regional comparisons, focusing on information pertaining to the relative desirability of places within a region. Context matters, so data is best understood in a comparative context. Small multiple replicate maps, charts, and digital images can be used to understand many aspects of places with TOD potential. Place comparisons can be made across space, time, and scale. The study focus is on understanding the neighborhoods surrounding transit centers and their context in terms of the character of areas within walking distance (< 1/2 mile), bicycling distance (< 2 miles) and five-mile driving or transit distance. These ranges of analysis include the areas where residents of possible TODs might work, shop, or prefer to go for services. This project includes a comprehensive case study application envisioning the Hayward BART Station area. Other case studies cover the Fruitvale BART in Oakland, Redwood City and Mountain View CalTrain, Campbell LRT site, and Sacramento's 65th St. Station areas. Abstract by the author.

CALTRANS. (2003). *California transit-oriented development (TOD) searchable database*. Retrieved Oct. 8, 2003, from http://transitorienteddevelopment.dot.ca.gov/miscellaneous/NewHome.jsp.

California's urban and commuter rail systems have tremendous potential to develop transit-oriented land use around their urban and suburban rail stations. This web-based database provides convenient access to the body of literature regarding TOD experience throughout California, and incorporates

analytical tools that enable a user to search the data and perform analysis. Abstract by the author.

Ewing, R. (1996). *Best development practices: Doing the right thing and making money at the same time*. Tallahassee, FL: Florida Department of Community Affairs.

Florida is expected to grow by five million people over the next 20 years. Without changes in development policy and practice, this growth will take the form of urban sprawl, sprawl being Florida's now-dominant development pattern. The economic and social costs will be enormous. In *Best Development Practices,* we define good community development, as distinct from sprawl, in operational terms. Our recommendations cover four aspects of development–land use, transportation, environment, and housing. The emphasis is on the physical environment. Abstract by the author.

Lefaver, S. (2001). *Construction of transit-based development* (FHWA/CA/OR-2001/2002). San Jose, CA: Mineta Transportation Institute, San Jose State University. Retrieved Oct. 8, 2003, from http://transweb.sjsu.edu/publications/ConstructionTBD.htm http://transweb.sjsu.edu/publications/ConstructionTBD.pdf.

From this study, new policy initiatives for local, state, and national governments are recommended in order to encourage transit-based development. The recommendations include potential actions in land use, legislation, and fiscal powers. Six cities (five in California and one in Oregon) are examined as case studies. Each city has taken a different approach to transit-based development. Existing incentives for transit-based development, their success, and possible improvements were reviewed. The results to further encourage transit-based development included such recommendations as: adopting local land use policies and implementing them; using tax credit and tax-exempt private development to encourage affordable housing within transit-based development; and expanding legislation, such as the Transportation Enhancement Fund to encourage transit-based development.

Mineta Transportation Institute. (2001). *Envisioning neighborhoods with transit oriented development (TOD) potential*. San Jose, CA: San Jose State University, Mineta Transportation Institute. Retrieved Oct. 26, 2003, from http://transweb.sjsu.edu/publications/envisioning2/MTI2001_Etodp_website/.

This is an interactive website that presents the Envisioning Neighborhoods with Transit Oriented Development (TOD) Potential Project, which "seeks to introduce planners, developers, and urban analysts to information design techniques and digital computer tools which can be used to undertake and study TOD" (see also Bossard 2002 in this selection). The website offers case studies of six San Francisco Bay Area rail station areas and links to TOD-related sources in the Internet. However, at the time of the writing of this review, the site seemed to be still under construction and only partially implemented.

Parsons Brinkerhoff. (2002). *Statewide transit oriented development study: Factors for success in California*. Sacramento, CA: Caltrans. Retrieved Oct. 4, 2003, from http://www.dot.ca.gov/HQ/MassTrans/doc_pdf/TOD/Divided/TOD%20Study%20Final%20Report%20-%20cover%20and%20TOC.%2002.pdf http://www.dot.ca.gov/hq/MassTrans/doc_pdf/TOD/Divided/TOD%20Study%20Final%20Report%20-%20Section%202.pdf http://www.dot.ca.gov/hq/MassTrans/doc_pdf/TOD/Statewide%20TOD%20Study%20Final%20Report%20Sept.%2002.pdf http://www.dot.ca.gov/hq/MassTrans/doc_pdf/TOD/Divided/TOD%20Study%20Final%20Report%20-%20Section%204%20and%20Endnotes.pdf.

This study has taken a comprehensive look at the state of the art practice of transit oriented development in California and the United States. This 14-month study began in September 2000 and was completed by early 2002. The major objectives of this study were to: Define transit-oriented development and its successful components; describe the potential benefits of TOD; examine the status of implementation of TOD in the U.S. and California; identify the major barriers and impediments to the wider implementation of TOD; identify what is working well, as well as the need fro additional resources to overcome barriers; and finally, develop a set of potential strategies and activities that the state of California may implement to facilitate the broader implementation of TOD in this state. Abstract by the author.

Puget Sound Regional Council. (1999). *Creating transit station communities in the Central Puget Sound region*. Seattle, WA: Puget Sound Regional Council. Retrieved Oct. 8, 2003, from http://www.psrc.org/projects/tod/workbook.htm.

At its core, a transit station community is a compact, mixed use activity area centered around a transit station that by design encourages residents, workers, and shoppers to drive their cars less and ride mass transit more. The centerpiece of a transit community is the transit station—connecting the residents and workers to the rest of the region—and the civic and public spaces that surround it. The design, configuration, and mix of buildings and activities emphasize pedestrian-oriented environments and encourage the use of public transportation. The land uses within a transit station community are linked with convenient pedestrian walkways, and parking is managed to discourage dependence on the automobile. *Creating Transit Station Communities* can help transit agencies achieve transit-oriented land use development. The workbook focuses on the role that high capacity transit stations can play in stimulating and supporting local land use changes. The overall purpose for promoting transit-oriented land use development at transit stations is to increase region wide transit use and support local growth management objectives. Abstract by the author.

COUNTY, CITY, AND TRANSIT AGENCY STUDIES AND GUIDELINES

TOD experience across the nation varies a great deal in terms of location, size and type, challenges, strategies and rates of success. However, one common trait of the success stories profiled in the literature is that the leader agency (either the local government or the transit agency or both) produced and adopted TOD guidance systems and policies that served as action frameworks or roadmaps for TOD implementation. Depending on the specific local government and transit agency's urban or suburban context, these guidelines serve to direct a variety of TOD undertakings that can range from an urban infill or redevelopment project to a brownfield redevelopment or suburban greenfield development initiative, as well as from the very specific re-adaptive conversion of park-and-ride lots into TODs to the more broadly speaking conversion of TAD (transit adjacent development) to TOD.

This section contains two types of works: land use studies and TOD-related policy analyses and TOD land-guidance systems. Documents in the latter group take the form of standards and criteria intended to assist communities and transit agencies in working with the development industry. The first group of publications includes TOD studies such as those commissioned by the Akron Metropolitan Area Transportation District, the City of Forth Worth, TX, and the Forth Worth Transportation Authority, as well as the City of Houston, TX. The second group consists of "how to" handbooks and manuals with specific recommendations on how to implement JTD and how to apply urban design principles to station-area development. The Snohomish County Transportation Authority's (1993) *A Guide to Land Use and Public Transportation* and San Diego's *Transit Oriented-Development Design Guidelines* by Calthorpe Associates (1992) are now classic reference pieces repeatedly reproduced and emulated in local governments and transit agencies' TOD design guidelines and handbooks.

Akron Metropolitan Area Transportation Study. (2001). *Transportation access to development: A guide for local officials and developers*. Akron, OH: Akron Metropolitan Area Transportation Study. Retrieved Oct. 8, 2003, from http://ci.akron.oh.us/AMATS/whatsnew/forms/DevelopmentGuide-WebVersion.pdf.

A great deal of new commercial, residential, and industrial development has occurred in the AMATS area in recent years. From a transportation planning standpoint, there are two common problems associated with new developments:

1) Many are planned in a manner that does not take other modes of transportation into account. As a result, nearly all trips destined for the development are forced to use the automobile.
2) Many are designed in such a way that traffic flow on the adjoining arterial roadway is severely impeded.

The purpose of this Guide is to address these problems by reporting on strategies that encourage development patterns that are more pedestrian, bicycle, and transit-friendly, and that maintain traffic flow on adjoining roadways through access management techniques. Abstract by the author.

Alameda-Contra Costa Transit District. (1983). *Guide for including public transit in land use planning*. Oakland, CA: AC Transit.

This land use planning guide describes policies and approaches to integrate land use and public transit in order to bring about an increase in ridership. It lists the policies adopted by AC Transit to encourage greater use of the scarce public resource, namely public transit. It illustrates how to bring about development or redevelopment, that encourages

public transit use and is supportive of public transit and explains major considerations for transit planning like population densities, traffic generators and parking policies. It also illustrates location considerations for transit facilities that include transit orientation, transit corridors, and reverse commute trips. Factors to be considered while developing the design are street design and circulation, pedestrian access to public transit, and bus stops. It concludes that proper integration of transit and land use planning can bring about an increase in ridership.

Calthorpe Associates. (1992). *Transit-oriented development design guidelines*. San Diego: City of San Diego. Retrieved Oct. 8, 2003, from http://www.sandiego.gov/cityofvillages/pdf/todguide.pdf.

The aim of the Land Guidance Section of City of San Diego's Mobility Program is to reduce transportation demand through new and revised land development policies. This report intends to create an awareness of transit-oriented land development practices. It explains the applicability of transit-oriented development on redevelopable and urbanizing sites, new growth areas, core commercial areas, residential areas, secondary areas and open spaces. It offers design solutions that support transit by way of street design and circulation, transit stops and parking requirements.

Carter & Burgess. (2001). *Fort Worth transit alternatives analysis: Transit supportive land use policies.* Fort Worth, TX: The City of Fort Worth and The Fort Worth Transportation Authority. Retrieved Oct. 14, 2003, from http://www.fwtaa.org/PDF/report_r06.pdf.

As the ability to try to address congestion through continued expansion of roadways has become constrained by funding limitations, lack of right-of-way, federal mandates and growing opposition from citizens' groups, new policy approaches have been considered, and in some case actually implemented. These policy approaches include:

- Improving the quantity of and quality of infrastructure that serves pedestrians, bicyclists and high occupancy vehicles
- Increasing the price of auto travel relative to other modes of travel
- Regulating more directly the design of new development
- Restricting the spread of urban expansion
- Encouraging or requiring suburban development at higher densities
- Creating nodes of new high intensity development.

The City of Fort Worth's 2000 Comprehensive Plan and recently adopted Mixed Use zoning address, to some degree, five of the six policy types listed above. The purpose of this report is to present an overview of land use and transportation policies, present examples where such policies have been implemented and identify additional policies that could be implemented by the City of Fort Worth to meet goals and objectives presented in the 2000 Comprehensive Plan. Abstract taken from author's introduction (p.1).

Center for Urban Transportation Research. (1994). *Land development and subdivision regulations that support access management for Florida cities and counties*. Retrieved Oct. 14, 2003, from http://www.cutr.usf.edu/research/access_m/pdf/Land_Regs.pdf.

This report presents strategies for local access management programs framed under local comprehensive and subarea plans. It discusses access management approaches that address issues related to the division and subdivision of land associated with commercial development along thoroughfares, flag lots, residential strips,

etc. It presents model land development and subdivision regulations that cities and counties can use with transportation departments to: foster well designed circulation systems that improve the safety and character of commercial corridors; discourage subdivision practices that destroy the rural character of the landscape or essential natural resources; advance economic development goals by promoting more efficient use of land and transportation systems; and help control public service costs and the substantial public investment in infrastructure and services. Abstract taken from author's introduction (p. 1-10).

Denver Regional Transportation District. (1996). *Creating livable communities: A transit friendly approach*. Denver, CO: Regional Transportation District.

The purpose of this document is to provide a process with guidelines, standards and criteria, for communities who wish to encourage transit-oriented development in their jurisdiction. The manual consists of five chapters. Chapter 1 provides background on transit-oriented development, dicusses the benefits of TOD and explains role of government in achieving TOD. Chapter 2 addresses provision of transit in the Denver region and the types of transit planning areas in the region. Chapter 3 describes a process and identifies policies, strategies and regulatory tools that can be utilized to accomplish TOD. Chapter 4 provides guidelines for transit-oriented development. Chapter 5 discusses ways in which each local community, working with RTD and the development industry, can begin implementing these strategies and techniques.

Goodwin, R. E. (1997). *Land value assessment near bus transit facilities: A case study of selected transit centers in Houston, Texas* (SWUTC/98/721924-1). Houston, TX: Texas Southern University. Retrieved Oct. 17, 2003, from http://utc.dot.gov/cgi-bin/displayDocument.cgi?doc_group_id=1.

This is a study designed to measure the potential impacts of transportation facilities upon land values of contiguous properties compared to non-contiguous properties, within a quarter-mile "zone of influence". A survey was designed and randomly administered to residents within each stated zone of influence, and provided information about the neighborhood and land values. The results of the survey were compared to data from the Harris County appraisal District. Census data were obtained to measure demographic changes from 1980 to 1990 and determine the relationship between socioeconomic variables and the transit facility. The existence of the transit facility was welcomed by a majority of the residents, although adjacent land values did decrease near three of the four facilities. The areas where the transit sites are located experienced decreases in population over the period 1980 to 1990, and coincide with the general population decline that occurred within Houston's inner freeway loop. Overall the findings indicate that the transit facility was not the overriding variable causing changes in land values. Abstract by author.

Lincks & Associates Inc. (1994). *Transit-friendly development*. Tampa, FL: Hillsborough Area Regional Transit (HARTline).

There is an emerging trend of basing development and land use performance standards on the specific characteristics and needs of a community. Therefore this study includes a major research effort that provided a factual foundation upon which to build the recommended local program. The purpose of the report is to establish workable *transit-friendly*

development principles that could be implemented by the different governmental units in Hillsborough County. The process followed in this report begins with the consideration of general principles and progresses towards specific solutions of commonplace development problems. The report presents conclusions and recommendations of the research process after the introduction of what is known as a transit-friendly development. This section of the report describes the principles of transit-friendly design and also presents issues that need to be overcome in achieving it. The final section presents case studies of transit-friendly designs and provides implementation procedures.

Lincks & Associates Inc. (1993). *Transit-friendly development: Task 2 principles*. Tampa, FL: Hillsborough Area Regional Transit (HARTline).

This working paper is an overview of land use planning, traffic engineering and urban design principles that can be utilized to encourage transit usage. Based on findings from previous literature and telephone interviews with transit agencies, the paper presents discussion on land use planning principles, operational criteria, building and urban design standards, and integration of transit into the community. The paper concludes with recommendations of preferred development incentives that would support increased transit usage.

Seattle Metro. (1987). *Encouraging public transportation through effective land use actions*. Seattle, WA: Seattle Metro. Retrieved Oct. 24, 2003, from http://dnr.metrokc.gov/WTD/library/mr6090.htm.

This is a companion document to Metro's *Transportation Service Guidelines* and the *Metro Transportation Facility Design Guidelines*. It provides information for local planning staffs on the effects of land use decisions on public transportation service and provides guidelines for the private sector on how to design new projects to be compatible with public transportation.

Snohomish County Transporation Authority. (1989). *A guide to land use and public transportation*. Lynnwood, WA: Unites States Department of Transportation.

The authors offer suggestions to local jurisdictions, developers, community groups, and land owners working with their local transit operators to locate and design activities and facilities and change trip-making behaviors so that alternatives to autos can become reality. They present the advantages of two common forms of public transportation —buses and ridesharing. They illustrate how developers and business people can derive substantial benefits by integrating public transportation into their development projects and businesses. They present model public transportation supportive goals and policies for community plans. They conclude with the idea that if a community's plan contains public transportation-friendly goals and policies, then zoning provisions can put those goals and policies into action.

Snohomish County Transportation Authority. (1993). *A guide to land use and public transportation volume ii: Applying the concepts*. Lynnwood, WA: Unites States Department of Transportation.

The report points out the differences between suburban sprawl development and planned development in terms of design, compatibility of land uses and support for public transit. It presents the characteristics and advantages of transit-compatible site plans over typical site plans and presents guidelines on how to plan sites that are transit compatible.

JOURNAL ARTICLES ON TRANSIT-ORIENTED DEVELOPMENT AND TRANSIT-FRIENDLY DEVELOPMENT

Thematically the articles contained in this section encompass a wide range of topics including: analyses of TOD implementation processes (Boarnet 1999); assessments of TOD prototypes (Atash 1994); TOD's suitability analyses (Banai 1998); studies of TOD influence on mode choice and travel (Cervero 1996, 2002; Crane 1998; Shinbein 1997); assessments of TOD market potential and real estate impact (Cervero and Bosselman 1998, Nelson 1999, Pulugurtha and Nambisan 1999), and urban and suburban TODs comparisons (Filion 2001). Collectively these annotated sources provide a glimpse of academic and professional efforts to come to terms with the many issues of TOD implementation as well as to assess and gauge the overall modal choice, quality of life, and urban development impact associated with TOD.

Atash, F. (1994). Redesigning suburbia for walking and transit: Emerging concepts. *Journal of Urban Planning and Development, ASCE 120* (1), 48-57.

Suburban sprawl has caused many problems in the last several decades. Of particular concern is over reliance on the automobile and the lack of alternative forms of transportation such as walking, bicycling, and transit. The advocates of neo-traditional town planning have developed the traditional neighborhood development (TND) and pedestrian pocket (PP) concepts for redesigning American suburbia to solve its deficiencies. This paper describes these concepts and then evaluates their potential usefulness to allow walking and transit in suburbia. It is concluded that these concepts offer a unique opportunity to integrate land-use and suburban development policies with transportation policy to stop sprawl and create compact, mixed-use communities. The pedestrian pocket offers a better potential for developing a new suburban growth pattern on a metropolitan scale that is pedestrian- and transit-oriented. Its successful implementation depends on the existence of a supportive metropolitan-scale land-use and transportation plan. Abstract by the author.

Banai, R. (1998). Transit-oriented development suitability analysis by the analytic hierarchy process and a geographic information system: A prototype procedure. *Journal of Public Transportation, 2* (1), 43-64.

A prototype procedure is illustrated to assess the suitability of land use around proposed light rail transit stations of a metropolitan area, with an example of a focus on one station area land use pattern. Transit oriented development (TOD) guidelines provide the criteria for an assessment. The procedure for assessment is facilitated by a geographic information system (GIS), and the Analytic Hierarchy Process (AHP), a multicriteria methodology that is increasingly employed in conjunction with geographic information systems. The weights of the criteria are determined through paired comparisons (relative measurement), and a ratings intensity scale is used to determine the scores of land units (absolute measurement). This flexibility in measurement is helpful in situations where land use criteria, such as TOD guidelines, as suitability factors and with certain desirable thresholds of intensity are known, but must be considered strategically and adaptively, responsive to local priorities and site-specific conditions. The scores of land uses on a scale of zero to 100 percent are determined, which indicate the degrees of the suitability of a transit station area as a potential TOD. As well, the proportions suggest changes that target particular parcels—individually and as a group—so as to bring about a desirable mix of the public, core/employment, and housing uses for an urban TOD. This prototype application highlights the versatile properties of the AHP, particularly when used in the specific context of a development paradigm (TOD) in conjunction with a geographic information system that has not been previously addressed in the literature on

applications. Abstract by the author.

Boarnet, M. (1999). Transit oriented development in San Diego County: The incremental implementation of a planning idea. *Journal of the American Planning Association, 65* (1), 80-95.

Although transit-oriented development (TOD) has become an increasingly popular planning idea, very few studies have examined how localities plan for and implement transit-oriented projects. This article helps fill that gap by studying the TOD implementation process near stations on the oldest of the current generation of light rail lines in the United States—the San Diego Trolley. Some parts of the San Diego Trolley have been in operation since 1981, but there are still only a few projects that both incorporate TOD concepts and were built after planning for the nearby rail line began. TOD projects were pursued most aggressively in the City of La Mesa, largely because TOD was consistent with local goals that went beyond transportation. Elsewhere in the San Diego region, several barriers have limited TOD implementation. Overall, the cities along trolley routes, though sympathetic to regional rail objectives, have approached TOD from a perspective of local goals, opportunities, and constraints. The result is that regional TOD implementation resembles the incremental model of policy-making. One implication of the San Diego experience is that incorporating TOD concepts into station-area developments is likely to be a slow process. Abstract by the author.

Cervero, R. (2002). Built environments and mode choice: Toward a normative framework. *Transportation Research Part D: Transport and Environment, 7* (4), 245-284.

Compact, mixed-use, and walk-friendly urban development, many contend, can significantly influence the modes people choose to travel. Despite a voluminous empirical literature, most past studies have failed to adequately specify relationships for purposes of drawing inferences about the importance of built-environment factors in shaping mode choice. This paper frames the study of mode choice in Montgomery County, Maryland around a normative model that weighs the influences of not only three core dimensions of built environments—density, diversity, and design—but factors related to generalized cost and socioeconomic attributes of travelers as well. The marginal contributions of built-environment factors to a traditionally specified utility-based model of mode choice are measured. The analysis reveals intensities and mixtures of land use significantly influence decisions to drive-alone, share a ride, or patronize transit, while the influences of urban design tend to be more modest. Elasticities that summarize relationships are also presented, and recommendations are offered on how outputs from conventional mode-choice models might be "post-process"; to better account for the impacts of built environments when testing land-use scenarios. Abstract by the author.

Cervero, R. (2003). Green connectors: Off-shore examples. *Planning, 69* (5), 25-29.

Cervero gives examples from Europe and Bogota, Colombia of ways that America can change from being park-and-ride centered to providing more car-free transit access.

Cervero, R. (1996). Traditional neighborhoods and commuting in the San Francisco Bay Area. *Transportation, 23* (4), 373-394.

Neo-traditional designs, proponents argue, reduce dependency on the automobile and provide attractive environments for walking, bicycling, and transit riding. This paper explores the extent to which this proposition holds for seven traditional neighborhoods in the San Francisco Bay Area that evolved

around early streetcar services. Matched-pair comparisons of modal shares and trip generation rates for work trips are made between these neighborhoods and newer auto-oriented suburbs, controlling for the effects of income and, to a lesser extent, existing bus service levels. Pedestrian/bicycle modal shares and trip rates tended to be considerably higher in transit-oriented than in the paired auto-oriented neighborhood. Higher residential densities were also found to have a proportionately greater impact on transit commuting in transit-oriented than in auto-oriented neighborhoods. The paper concludes that neo-traditional development must be coordinated with larger regional planning efforts and public policy initiatives to reduce automobile dependency. Abstract by the author.

Cervero, R., & Bosselmann, P. (1998). Transit villages: Assessing the market potential through visual stimulation. *Journal of Architecture and Planning and Research, 15* (3), 181-196.

Transit villages could reduce automobile dependency and improve urban environments; however, there are few contemporary examples of such development, in part because of uncertainty about the market demand for transit-oriented living. This article assesses the market potential of transit villages using visual simulation techniques. Photoslide images were created to simulate a 'walk' through four neighborhoods with different density and amenity mixes. Based on the survey responses of over 170 Bay Area residents, the lowest density neighborhood was the most preferred. However, far more respondents liked the simulated transit village designed at 36 dwellings per acre with nicer amenities than liked the village designed at 24 dwellings per acre but with fewer community services. The research suggests Americans will trade-off higher residential densities for more amenities in transit village settings. Visual simulations, we believe, provide a richer context for probing the market potential for transit-oriented development than do traditional market research approaches because visual simulations convey a wider array of environmental choices. Abstract by the authors.

Crane, R. (1998). Does neighborhood design influence travel? A behavioral analysis of travel diary and GIS data. *Transportation Research Part D: Transport and Environment, 3D* (4), 225-238.

Can urban design improve the environment? If communities could be designed to reduce automobile use, then yes. But can urban design influence travel? Surprisingly perhaps, the effects of any specific neighborhood feature on travel behavior at the margin are all but unknown. The policy significance of this issue is reflected in the swelling popularity of the "new urbanism" and other planning strategies employing land use tools to mitigate the environmental impacts of metropolitan development. In addition to asserting that development patterns and densities affect how far, how often, and by what means people travel, urban designers frequently argue that the legibility and shape of the local street pattern play a key role. "Connected" residential blocks are thus associated with less driving by comparison with the circuitous routes of the modern suburban cul-de-sac—chiefly by reducing trip lengths and facilitating pedestrian and transit access. Remarkably, there is little empirical and theoretical support for these claims. This paper provides the first direct tests of these hypotheses within a consistent behavioral framework. An analysis of household travel diary and GIS data for San Diego finds little role for land use in explaining travel behavior, and no evidence that the street network pattern affects either short or long non-work travel decisions. While results may vary in other areas, the empirical argument for using land use as an element of regional air quality or other environmental plans remains to be demonstrated. Abstract by the author.

Filion, P. (2001). Suburban mixed-use centers and urban dispersion: What difference do they make? *Environment and Planning A, 33* (1), 141-160.

In a context of growing car dependency and suburban sprawl, planners search for ways of intensifying urban development and reducing reliance on the automobile. The creation of planned mixed-use centers intended to become hubs of transit and pedestrian movement within the dispersed suburban environment represents one such intensification strategy. I investigate three suburban mixed-use centers in the Greater Toronto Area, selected for their advanced level of development, and identify the planning rationales and objectives that have led to their creation. To verify the extent to which they meet their intensification goal, I monitor the three selected centers' level of development, modal split, land-use pattern, inner synergy, and inner movements. Findings are mixed. If the suburban centers have been successful in attracting development and attaining levels of transit use, pedestrian movement and inner synergy exceeding those of the typical suburban area, they are not as distinct from the remainder of the suburb as intended and thus fall short from their planning objectives. I conclude that a strategy combining the creation of nodes (such as suburban mixed-use centers) with high-density, transit-oriented corridors within the suburban environment would be more effective in bringing intensification to this portion of the metropolitan region. Abstract by the author.

Frank, L. D. (1999). Assessing transit station area redevelopment: A case study of the Lindbergh Station in Atlanta. *Journal of Public Transportation, 2* (3), 21-51.

This article assesses the land-use, demographic, circulation, and economic development attributes of transit station area development. Findings from this assessment are applied to the Lindbergh Metropolitan Atlanta Rapid Transit Authority (MARTA) Station area in Atlanta, Georgia, for which a private-public partnership is currently being negotiated. Recommendations for the redevelopment of the Lindbergh Station area are provided, including a schematic design that integrates those recommendations. The resulting recommendations are intended to maximize the likelihood for transit ridership and economic benefit while offsetting traffic congestion and vehicle emissions—in keeping with the objectives of the Federal Transit Administration's Livable Communities Initiative. A safe and inviting walking environment throughout a station area—extending well beyond the area of physical redevelopment itself—is fundamental to achieving these objectives. Existing barrier effects and lack of pedestrian connectivity associated with major transportation corridors within the Lindbergh Station area will significantly offset transportation and environmental benefits on which public investment in the redevelopment is predicated. Solutions are required that provide not only safer street crossings, but a larger proportion of rights-of-way devoted to pedestrian movement and the development of a street life. Priority should be given to pedestrian improvements that increase access to transit for traditionally undeserved populations. Finally, open space is required to effectively compete with other more auto-dependent areas and to draw higher income populations to transit station areas. Abstract by the author.

Kreyling, C. (2001). Hug that transit station. *Planning, 67* (1), 4-9.

New transit agencies across the country-in New Jersey, Atlanta, the San Francisco Bay region, and elsewhere-are taking up the cause of a new approach to transit station planning. Their hope is that by locating housing and shops within walking distance of stations, they can increase ridership and

rejuvenate surrounding communities. One ambitious planned community called Orenco Station is being built around a light rail station in Hillsboro, OR, located ten miles west Portland. When complete in 2002, the development will include more than 1,800 housing units plus offices and shops, on 200 acres of what was originally zoned as industrial land. Extended cases are cited for the Bay Area Rapid Transit (BART) system in the San Francisco Bay Area, the Atlanta Metropolitan Area Rapid Transit Authority (MARTA), and five so-called transit villages in New Jersey. Strategies for building such complexes are discussed.[9]

Loukaitou-Sideris, A. (2000). Transit-oriented development in the inner city: A Delphi survey. *Journal of Public Transportation, 3* (2), 75-97.

This study presents the results of a three-round Delphi survey that focused on issues and opportunities related to transit-oriented development (TOD) in U.S. inner cities. The survey queried a panel of 25 experts about the various goals and objectives of the practice of TOD, as well as the preconditions and constraints surrounding such development in economically disadvantaged areas of the inner city. Starting from a wide range of responses, the panel was eventually able, through the Delphi process, to focus on specific issues and propose a concrete set of strategies for the implementation of TODs. Abstract by the author.

Nelson, A. C. (1999). Transit stations and commercial property values: A case study with policy and land-use implications. *Journal of Public Transportation, 2* (3), 77-93.

There is little research about the association between rail transit station proximity and commercial property values. There is even less research on the role of public policy in influencing commercial property markets near transit stations without resorting to supply-side constraints. The research reported in this article helps close these gaps in research. This article develops a theory on commercial property value with respect to both transit station proximity and the role of policies that encourage commercial development around transit stations without discouraging commercial development elsewhere. The theory is applied to the universe of commercial property sales in the area of Atlanta known as Midtown, which is located about 1 kilometer north of the downtown edge. Midtown is served by three heavy rail transit stations operated by the Metropolitan Atlanta Rapid Transit Authority (MARTA). To encourage development around MARTA stations, Atlanta waives parking and floor area ratio requirements in Special Public Interest Districts (SPIDs) located around rail stations. Research shows that commercial property values are influenced positively by both access to rail stations and policies that encourage more intensive development around those stations. This article explores both theoretical and policy implications. Abstract by the author.

Pulugurtha, S. S., & Nambisan, S. S. (1999). Evaluating transit market potential and selecting locations of transit service facilities using GIS. *Journal of Public Transportation, 2* (4), 76-92.

Accessibility to transit service facility (TSF) locations plays a significant role in the success of public transportation systems. The ease with which the end-user can reach a TSF (e.g., bus stops, rail stations, or multimodal centers) plays prominently in the decision-making process of the individual. This article presents a working definition for transit market potential based on accessibility in terms of walking distance and walking time. Further, a measure is constructed to evaluate transit market potential for TSF locations for a transit system. The measure of transit potential is represented by an index value based on demographic criteria such as employment, household size, vehicle ownership, etc. This index can be used to identify

locations of TSFs that increase a route's potential for ridership. A methodology is proposed to estimate the Index of Transit Potential for TSFs. This methodology involves (1) identifying the accessible network of streets around each TSF that is within an acceptable access threshold for a transit rider and (2) estimating the transit market potential based on key demographic characteristics. The analytical and visualization capabilities of a Geographic Information Systems (GIS) program are utilized to help attain the objective. A case study is used to demonstrate the application of the methodology. In the case study, a portion of a route of the Las Vegas Citizens Area Transit (CAT) system is analyzed and the Index of Transit Potential is estimated. The index values are then used to locate TSFs along the route. This is compared with the existing stop locations for the route. Abstract by the authors.

Shinbein, P. (1997). Multimodal approaches to land use planning. *ITE Journal, 67* (3), 26-32.

In the US suburban land use patterns that exclusively accommodate the automobile afford little choice in other travel mode options and in fact increase automobile trip-making. Walking, biking and mass transit are not encouraged options for most travel due to segregated land uses and low densities resulting in dispersed origins and destinations. In order to make alternative modes more viable, a more balanced approach to planning that includes transportation modes is warranted. Compact, mixed-use land development places employment and retail activities in closer proximity to living areas with designs that favor nonmotorized transportation and transit access. Benefits of these developments include automobile trip reduction, decreased road congestion and lowering of urban area vehicle miles of travel. These new developments do not exclude the automobile; rather they favor pedestrian and transit activity. Bus or rail transit service would be available, providing viable transportation alternatives to shopping and employment activities in other communities and areas. Abstract by the author.

Tumlin, J., & Millard-Ball, A. (2003). How to make transit-oriented development work. *Planning, 69* (5), 14-19.

The authors discuss how to achieve true transit-oriented development as opposed to transit-adjacent development. They incorporate Robert Cervero's "three D's" of density, design, and diversity while stressing the important role parking plays in developing and maintaining a TOD environment. Several real-world examples are given as well as a TOD check list.

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3.2: Parking and Auto Relationship to Transit

There are two fundamental approaches to parking and transit. The first, in the form of park-and-ride and kiss-and-ride facilities, views parking as necessary to attract and serve transit patrons beyond a pedestrian catchment area. This type of parking is often controlled and provided by the transit agency. The second approach involves reduced parking ratios for residential and non-residential land uses premised on the assumption that commuters will substitute car trips for transit trips. This type of parking is associated with transit-oriented development (TOD) and is often controlled by the local jurisdiction through a variety of planning tools, land development regulations, and municipal codes that establish the permitted minimum and maximum parking ratios (see Table 1 for examples from Florida). Permitted parking ratios, especially in TOD station areas, result from an intensive negotiated process between the local jurisdiction, the transit agency, the area's business community (i.e., employers, merchants), developers, surrounding neighbors, and lending agencies. For a detailed case study analysis of TOD and parking see Parsons and Brinckerhoff's (2002) special report *Parking and TOD: Challenges and Opportunities*, annotated in this section.

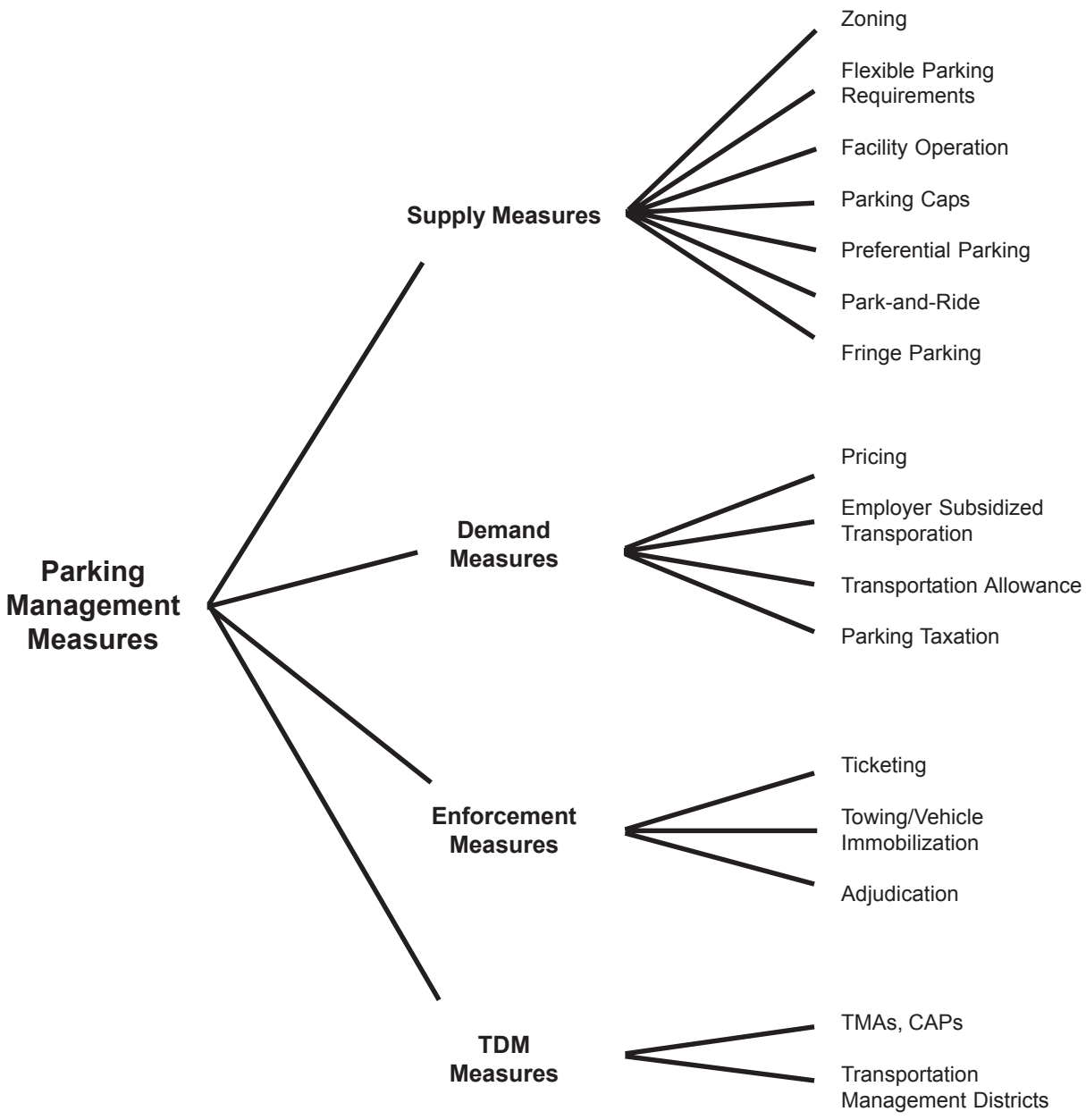
As depicted in Figure 1, there are a variety of parking management approaches devised to influence the demand and supply of parking. Controlling the parking supply is typically the method endorsed by TOD design manuals and transportation planners for shifting people's mode of travel from car to transit. Parking supply mechanisms such as zoning, flexible parking requirements, and parking caps are applied and administered to development projects through local codes. These mechanisms generally control the supply of privately built parking. On the other hand, local jurisdictions —in the case of on-street and municipally owned parking garages— the transit agencies—station area park-and-ride facilities—and other public agencies control the supply of public parking. Examples of this include local jurisdictions' use of on-street metered parking and parking garages and transit agencies' use of kiss-and-ride facilities. How and whether transit considerations are incorporated in local codes strongly depends on the nature and strength of interagency coordination between jurisdictions and transit agencies and on the quality of the local transit service. In contrast, a large number of factors such as the price of parking, price of gasoline, state of the economy, attractiveness of on- versus off-street parking, crime and safety issues—often beyond the control of transit agencies and jurisdictions—influence parking demand. Therefore, shifting the cost of parking from the employer, retailer, municipality or transit agency to the driver through parking charges is another frequently used method for reducing parking demand. The underlying expectation of this measure is that an increasing number of drivers will shift to transit and alternative modes of travel.

Table 1. Parking Requirements in Four Florida Central Business Districts

City	Residential				Non Residential							
	Single Family		Multifamily		GFA > 10,000 sq ft		GFA < 10,000 sq ft					
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.				
Orlando	1 per 2 patrons	None	1-2 /unit [depending on number of bedrooms]	None	2 / 1,000 sq ft GFA	3 / 1,000 sq ft GFA	None	2 / 1,000 sq ft GFA				
					Office		Retail		Hotel		Restaurant	
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Miami	None	2 per dw elling	None	None	1 / 1,000 sq ft² GFA	1/ 600 sq ft GFA	None	1 / 300 sq ft GFA	None	1.5 per room	None	1/ 100 sq ft GFA
Ft. Lauderdale	1 / unit	none	1.2 / unit	None	1 / 400 sq ft of GFA [in excess of 2,500 sq ft]	None	1 / 400 sq ft of GFA [in excess of 2,500 sq ft]	None	0.75 per room	None	1 / 50 sq ft GFA of customer service	None
Ft. Myers	2 per dw elling	None	1.5 per 1 Bed unit; 2 per 2 or more Bed units	None	1 / 250 sq ft GFA	None	1 / 300 sq ft GFA	None	1.25 per room	None	1 per 3 seats	None

GFA = Gross Floor Area

Source: Center for Urban Transportation Research (1993)



Source: Center for Urban Transportation Research (1993) *Parking and Transit Policy Study*, p. 3
TDM = Transportation Demand Management
TMA = Transportation Management Associations
CAP = Commuter Assistance Programs

PARKING MANAGEMENT ESSENTIAL IN TOD

The parking approach to TOD acknowledges that cars will continue to be a major way to access transit stations and facilities, but also attempts to promote pedestrian and transit-supportive mixed land uses and densities in and around station areas. This requires aggressive parking and access management measures that can adequately balance the conflicting demands for access and circulation of pedestrians, cyclists, and automobile drivers within a compact area. Off-street parking requires about 350 square feet per space due to driveways, drive aisles, landscaping and pedestrian walkways. Thus, it consumes 1.8 times more land area than on-street parking, which requires about 190 to 200 square feet per space. According to the Puget Sound Regional Council's (1999) *Creating Transit Station Communities* (abstracted in the previous section), applying typical suburban off-street parking standards to a mixed-use station area would require two blocks of surface parking for every one block of two-story buildings. In other words, two-thirds of the land would be devoted to automobile circulation and parking and the remaining third to all other activities. Clearly, typical surface parking standards are not appropriate to accomodate parking demand in compact station area development.

Solutions to this crucial issue in TOD development range from reducing parking ratios and putting most parking on streets to building underground and above-ground parking garages. Since spaces in structured parking can cost from $10,000 to $30,000 vis-à-vis $5,000 per space in surface lots, inevitably, structured parking is a costly solution challenging TOD development due to unrelenting parking demand and the relatively low rates of cars substituted for transit experienced to date. Also when parking ratios have been set on the tight side, parking tends to spill over to neighboring areas and to become a troubling issue that requires strong parking management measures. These measures can vary from preferential parking (e.g., for short-term parking and car pooling) and intense enforcement to the establishment of parking and transportation management districts. In fact, the State of Maryland's Smart Growth TOD Task Force, acknowledges this barrier to TOD financing and construction by recommending in 2000 that the State create a program to fund parking structures. Through the Maryland Transportation Authority the State will provide financial support for structured parking in TODs. Such aggressive demand management programs should decrease the negative effects of the program where the supply of parking would have been squeezed out by reduced parking ratios or by the redevelopment of surface lots (Parsons and Brinckerhoff 2002).

PRINCIPLES FOR EFFECTIVE PARKING MANAGEMENT

The handbook *Creating Transit Station Communities* by the Puget Sound Regional Council (1999, pp. 34–40) makes the following 14 recommendations for effective parking management in TOD.

1. Carefully control the total supply of parking by applying reduced parking standards and avoiding large surface parking lots.
2. Use parking charges to control demand for parking by shifting the cost of parking from employer and retailer to the automobile driver. Establish preferential parking rates emphasizing short-term and car-pool parking and discourage commuter parking.
3. Keep the size of surface small—below two acres in size—and tuck them behind buildings.
4. Design and plan surface lots to convert to other uses over time as a first phase of long-term development strategy.
5. Encourage the development of parking structures.

6. Encourage development on street-side edges of parking structures by providing ground and first-level retail or other activities in structured parking such that parking stalls and structures do not dominate the frontage of the property abutting the pedestrian realm.
7. Carefully plan and design park-and-ride lots by giving special attention to the location and type of park-and-ride lot in terms of the entire system's goals and functions.
8. Locate parking lots behind buildings or in the interior of a block to avoid conflict with pedestrians and encourage access via driveways or alleys located in the rear.
9. Design parking lots and garages with pedestrians in mind by providing a well interconnected and well lit network of pedestrian walkways linking the parking lot to all building entrances.
10. Provide adequate bicycle parking by placing it closer to the building than any automobile parking and separate it from wheelchair access. Bike parking should not be hidden. It should be rather visible from the street or buildings.
11. Encourage joint use of parking spaces for adjacent uses with staggered peak periods of demand such as retail, office and entertainment.
12. Support the creation of public community parking lots for short-term parking, which can be financed via assessment districts or other mechanisms.
13. Provide on-street parking on pedestrian streets. This brings activity to the street and buffers the pedestrian from vehicle traffic.
14. Ensure convenient access for transit vehicles by avoiding conflicts between circulating automobiles and buses. This is accomplished by locating parking lot entrances and exits away from heavy bus traffic and by providing safe walkways and travel routes where bus patrons must cross parking lots.

Although the above recommendations are considered best practice for parking in TOD, particularly since strict adherence to conventional parking standards developed by the Institute of Transportation Engineers (ITE) often results in oversupply of parking, the literature shows that the experience implementing best practice TOD parking principles is very mixed, and to date, "there are no clear conclusions regarding how much parking may reasonably be reduced for any particular TOD. Therefore parking needs must be calculated on a site-by-site basis" (see also Higgins (1993) *Parking Requirements for Transit-Oriented Development* in this selection).[10] Table 1 shows the parking standards applied in four Florida central business districts and Table 2 shows parking solutions and parking ratios as practiced by a diverse number of TOD station areas. Some jurisdictions have adopted specific TOD parking standards. In others, recognizing a project's proximity to transit, developers have simply negotiated variances from the application of conventional parking standards with local jurisdictions or transit agencies.

ORGANIZATION OF THE LITERATURE

The annotated literature included in this section is grouped into general and specific studies and recommendations regarding parking and transit. In the general category we have included reports, articles and studies whose recommendations are based on data from a variety of cases. These include national state, and regional studies. In the specific category we have classified publications on parking management related to specific management practices (e.g., shared parking, district parking, transit pass programs, etc.) or parking studies commissioned by specific localities.

Table 2. Parking Requirements at Transit-Oriented-Development Sites

Source: Parsons Brinckerhoff (2002) *Statewide Transit-Oriented Development: Parking and TOD, Challenges and Opportunities.* Retrieved on Dec. 10, 2003, from http://www.dot.ca.gov/hq/MassTrans/doc_pdf/TOD/Parking%20and%20TOD%20%20Report.pdf

TOD Site	Transit	TOD Characteristics	Parking Characteristics	Parking Ratios					
				Retail	TOD Retail	Residential	TOD Residential	Hotel/ Guest	Office
Pacific Court, Long Beach, CA	LRT & bus	2-ac, mixed-use, infill, urban location, 142 apartments, 96,000 ft² retail	Developer built 400 undergroud parking spaces; plus public parking lots in the area	5 / 1,000 ft²	2 / 1,000 ft²	1 / studio; 2 / 1 + Bd unit	1 / studio; 2 / 1 + Bd unit	Guest: 3 / 10 units	None
Hollywood/ Highland, Los Angeles, CA	Heavy rail & bus	Major entertainment & retail complex on 8.7 ac, 640 room hotel, 6 screen multiplex theater, MTA bus transfer station, and kiss-&-ride zone	3,000-space underground parking structure	2-4 / 1,000 ft²	None	None	None	None	2 / 1,000 ft² for office/retail in redevelopment areas
No Ho, Arts District, Los Angeles, CA	Bus (25-40 min.)	"Art park" created from a vacant lot; a nonprofit's redevelopment project	85 space parking lot; parking spillover from subway station 3 blocks away	2-4 / 1,000 ft²	None	None	None	None	2 / 1,000 ft² for office/retail in redevelopment areas
Uptown District, San Diego, CA	Bus (15-30 min.)	14-ac, mixed-use, infill, urban, 42,500 sq ft market, 66,000 ft² ground level retail, 28,500 ft² upper level commercial, a 3,000 ft² community center, and 320 dwelling units	1,068 spaces, under-ground. Street-level spaces for retail shoppers. No parking for transit riders. Residents walk to bus stop.	1/250 ft²	1/285 ft²	2.25/unit	None	None	None
Martin Luther King, Jr. Plaza, Miami, Fl	LRT & bus	Office = 191,000 ft²; retail/restaurant = 3,000 ft²	800 existing garage spaces constructed by transit agency	Retail/ Restaurant 1/50 ft²	None	None	None	None	1/250 ft²
Dadeland-South, Miami, Fl	LRT & bus	Suburban project: Office = 290,000 ft²; Hotel = 605 rooms	2500-spaces structured parking	1/250 ft²		1.5/1 Bd; 1.75/2 Bd; 2/3 Bd	1/unit	Hotel: 1/2 rooms	1/250 ft² TOD: 1/400 ft²
Mockingbird Station, Dallas, TX	LRT & bus	Suburban project: Office = 140,000 ft²; Hotel = 250 rooms; Residential = 211 loft apartments	1,600-space parking, 72% underground, rest surface and structure	4 / 1,000 ft²			1.16/unit	Hotel: 1/1 rooms	3/1,000 ft²

PARKING AND TRANSIT "GENERAL" STUDIES

Center for Urban Transportation Research (CUTR). (1993). *Parking and transit policy study: Overview of urban transit and parking policies* (Technical Memorandum No.1). Tampa, FL: CUTR, College of Engineering, University of South Florida.

This report, the first of three technical memoranda, describes parking policies currently in place in Florida and in other states and identifies issues related to policy implementation. Firstly it presents a summary of parking and transit policy-related literature. Then it discusses the regulatory framework that exists within the systematic planning process in Florida. It provides an overview of the urban areas in Florida that have fixed-route transit system and offers preliminary data on four Florida urban areas that have been selected for a closer examination of parking and transit coordination. The last section is a summary of this report and discusses issues that will be addressed in two future technical memoranda. Abstract by the author.

Dueker, K., Strathman, J., & Bianco, M. (1998). *Strategies to attract auto users to public transportation.* (TCRP Report 40). Washington, D.C.: Transportation Research Board. Retrieved Dec. 15, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_40.pdf

TCRP Report 40 focuses on parking strategies as a means of increasing transit patronage, particularly for work trips. This report will be of interest to transportation and urban planners and to local decisionmakers. The effectiveness of automobile parking strategies as a means of increasing transit ridership was analyzed. Eight strategies affecting the price and availability of parking and transit service levels were examined, alone and in combination, to assess their effects on travel mode choice, particularly transit. The final chapter of the report is an implementation guide for transportation planners and decisionmakers.

The study concludes that no single strategy is both effective and politically feasible enough to warrant implementation throughout a metropolitan area. Rather, the researchers recommend that policymakers implement combinations of parking strategies, in response to the policy and transportation objectives of specific geographical areas. The final chapter of the report, an implementation guide, provides forms, examples, and other information to assist agencies in selecting combinations of parking strategies that will be appropriate for local needs. Abstract by the authors.

Ewing, R. (1997). *Transportation and land use innovations: When you can't pave your way out of congestion*. Tallahassee, FL: Florida Department of Transportation.

Vehicle miles of travel (VMT) have risen at an alarming rate. Between 1983 and 1990, VMT in the U.S. grew by 42%, about seven times the growth of the population. We cannot build roads fast enough to keep up with VMT. By the best available estimate, a 1 percent increase in highway lane miles leads, after only 4 years, to a .9 percent increase in metropolitan VMT. Even if we had the resources, would we want to supply all the road capacity demanded? The out of pocket costs of auto use are low- averaging about 11 cents a mile; depreciation, insurance, and other fixed costs add another 29 cents per mile. These costs are borne by auto users themselves. But when you consider road subsidies from the general taxpayer, costs of free parking, and various social costs, the automobile is extraordinarily expensive. To charge auto users for all social costs would require a gas tax of $1.80 to $3.00 per gallon. Moreover, the ability of some to travel far and fast by automobile does not translate into mobility for all. A full 37

Figure 6 - A park-and-ride facility in California.
Image from: Authors

percent of Floridians fall into one or another transportation disadvantaged category, whether physically handicapped, too young or too old to drive, or too poor to afford an automobile. In an auto-centric society, these groups suffer from what one sociologist calls deprivation of access. Therefore, in this handbook, mobility is conceived differently than usual. It is not the ability to travel far and fast by automobile. Rather it is the ability of people, regardless of age and status, to engage in desired activities at moderate cost to themselves and society. This handbook offers practical suggestions for reducing congestion, automobile dependence, and vehicle miles of travel. Abstract by the author.

Higgins, T. J. (1993). *Parking requirements for transit-oriented developments* (Transportation Research Record 1404), 50-54. Washington, DC: National Research Council, Transportation Research Board.

Local transportation and land use planners are increasingly attempting to develop parking requirements (both minimum and maximum) to encourage transit use and avoid excess parking supply. Planners are focusing particular attention on transit-oriented developments in proximity to transit where tight parking supply, good pedestrian access to transit, and dense develpment are aimed at increasing transit use. This paper presents a method for setting parking requirements for office, commercial, and industrial developments in proximity to transit stations and stops. The method presented relies on annual employee transporation surveys of the kind typically required under trip-reduction ordinances. These ordinances are now present, or soon will be, in many urban areas and are the result of air quality regulations, traffic management regulations, or both. The method derives a range of estimates for parking demand in proximity to transit stops on the basis of high and low use of transit and other alternatives to solo driving, as revealed in the employee survey data. The author draws implications for maximum and minimum parking requirements in San Diego and suggests general cautions in applying the method and areas for further research to improve results from the method. Abstract by the author.

Parsons and Brinckerhoff. (2002). *Parking and TOD: Challenges and opportunities (special report)*. Sacramento, CA: CALTRANS, California Department of Transportation. Retrieved on Dec. 12, 2003, from http://www.dot.ca.gov/hq/MassTrans/doc_pdf/TOD/Parking%20and%20TOD%20%20Report.pdf

The research summarized in this special report indicates that TOD can potentially reduce parking per household by approximately 20 percent, compared to non transit-oriented land uses. A wide range of parking reductions (from 12 percent to 60 percent) has also been found for commercial parking in TODs. To date, however, there are no clear conclusions regarding how much parking may reasonably be reduced for any particular TOD. Therefore parking needs must be calculated on a site-by-site basis. Abstract by the author.

Shoup, D. (1997). The high cost of free parking. *The Journal of Planning Education and Research, 17* (1), 3-20. Retrieved Dec. 12, 2003, from http://www.sppsr.ucla.edu//dup/people/faculty/Shoup%20Pub%204.pdf.

Urban planners typically set minimum parking requirements to meet the peak demand for parking at each land use, without considering either the price motorists pay for parking or the cost of providing the required parking spaces. By reducing the market price of parking, minimum parking requirements provide subsidies that inflate parking demand, and this inflated demand is then used to set minimum parking requirements. When considered as an impact fee, minimum parking requirements can increase development costs by more than 10 times the impact fees for all other public purposes combined. Eliminating minimum parking requirements would reduce the cost of urban development, improve urban design, reduce automobile dependency, and restrain urban sprawl. Abstract by the author.

Turnbull, K. (1995). *Effective use of park-and-ride facilities* (NCHRP synthesis 213). Washington, D.C.: Transportation Research Board.

This synthesis was developed to provide a state of the art synopses of the current practices associated with all types of park-and-ride facilities in the United States. Included is an overview of the current use of park-and-ride facilities and existing practices for estimating demand for park-and-ride services; locating, sizing, and designing facilities; and funding constructing, operating, and maintaining park-and-ride lots. Approaches being used to address potential safety and security concerns are also examined, as well as supporting policies and programs that may enhance the effectiveness of park-and-ride facilities. Further, innovative approaches to developing and operating park-and-ride programs and enhancing multimodal integration to improve the overall management of the transportation system are identified.

Figure 7 - A transit parking structure in downtown St. Louis, MO.
Image from: www.hbdcontracting.com/ Pages/Parking.html

Willson, R. W. (2000). Reading between the regulations: Parking requirements, planners' perspectives, and transit. *Journal of Public Transportation, 3* (1), 111-127.

This article reports on local planers' perspectives on metropolitan parking requirements. Workplace parking requirements, which are often in excess of demand, influence parking pricing and urban form. In turn, these affect transit demand and transit service potentials. These connections have led researchers and policy-makers to call for changes, but the perspectives of planners who create the parking requirements are not well understood. Using Southern California cities as a study area, a telephone survey revealed that most parking requirements are driven by concerns about traffic mitigation, spillover parking, and risk avoidance. These factors push parking requirements in the direction of oversupply. The article proposes methods to reduce the risk of changing parking requirements and develops a typology of approaches for change. Transit agencies will benefit if they play a role in reforming local parking requirements. Abstract by the author.

PARKING AND TRANSIT "SPECIFIC" STUDIES

Bianco, M. J. (2000). *Effective transportation demand management: Combining parking pricing, transit incentives, and transportation management in a commercial district of Portland, Oregon.* (Transportation Research Record 1711), 46-54. Washington, DC: National Research Council, Transportation Research Board.

The Lloyd District is a high-density commercial and residential district located a short distance from downtown Portland, Oregon. To address parking and congestion problems, the City of Portland implemented a Lloyd District partnership plan in September 1997. This Plan consists of a number of elements aimed at curbing single-occupancy vehicle use for the commute to and from the district. This plan included parking pricing in the form of meters (whereas on-street parking had been free), discounted transit passes, and other transportation demand management strategies. The effects of these strategies on travel and parking were assessed, with an emphasis on the relationship between parking pricing and mode choice. A random sample of 1,000 employees in the Lloyd District was surveyed about their travel and parking behavior before and after the instillation of the new meters. Research found that, during the 1 year that had elapsed between the implementation of the Lloyd District transportation management programs and the survey information collected, the drive-alone mode for the trip to work by employees in the Lloyd District had decreased by 7 percent. For the district as a whole, the drive-alone commute share is now about 56 percent. The program strategies that have emerged as the most significant in effecting this decrease are the instillation of the meters and the discounted transit pass program. Abstract by the author.

Carter, C. R. (1996). A campus transportation alternative revised. *Transportation Quarterly, 50* (3), 123-129.

This article describes the Free Local Area Shuttle (FLASH) system, which is a joint venture undertaken by Arizona State University (ASU) and the city of Tempe, AZ, to provide transit service for the university area. Originally, ASU had used a tram system to shuttle students from peripheral parking lots because there was insufficient parking on campus. However, to meet the requirements of the Americans with Disabilities Act (ADA) of 1990, the tram system needed to be replaced. The city and the university then combined efforts to develop a shuttle system in 1994. The system was funded using university, city, and federal monies. It was designed to replace the trams from the peripheral parking lots and transport students to and from downtown that had been caused by students looking for places to park. The author concludes that FLASH is an excellent example for other universities to follow in reducing parking and congestion problems near campus.[11]

Figure 8 - A park-and-ride facility in Cambridge, UK.
Image from: www.graftoncentre.co.uk/_gpride.asp

Freilich, Leitner, and Carlisle. (2002). *Parking ratios: White paper presented to: Town of Chapel Hill, NC*. Chapel Hill, NC. Retrieved Dec. 13, 2003, from http:// townhall.townofchapelhill .org/archives/ agenda/ca020918 Attachment%204%20 %20Final%20Parking%20Paper%208-12-02.htm

This paper introduces the role of minimum and maximum parking requirements in planning, and explains some of the issues that need to be considered by a municipality that is thinking of implementing maximum parking requirements. The appendix has ordinance examples from municipalities that have implemented maximum parking requirements, and web addresses for other ordinances. The bibliography also includes several addresses to websites that contain additional information about minimum and maximum parking requirements. Following the appendix there is an attached exhibit that illustrates existing parking ratios in Chapel Hill. Abstract by the author.

Mathers, S. (1999). Reducing travel in the city of Bristol: Promoting bus use through complementary measures. *Built Environment, 25* (2), 94-105.

Promoting bus use can form a component of a travel reduction policy, when used in conjunction with encouraging switching from car use. The City of Bristol, UK has assembled a complementary package of measures in which car travelers switch to bus use through a park and ride scheme; bus priority measures give the bus an advantage over the car, and office car parking is replaced by parking at the park-and-ride site. In replacing car travel with bus travel it is possible to reduce vehicle kilometers traveled overall.[12]

Figure 9 - A park-and-ride facility in Devon, UK.
Image from:www.devon.gov.uk/_dro/gmhpage.html

Shoup, D. C. (1999). The trouble with minimum parking requirements. *Transportation Research Part A, 33*, 549-574. Retrieved Nov. 23, 2003, from http://www.vtpi.org/shoup.pdf

Urban planners typically set the minimum parking requirements for every land use to satisfy the peak demand for free parking. As a result, parking is free for 99 percent of automobile trips in the United States. Minimum parking requirements increase the supply and reduce the price-but not the cost-of parking. They bundle the cost of parking spaces into the cost of development, and thereby increase the prices of all the goods and services sold at the sites that offer free parking. Cars have many external costs, but the external cost of parking in cities may be greater than all the other external costs combined. To prevent spillover, cities could price on-street parking rather than require off-street parking. Compared with minimum parking requirements, market prices can allocate parking spaces fairly and efficiently. Abstract by the author.

Shoup, D. C. (1999). In lieu of required parking. *Journal of Planning Education and Research, 18* (4), 307-320. Retrieved Oct 25, 2003, from http://www.sppsr.ucla. edu//dup/people/faculty/ Shoup%20Pub%202.pdf

Some cities allow developers to pay a fee in lieu of parking spaces required by zoning

ordinances, and use this revenue to finance the public parking spaces to replace the private parking spaces the developers would have provided. This paper presents a survey of in-lieu programs in 46 cities in the United States, Canada, the United Kingdom, South Africa, Germany and Ireland. These in-lieu programs reduce the costs of development, encourage shared parking, improve urban design, and support historic preservation. The in-lieu fees also reveal that the cost of complying with minimum parking requirements is more than four times the cost of the impact fees that cities levy from all other public purposes combined. The high costs of required parking suggests another promising in-lieu policy: allow developers to reduce parking demand rather than increase the parking supply. Examination of an Eco Pass program in California shows that reducing parking demand can cost far less than increasing the parking supply. Abstract by the author.

Van Hattum, D. (n.d.). *Parking cash-out: Where "smart growth" and effective transit intersect*. Minneapolis, MN: Downtown Minneapolis Transportation Management Organization (TMO). Retrieved Dec 11, 2003, from http://www.mplstmo.org/Parking%20Cash-out%20Article.pdf

The paper reports on the implementation of parking cash-out in the Minneapolis-St. Paul Metropolitan Region in 1999 and 2000. Parking cash-out refers to employers offering employees the cash equivalent of any parking subsidy. Since parking costs in a downtown setting are typically a substantial portion of commuting costs, cashing-out parking subsidies can provide a strong incentive for commuters to choose an alternative to driving alone. Abstract by the author.

Notes

[1] Quote from page 5 in Bernick, Michael and Robert Cervero. (1997). *Transit villages in the 21st Century*. New York: McGraw-Hill, 1997.

[2] Cervero, R., Hall, P. & Landis, J. (1991). *Transit joint development in the United States: A review and evaluation of recent experience and assessment of future potential*. Washington, D.C.: Urban Mass Transit Administration.

[3] Cervero, R., Ferrell, C. & Murphy, S. (2002). *Transit-oriented development and joint development in the United States: A literature review*. (TCRP Research Results Digest 52). Washington, D.C.: Federal Transit Administration.

[4] Quote from page 21 in Porter, D. (1997). *Transit focused development* (TCRP Synthesis 20). Washington, D.C.: Transportation Research Board.

[5] Page 22 in Porter (1997).

[6] Page 23 in Porter (1997).

[7] Page 78 in Parsons Brinkerhoff (2002). *Statewide transit oriented development study: Factors for success in California*. Sacramento, CA: Caltrans.

[8] Page 113 in Parsons Brinckerhoff (2002)

[9] Abstract obtained from *Journal of Planning Literature*, 15 (4), 624.

[10] Page 2 in Parsons and Brinckerhoff. 2002. *Parking and TOD: Challenges and Opportunities* (Special Report). Sacramento, CA: CALTRANS, California Department of Transportation (annotated in this selection).

[11] Abstract obtained from *Journal of Planning Literature*, 11 (4), 557.

[12] Abstract obtained from *Journal of Planning Literature*, 14 (3), 466.

4: Funding and Marketing Transit

As federal, state and local subsidies shrink, transit agencies across the nation are seeking new sources of funding and new strategies for leveraging capital. At the same time that transit agencies' funding needs become ever more pressing, so does the need for transit to establish a stronger community presence and visibility, not only among riders but also among non riders.

The literature on funding for transit and marketing and visibility of transit annotated in this chapter may be thought of complementary. First, as the search for new sources of operating and capital funds have pushed the transit industry to market its services like any other privately provided service, transit agencies are now exploring and developing extensive promotional strategies and marketing plans. Increasingly, these plans are not only similar to private sector marketing, but also the plans themselves are drawing transit agencies and the corporate sector closer together through partnerships with the media such as radio and TV as well as through corporate sponsorships of transit marketing and promotional campaigns and events. Second, with decreasing government funding, transit agencies have had to creatively partner with the private sector in procuring new sources of revenue through real estate leases and air rights above and around stations, leases of right-of-way space and infrastructure to utility, cable, and telecommunications companies, fees from retail concessions, vending machines and pay phones, the selling of advertising space on and inside buses and bus shelters, merchandising sales, and the commercialization of stations and terminals. While this wide-ranging commercialization of transit property, facilities, and rolling stock is seen as controversial and still raises opposition in many quarters, the trend is increasing rather than declining. Third, the tendency for agencies to increasingly shift from pay-as-you-go for capital facilities to debt financing, such as bonds, loans, and equity securities, has also its pros and cons. It is still controversial for small and mid-size transit agencies, given their limited experience with these funding mechanisms and uncertainties about repayment streams. Fourth, the funding shift from the federal to the local has also ushered a stronger reliance on regulatory funding mechanisms such as development exactions and impact fees for the building of transit passenger facilities (e.g., bus shelters and transfer stations) and accessibility infrastructure to these facilities (e.g., sidewalks). These are many of the topics examined in this literature, which is based on TRB and FTA sponsored research carried out across the nation and by and large obtained through the fielding of many transit agencies of different sizes.

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4.1: Funding

It is well known that transit fares cover a very limited fraction of the operating costs of transit systems, approximately less than 40% on average.[1] Likewise, it is also known that transit agencies are strapped for the capital investment necessary to keep existing systems running, to develop new systems, or expand current system capabilities. Furthermore, it is also a recognized fact that small and mid-sized systems face unique financing challenges and that compared to larger systems, they have had relatively limited financing experience. The literature annotated in this section examines these issues and provides recommendations and lessons learned based on studies of creative funding mechanisms and financial approaches practiced by transit agencies.

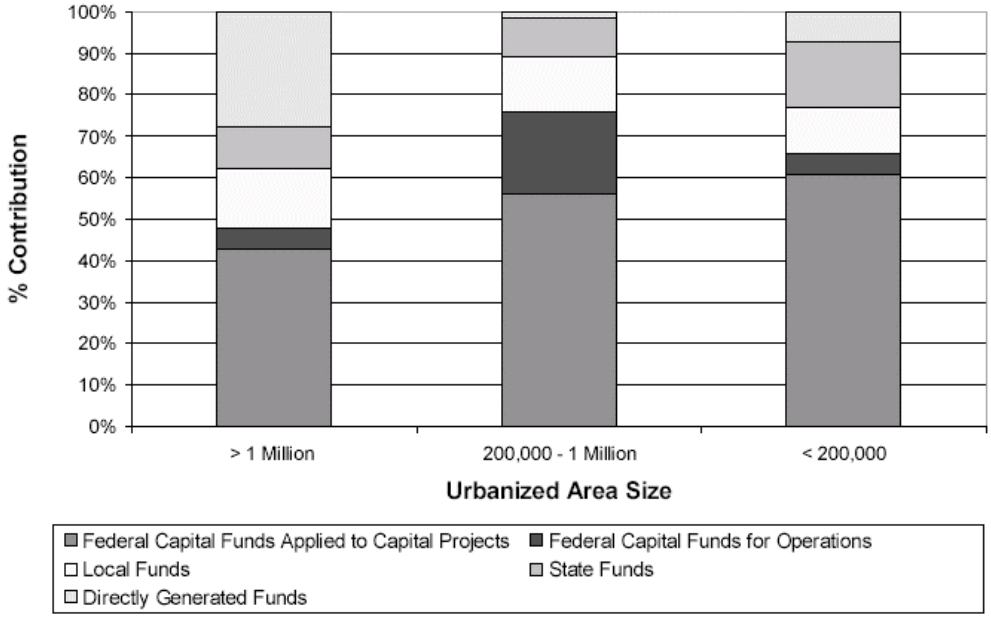
Across the nation, public transit's capital funding has traditionally relied on federal assistance. For example, in 2000 the federal government contributed 47% to the total transit capital funding.[2] Thus, TEA-21 (Transportation Efficiency Act for the 21st Century) capital funding parameters and provisions are of great importance and crucial to small and mid-size transit systems. This is the case of many systems in Florida, whose urbanized area population is growing and demanding the expansion of current transit services. However, in addition to changing demographics and travel patterns, which make transit service provision more expensive, federal unfunded mandates such as ADA—requiring the accommodation of passengers with disabilities—and the Clean Air Act Amendments of 1990 and the Energy Policy Act of 1992—requiring less polluting fleets, have added new layers of expenditures without additional federal assistance to pay for them. This is forcing transit agencies to review their business models and to become very creative about the way they procure new sources of capital. However, there are vast differences between large, mid-size and small transit systems in funding practices.

Figure 1 shows how mid-size and small transit agencies depend on federal funds for capital projects and operations. This federal component ranges from 65% for small systems to 75% for mid-size systems. Therefore, many small and mid-size transit agencies rely almost completely on pay-as-you-go (PAYGO) and grant assistance to manage their capital programs. TRB researchers believe that this approach is unsustainable and that these agencies must become as financially savvy as their larger counterparts in order to face upcoming capital and operating budget challenges.

TCRP Report 31 by Price Waterhouse (1998) and TCRP Report 89 by Transtech Management (2003)—annotated in this section—provide valuable information in this respect. TCRP Synthesis 32 by Silverberg (1998) and TCRP Report 79 by KFH Group (2002)—also annotated in this section—respectively offer information about revenue generation through advertising and ways of funding intercity bus systems. These two documents profile illustrative case studies from across the nation and include Florida bus systems. LYNX in Orlando is showcased for advertising practices and Polk County for intercity bus services. Except for the publication on intercity bus funding, collectively the literature included in this section proffers current knowledge on best practices surrounding alternative sources of funding above and beyond federal and state grants. The two-volume TCRP Report 31, *Funding strategies for public transportation* by Price Waterhouse (1998) and TCRP Report 89, *Financing capital investment: A primer for the transit practitioner* by Transtech Management Inc.

Figure 1. Transit Captial Funding by Source and by Population Size

Source, TCRP Report 89, *Financing capital investment: A primer for the transit practitioner*. Retrieved Feb. 4, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_89a.pdf.



(2003) offer useful information to managers of small transit agencies interested in learning about alternative funding sources—often exclusively the domain of large transit systems. The first volume gives a comprehensive overview of the public funding environment up to 1997, while Volume 2 is a casebook that illustrates different alternative and creative sources of funding practiced by the transit industry. This work, along with the literature on funding for public transit, stresses the shift in funding responsibility from the federal to the local and how this has augmented the importance of dedicated funding for operations (i.e., dedicated taxes and funds) at the state, local, and agency-jurisdiction level. Moreover, the growth in state and local funding ostensibly corresponds to dedicated taxes approved via the ballot box, while funding from general revenue sources, which are not voter-approved, have significantly decreased over time. A similar shift to the ˙ocal level has occurred for dedicated capital funds as the Federal Transit Administration's capital funding increased from 1989 to 1994—the period analyzed in this report— have consistently remained well bellow the inflation rate.

The central question of this literature is how have public transit agencies responded to this funding challenge? In procuring financial support at the local level, TCRP Report 31 finds that agencies have: (a) focused on their key and most valued services; (b) cut costs in existing services and sought to increase productivity; or (c) reduced services levels (e.g., headways) or service quality (e.g., less frequent cleaning). Furthermore, funding coping mechanisms developed by agencies involve a vast number of strategies, grouped in the following three categories:

- **Partnerships with the private sector and transit users**
  Agencies work directly with large customers (i.e., universities or employers) to provide service

directly tied to the funding source. Partnerships with entire communities may also include impact fees, local sales or utility taxes, direct operating support, and the use of passes such as Denver's "Eco Pass." Partnerships can also include strategic alliances with suppliers, investors, or developers.

- **Utilization of assets to maximize value**
  Rolling stock and an agency's real property can generate additional revenues through advertising and leasing. Joint development and concessions and leasing of rights-of-way to fiber optic and telecommunications companies are also sources that agencies have tapped into.
- **Leveraging scarce dollars**
  Public transit agencies, primarily the larger ones, have secured funding through financial leveraging mechanisms in the form of debt financing. Some of these mechanisms include: revolving loan funds and credit enhancements.

Volume 2 of this report is a casebook with examples of all the above strategies.

Noting that debt financing could become the wave of the future for public transit agencies, the authors of TCRP Report 31 caution agencies against becoming over-leveraged. They, as well of the rest of the literature in this section, stress that rather than complete solutions to the funding crisis of a particular agency, these strategies must be seen as useful tools in addressing funding needs.

TCRP Report 89 *Financing capital investment: A primer for the transit practitioner* by Transtech Management Inc. (2003) picks up where the aforementioned report left regarding sources and strategies of financial capital leveraging. It provides recommendations and approaches for taking advantage of access to public capital markets and evaluates the tradeoffs of PAYGO versus debt financing approaches. Although small and mid-sized transit systems are the primary target group, this primer seeks to educate managers of transit systems of all sizes about the benefits and tradeoffs of debt financing. The primer instroduces transit managers to the fundamentals of financing via a three pronged framework covering:

- Sources of capital
- Financing (debt) mechanisms; and
- Repayment streams.

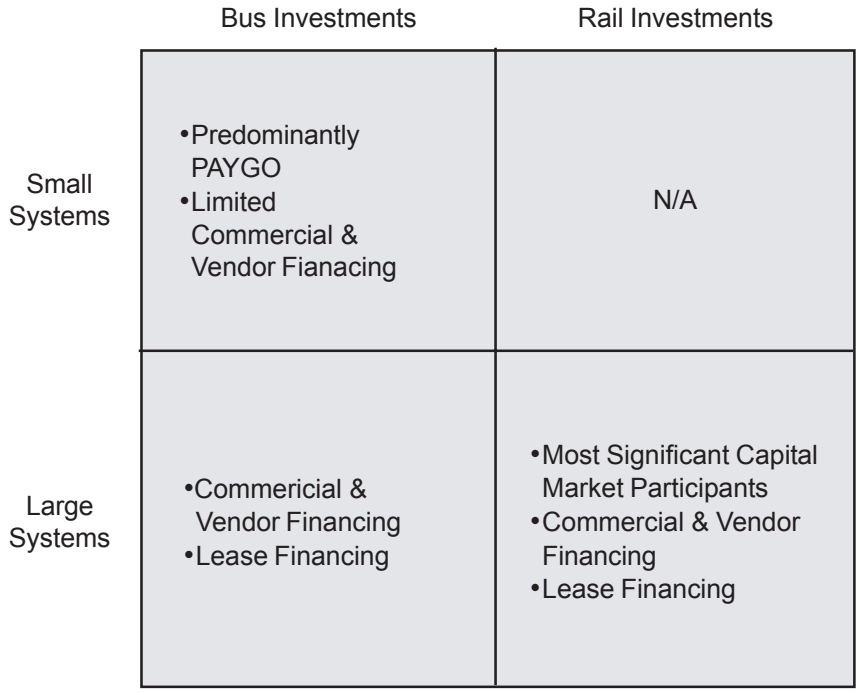
Capital market experience is primarily concentrated among the largest transit systems and major players like New York Metropolitan Transportation Authority and among the new light rail systems sprouting in many large and mid-size cities like Dallas Area Rapid Transit Authority (DART) or Denver's Regional Transit District (RTD). However the experience of bus-only systems, which have heavily relied on federal and state grants has been limited to PAYGO approaches which are seen as more feasible "because acquisition of replacement buses can generally be staggered over an extended time period, reducing one-time capital costs." [3] Smaller agencies, which are chiefly risk- aversive, have also little experience with debt financing due to their reliance on state and federal assistance and their lack of alternative repayment stream for debt service. Nonetheless, the authors of this report discuss instances in which the benefits of debt financing versus PAYGO approaches may override the costs even for med-size and small agencies.

The primer discusses a variety of primary sources of investment capital such as investors in the tax-exempt and taxable bond markets, equity investors, vendors and lessors, and new governmental sources of capital structured by TEA-21. It overviews the basic dynamics of accessing each particular capital source, and links the financing mechanisms (e.g., bonds, loans, equity securities) to the most commonly used repayment streams (e.g., grant funds, taxes, and operating revenues).

In his selection, Hendricks' (2002) *Land developer participation in providing*

Figure 2. Matrix of Financing Approaches by System Size and Investment Type

Source, TCRP Report 89, *Financing capital investment: A primer for the transit practitioner*. Retrieved Feb. 4, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_89a.pdf.



for bus transit facilities and operations provide extensive Florida examples of regulatory and non regulatory approaches to procuring private developers' participation in the provision of bus transit capital facilities and operations. Capital expenses include buses, shelters or new terminals as well as infrastructural facilities such as rights-of-way, sidewalks, and pull-out bays and park-and-ride lots and other passenger facilities. This work contains useful Florida-specific examples of the "partnerships with the private sector" funding approaches. Regulatory mechanisms include impact fees, transportation concurrency techniques, development of regional impact, trip reduction ordinances and special financing districts. Non regulatory approaches covered in this report include partnerships and incentive programs such as density bonuses, lower parking requirements, fast-track permitting, and low-income housing programs. Regarding the bus passenger facilities discussed in this literature review, this document offers useful examples and an overview of the Florida experience with developer's contribution to funding public transit capital facilities.

Hendricks, S. J. (2002). *Land developer participation in providing for bus transit facilities and operations* (416-06). Tampa, FL: Center for Urban Transportation Research, University of South Florida.

This report provides an overview of the various non-regulatory and regulatory approaches for engaging private sector land developer participation in contributing toward the provision of bus transit capital facilities and operations. It provides information from around the country but focuses on circumstances applicable to Florida localities. This study specifically examined the development of bus transit facilities and services. The funding needs of bus transit systems include capital expenses such as buses and shelters. Capital needs also exist for accessibility features at bus stops, such as sidewalks, adequate right-of-way, curb cuts and pull-out bays, passenger amenities, bus stop signage, and park and ride lots. Operating expenses constitute the most serious funding gap, and private sector contributions for operations, outside a special district, have been infrequent at best. Provided herein are examples of the provision of both on-site and off-site bus facility improvements. This investigation included a review of case studies nationwide. Case studies include 16 examples from eight Florida counties or municipalities and 15 additional examples from nine other states. Abstract by the author.

KFH Group Inc. (2002). *Effective approaches to meeting rural intercity bus transportation needs* (TCRP Report 79). Washington D.C.: Transportation Research Board. Retrieved on Feb. 2, 2004, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_79.pdf.

The Nation's Growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency and improve efficiency to meet these demands. This report highlights how less urbanized areas can meet their transportation needs. It addresses funding for intercity bus projects, discusses barriers to implementation, and identifies strategies for initiating, preserving, and enhancing effective intercity bus transportation. Abstract by the author.

Price Waterhouse. (1998). *Funding strategies for public transportation* (TCRP Report 31). Washington, D.C.: Transportation Research Board. Retrieved Jan. 23, 2004, from, http://gulliver.trb.org/publications/tcrp/tcrp_rpt_31-1-a.pdf. http://gulliver.trb.org/publications/tcrp/tcrp_rpt_31-2-a.pdf.

This report addresses the current state of funding for public transportation in the United States, the various circumstances that have contributed to today's funding environment, and specific strategies that transit agencies are pursuing to identify new sources of funding. The report is presented in two parts—a final report and a casebook. The former provides a national perspective on public transportation funding while the latter presents case-level information on innovative methods for generating revenue for public transportation capital and operating costs. The report will be of interest to federal, state, and local transportation officials, policy makers, and professionals concerned with funding for local public transportation services during the past decade and in the near future.

Silverberg, S. (1998). *Transit advertising revenue: Traditional and new sources and structures* (TCRP Report 32). Washington, D.C.: Transportation Research Board. Retrieved Feb. 4, 2004, from http://gulliver.trb.org/publications/tcrp/tsyn32.pdf.

The intent of this synthesis is to describe current practices in transit advertising.

Thirty transit agencies were surveyed to find out what advertising facilities they had and how much revenue these facilities generated. This report specifically: Provides pictures and descriptions of the equipment and facilities, reports the total revenue from advertising, describes advertising policy guidelines (for alcohol and tobacco), outlines advertising contract management, and provides other innovative revenue sources.

Staes, L., & Hinebaugh, D. (2001). *Analysis of Florida department of transportation transit corridor program/projects* (NCTR 392-01). Tampa, FL: CUTR, University of South Florida. Retrieved Jan. 28, 2004, from http://www.nctr.usf.edu/pdf/Transit%20Corridor3.pdf.

Traffic congestion has become a severe problem in Florida's urban areas. The inability to construct new capacity fast enough to keep up with the demand, the increasing costs associated with adding that capacity, and the political and environmental controversy often associated with building new roads compound the mobility dilemma requiring different approaches to mobility. Now, more than ever, alternative solutions to mobility must be developed and supported to succeed.

The Florida Department of Transportation (FDOT), in an effort to provide flexibility to urbanized areas to identify and implement congestion and mobility management techniques, developed the Transit Corridor Program. The Transit Corridor Program provides funding to urbanized areas for projects designed to relieve congestion and improve capacity, within a designated transportation corridor, by increasing the capacity of the corridor through the use and facilitated movement of high occupancy conveyances.

In the process of developing and implementing the program, the FDOT established a procedure for administering the Transit Corridor Program that specifically identifies the requirements of the program and the responsibilities given to the FDOT Central Office, each of the district offices, as well as the recipients of the program. Since the inception of the program, there has been no consolidated, comprehensive review of the program, nor the individual projects selected for funding. In addition, there has not been a single source of information developed that identifies successful corridor programs or projects and the lessons learned through the implementation of those projects. Each project selected for corridor funding must have clearly defined goals and objectives. Milestones must be established by which progress toward the goals and objectives can be measured. The goals, objectives, and milestones are defined by the grantee and must be consistent with local, regional and state plans. After an initial two year period, projects consistently meeting milestones can be reauthorized. Written progress reports are required of the grantee as well as a final report that includes, at a minimum, a description of the project's history, a summary of its successes, any problems encountered, and recommendations for future implementation. A thorough review of these items should assist in determining the overall success of the program. Abstract by the author.

Transtech Management Inc. (2003). *Financing capital investment: A primer for the transit practitioner* (TCRP Report 89). Washington, DC: Transportation Research Board. Retrieved Feb. 4, 2004, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_89a.pdf.

This primer is organized to provide a wide-ranging audience with easy access to the information they need most regarding capital financing for public transportation. The primer includes descriptive sections that outline the basic financing approaches and structures available to transit systems, as well as sections that help system managers and public officials decide when it is most

appropriate to apply alternative financing techniques. Following the introductory Chapter 1, Chapter 2 discusses the financing opportunities created by federal legislation and programs, emphasizing the current federal transportation program. Chapter 3 offers an introduction to the world of municipal debt finance and offers those readers with less background in public finance a framework for making the choice between pay-as-you-go funding and financing alternatives. Chapters 4, 5, and 6 introduce the three components of finance-capital sources, financing mechanisms, and repayment streams. Together, these chapters provide an inventory of available funding and finance methods and offer real-life examples of many of the approaches. Chapter 7 addresses how-once the options are understood- a transit system and its managers go about formulating a comprehensive capital financing plan and carrying it out for individual projects or programs of projects. Chapter 8 offers insights and observations based on the research that contributed to development of the primer, including a collection of interviews with transit system managers, state and local officials, and members of the public finance community. Following the last chapter are five technical annexes (or appendixes), which provide supporting material or additional technical detail for readers who are interested in learning more about a particular subject. Abstract by the author.

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4.2: Transit Image Marketing and Community Visibility

Research dealing with the image and visibility of transit in its various forms, be it bus, heavy or light rail, has produced a body of literature and practical recommendations geared to enhancing the public perception of transit. Most of this work acknowledges that Americans value their automobiles for reasons above and beyond transportation needs, and that strategies designed to strengthen the image of public transit should not focus on the negatives of the automobile but rather on the community benefits associated with transit. Like any other industry, the transit industry has approached its public image through the marketing of its services to the public. Thus, the literature in this section, gathered from various TCRP sources, approaches the marketing of transit from a variety of perspectives. TCRP Report 50, *A handbook of proven marketing strategies for public transit* by the Texas Transportation Institute (1999), not only provides marketing theory and principles and practical worksheets for producing a transit-marketing plan, but also offers a plethora of successful examples from across the country, gathered from transit agencies of various fleet sizes. The examples offered represent an assortment of projects including:

- *community events* that show the role and place of transit in the community;
- *accessibility campaigns* for the disabled;
- *cooperative promotions* with the public sector that enhance transit image and secure the public sector's long term commitment to transit;
- *image promotion* projects that strengthen the bonds between a transit agency and the community by presenting the benefits of a publicly subsidized transit system;
- *internal promotions* that raise the transit agency's morale and build positive management, employee, and customers relations;
- *media relations* that utilize various local media, such as radio and TV, to promote understanding and good will of transit by the public;
- a variety of transit *promotion programs* and events.

This handbook stresses that successful marketing programs must deal with transit as a service designed to meet consumer needs. Therefore, before embarking on any promotional activity, transit service and marketing plans should be prepared in tandem. The marketing of transit as a service should be integrated with the development of the transit service itself—from the moment routes and schedules are planned, the service is distributed, and fares are determined. Also, the service must adapt to the changing needs of customers, and communication strategies should aim at changing attitudes and habits. In this last respect, TCRP Report 63, *Enhancing the visibility and image of transit in the United States and Canada* by Witrthlin Worldwide (2000), provides a set of message strategies designed to increase the image of transit among non-riders and to attract "swing" supporters to transit. The authors carried out a national opinion survey and found that the dominant value orientation toward transit can be best summarized by the motto: "community benefit built on personal opportunity." This value orientation is based on a widely shared view that transit can provide community opportunities through mobility, choice, and accessibility. The report provides a good summary and analysis of the challenges that public transit faces in boosting its image among non-riders. Some of the most important challenges include:

- The automobile is an indispensable and loved member of the American family; it is not an enemy of public transportation;
- Low public recognition of transit as a solution to public transportation;
- Lack of public familiarity with transit's community benefits;
- Nearly one third of American adults do not support transit, partly based on bad past experience with transit.

However in contrast to TCRP Report 50, which offers specific case study experience and best practice examples obtained from transit agencies, this report's recommendations emphasize the creation of a national public transportation brand built on public recognition of the positive personal benefits that transit provides to all citizens not only to transit riders. Its core recommendation is the creation of a nationally organized promotional campaign that speaks with "one voice" promoting transit inside and outside the transit industry and at national, regional, and local levels.

Other research reports annotated in this section approach transit's public image from quite different, yet related angles. TCRP Web Document 8, *Marketing transit services to business* by Multisystems Inc. et al. (1998), provides theory on business-to-business marketing and presents examples from the non-profit sector that are relevant to transit agencies seeking to expand both their economic support and community presence. TCRP Report 45, *Passenger information services: A guidebook for transit systems* by the Texas Transportation Institute (1999), advises transit agencies on how to design the best possible bus passenger information materials. Transit information aids, which can range from maps offering route guidance to bus stop signs and timetables, are critical components of a quality transit service and are also a form of customer relations through which a transit agency establishes community presence and visibility. TCRP Synthesis Report 17, *Customer information at bus stops* by John Dobies (1996), extends a similar set of ideas to passenger information aids provided at bus stops (see Table 1). It notes that the majority of transit agencies have detailed information displays at less than five percent of their bus stops, and that small transit systems are the less likely to afford well developed on-street information programs such as, an attractive logo, the provision of timetables, route maps, and system maps showing transferring points, etc. The personnel and maintenance costs of these facilities are high for any transit agency, but more insidiously so for small ones. Insufficient evidence supporting the payback in increased ridership associated with investments in detailed on-street programs has deterred many agencies from creatively broaching this issue. This TCRP Synthesis provides advice and useful practical information related to costs, staffing requirements, design considerations, and ADA requirements related to on-street information programs. It also provides an assessment of their cost effectiveness in terms of the need for user-friendly information and community and customer relations vis-à-vis the current budgetary pressures.

Finally, TCRP Report 70, *Guidebook for change and innovation at rural and small urban transit systems* by KFH Group Inc. (2001), identifies an array of innovations implemented by small transit agencies to improve service quality, efficiency, and productivity. This guidebook culls experience and information from over seven case studies of rural and small urban transit systems. The profiled agencies show that while facing the challenges common to many small systems, such as:

- meeting a wide range of riders' transportation needs;
- providing service in low density, dispersed settlement areas;
- operating with limited funding;

Table 1. Transit Information Sign Audiences and Functions

Source: Dobies, J. (1996). *Customer information at bus stops.* Retrieved Jan. 25, 2003, from http://gulliver.trb.org/publications/tcrp/tsyn17.pdf.

Rider Audiences
• Regular Riders
• New Riders
• Special Riders
  • Disabled
  • Non-English Speaking
  • Students
  • Tourists
	Non-Rider Audiences
	• Transit Drivers
	• New Drivers
	• Unfamiliar Drivers
	• Elected Representatives
	• Retail Merchants

Informational Functions • Bus Stop Identification • Mode Identification • Logo • Route(s) designation • Transfer Points or Centers • Days/Hours of Operation • Service Frequency Public Transit • Handicapped Accessability on Vehicles Servicing Route • Route Map(s) • Telephone Information Number	**Pyschological Functions** • Promote Corporate Identity (Name, Logo, Color Scheme, etc.) • Reinforce Other Consumer Aids • Rider Reassurance • Create Impression of Service Quality • Attract Non-Riders • Create a Positive Image
Operations Functions • Decrease Dependence on Bus Drivers for Information • Decrease Dependence on Telephone Information Service • Promote Additional Ridership • Improve Driver Morale • Designate Stops More Clearly for New Drivers	

- coordinating with a variety of local organizations; and
- being accountable to multiple sources of funding;

They tried new innovative programs that allowed them to remain responsive to their riders and communities. This report offers guidance based on transit agencies' experience related to public-private partnerships formed to augment funding by targeting service to grocery stores and community employers. Taking advantage of volunteer driver programs, boosting morale and service through organizational innovations, and new innovative uses and applications of federal funding are other illustrative examples of how rural and small urban transit systems are tackling both community and customer relations and budget limitations.

All in all the annotated documents in this section complement the literature annotated and described in the previous section. Together with the sources on funding, it will provide transit managers a good source of theory, research, and best practice advice about strategies that enhance transit visibility and image.

Cervero, R. (1994). Making transit work in suburbs. *Transportation Research Record, 1451*, 3-11.

Rapid decentralization of population and employment over the last several decades has chipped away at the U.S. transit industry's market share. The implications of decentralization on the ridership, operating performance, and fiscal health of the nation's largest transit operators are examined. On the basis of the results of a national survey, a number of service strategies that offer hope for reversing transit's decline are explored, including timed transfers, paratransit services, reverse commute and specialized runs, employer-sponsored van-pools, and high occupancy vehicle and dedicated busway facilities. Land use options, like traditional neighborhood designs, and transit-based housing, are also examined. A discussion of various institutional, pricing, and organizational considerations when implementing sub-urban targeted service reforms and land use incentives is also provided. The author argues that century-old models involving joint public-private development of communities and transit facilities also deserve reconsideration. Abstract by the author.

Charles River Associates, Inc. (1997). *Building transit ridership: An exploration of transit's market share and the public policies that influence it* (TCRP Report 27). Washington, D.C.: Transportation Research Board. Retrieved Jan. 29, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_27.pdf.

State and local transportation officials constitute the primary intended audience for this report. This includes elected and appointed board members who deal with local transportation policy, transit agency officials, transit agency professionals, and metropolitan area transportation planners. The report addresses transit's ridership and its share of the

travel market. The research explored a variety of different public policies and transit management actions that can potentially influence transit ridership, particularly in comparison to local travel by private vehicle. The policies are presented through case studies, which are summarized in the report and documented in greater detail in the accompanying appendices. Abstract by the author.

Dobies, J. (1996). *Customer information at bus stops* (TCRP Synthesis Report 17). Washington, D.C.: Transportation Research Board. Retrieved Jan. 25, 2003, from http://gulliver.trb.org/publications/tcrp/tsyn17.pdf.

It is commonly held that ineffective user information systems are barriers to increased ridership. In recent years, more research and other efforts have increased to advance the state of the art for information systems for transit users. However, the bus stop sign, with its potential for displaying a wide range of user information, has been highly underutilized. Typically, transit agencies do not provide this information at bus stops, or provide information at a relatively small number of stops.

The major focus of this synthesis is to gather information on current transit industry practices and research related to the provision of customer information at bus stops. The study: 1) Summarizes and presents ideas for transit agency managers to develop or enhance their information program; 2) provides information on costs, staffing requirements, design considerations (pp29-39), and ADA requirements ; and 3) addresses the cost effectiveness of the transit agency's investment in these information systems and programs. Appendices B and C provide photos of information systems.

KFH Group Inc. (2001). *Guidebook for change and innovation at rural and small urban transit systems* (TCRP Report 70). Washington, D.C.: Transportation Research Board. Retrieved Jan. 13, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_70a.pdf.

This report will be of interest to individuals who provide public transportation in rural and small urban areas; local, regional, state, and federal planners and funders of these services; and the administrators of these programs at state departments of transportation. The research, presented in the form of a guidebook, provides a valuable resource to many people who may implement or adapt new concepts to improve public transportation in their community. Much of the information was derived from a careful review of innovative public transportation initiatives undertaken in rural and small urban communities throughout the United States. The guidebook is divided into two parts: Part I addresses the culture for change and innovation and Part II presents more than 40 initiatives and innovations implemented by an array of organizations, including public and nonprofit transit systems, regional planning agencies, state transit associations, and state departments of transportation. Abstract by the author.

Koppa, R., & Higgins, L. (1996). *Bus route guidance information design: A manual for bus and light rail transit systems - second edition*. College Station, TX: Texas A&M University.

Design guidelines and information are offered for static signage and handout information to assist transit riders in route planning and guidance. An earlier version of the manual was published in 1994. The manual now incorporates Americans with Disability (ADA) design guidelines, and also has an Appendix which is comprised of a digest of ADA Accessibility Guidelines applicable to

bus and light transit stop design. The manual provides concise and explicit advice on how to design signs at stops, transfer points, and terminals for street and system maps, route maps and timetables, route and direction designation, and locator signs. Information is also given for the design of timetables and system maps for distribution to riders. One hundred transit companies were surveyed by mail and telephone of which 65 sent specimens of their route guidance material. This material helped the authors arrive at these suggestions, however, in some cases the authors had to rely upon their human factors and ergonomics backgrounds to provide guidance in the absence of consensus.

Mustard, W. A. (1999). *Enhancing consumer awareness and perceptions of public transit providers* (NUTI4-FSU-3). Tallahassee, FL: Florida State University.

This research project was undertaken to determine public opinion about the use and effectiveness of public transportation services and organizations. This includes local bus systems, subways, and commuter railroads. An important part of the mission of the public transit organizations is to foster a positive public perception of their services. Some describe this process as building brand equity, others refer to it as image building or product positioning. No matter the description, the process requires a fundamental understanding of how consumers perceive the services offered. The primary objectives of this study were to (1) identify current opinions, attitudes, and perceptions of public transit services and (2) establish marketing priorities for public transit service organizations. This report summarizes the results of personal interviews conducted by trained student interviewers. The students were offered bonus points in classes taught by the primary researcher in return for their efforts. Training took place in class and specific written instructions were given to each interviewer. A total of 371 interviews were completed. Abstract by the author.

Pucher, J., & Kurth, S. (1995). Making transit irresistible: Lessons from Europe. *Transportation Quarterly, 49* (1), 117-128.

Decreasing transit ridership and increasing auto-dependency have resulted in environmental degradation and increasing congestion. This is leading some countries to examine their public transit systems and policies. The authors investigate the shifting policy and coordination issues surrounding Western European countries, most specifically, the former country of West Germany. The authors conclude that transit can be a viable alternative if protransit governmental policies are maintained or enhanced. They fear, however, that without transit friendly policies, long-term environmental concerns will be discarded in favor of short-term political victories.[4]

Texas Transportation Institute. (1999). *A handbook of proven marketing strategies for public transit* (TCRP Report 50). Washington, DC: Transportation Research Board. Retrieved Jan. 21, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_50-a.pdf.

Texas Transportation Institute, in association with the South West Transit Association and the Center for Transportation Education and Development at the University of Wisconsin-Milwaukee, prepared the handbook for TCRP Project B-13. To achieve the project objective of identifying proven marketing strategies to implement at transit agencies, the researchers identified and described low-cost and cost-effective marketing techniques currently used at large, medium, and small, urban and rural transit agencies throughout the transit industry. The complete range of lowcost marketing activities includes traditional, broad marketing activities such as pricing, promotions, advertising, planning, and service delivery targeted at specific submarkets. Further, a method was developed to define the

criteria that would be used to assess and select creative and promising marketing techniques. Selection of promising practices was made on the basis of cost, cost-effectiveness, ease of implementation, community support, and staff time required to implement the marketing program. A general overview of each strategy is provided. The overview includes a basic description of the strategies, the objective of its implementation, the resources necessary, the time required, the results of the project, any suggested adaptation or refinements, and when the project was implemented. The size of the transit agency implementing the project is indicated by fleet size. Also provided in this handbook are summary materials on general principles of marketing public transit. Included are checklists and forms to make it easier for the public transit manager to incorporate solid principles of marketing and public relations. Abstract by the authors.

Texas Transportation Institute (1999). *Passenger information services: A guidebook for transit systems* (TCRP Report 45). Washington D.C.: Transportation Research Board. Retrieved Jan. 21, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_45.pdf

This guidebook is written for transit planners, customer service departments, marketing and graphics professionals, consultants, and all others responsible for the design of passenger information materials for public transit systems. It is intended to provide basic instructions for designing passenger information aids, as well as theory and background material for those who need or want more of the "why" that is behind the "how."

The guidebook is organized into three main sections:

Section 1-Preliminary Considerations-This section addresses basic information needs of transit passengers, including wayfinding behavior and decision making during a trip.

Section 2-Suggestions for Route Guidance Information Aids-Each type of recommended route guidance information is briefly described, with examples where applicable.

Section 3-Design Elements for Information Aids-Design and format details for information aids (e.g., print sizes, visual contrast, use of color and symbols, and map legends) are discussed.

In addition, there are two appendixes. Appendix A provides background and reference information about some of the topics and recommendations contained in Sections 1 through 3. Appendix B contains material from the Americans with Disabilities Act of 1990 pertaining to elements of bus stop design. Although the instructions in this guidebook refer to bus service, the same information aids and design elements described also apply to rail transit. Abstract by the author.

Transportation Research Board. (1999). *Marketing transit services to business* (TCRP Web Document 8). Washington, DC: Transportation Research Board. Retrieved Jan. 29, 2003, from http://books.nap.edu/books/tcr008/html/8.html#pagetop.

This TCRP web document presents "how to" information about the marketing of transit to businesses such as employers, developers and other consumers of transit. It draws on best practices related to business-to-business marketing techniques developed by the non-profit-sector; it provides the principles of business-to-business marketing theory and offers practical recommendations for transit-to-business marketing. The document also presents case studies and examples of transit agencies, whose transit-to-business marketing has proven successful.

Transportation Research Board. (2001). *Making transit work* (Special Report 257). Washington, D.C.: National Academy Press. Retrieved Jan. 29, 2003, from http://gulliver.trb.org/publications/sr/sr257.pdf.

This report was prepared for policy makers searching for ways to boost public transit use in U.S. urban areas and wishing to know what can be learned from the experiences of Canada and Western Europe. With few exceptions, public transit has a more prominent role in Canada and Western Europe than in the United States. This is true not only in large cities, but also in many smaller communities and throughout entire metropolitan areas. Transit is used for about 10% of urban trips in Western Europe, compared with about 2% in the U.S. Canadians use public transit about twice as much as Americans, although there is considerable variation across Canada, just as there is in Western Europe and the U.S.

This report describes the differences in public transit use among U.S., Canadian and Western European cities; identifies those factors, from urban form to automobile usage, that have contributed to these differences; and offers hypotheses about the reasons for these differences—from historical, demographic, and economic conditions to specific public policies, such as automobile taxation and urban land use regulation. Chapter 1 provides an introduction. In Chapter 2, international trends in transit ridership, automobile use, and urban development are compared. In Chapter 3, descriptions are given of a number of policies and practices that have been directly supportive of transit in Europe and Canada, enhancing transit quality, reliability, and availability.

The discussion then turns to other, broader policies that have been complementary to transit, including high taxes on automobiles and motor fuel. The chapter concludes by comparing the extent to which urban land use and transportation infrastructure are coordinated in Western Europe, Canada, and the U.S. The external factors and conditions that have spurred transit use and the many transit-supportive policies found abroad are examined in Chapter 4. Differences in political institutions, public attitudes, and economic and social trends, among other factors, are discussed. The main findings of the report are summarized in Chapter 5. Opportunities for applying the successes of Canada and Western Europe in the U.S. to enhance the use and availability of public transit are indicated. Abstract by the author.

Wirthlin Worldwide. (2000). *Enhancing the visibility and image of transit in the United States and Canada* (TCRP Report 63). Washington, D.C.: Transportation Research Board. Retrieved Jan. 12, 2003, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_63-a.pdf.

This report will be of interest to transit managers, marketing professionals, and others at the local, regional, and national levels interested in improving the visibility and image of transit in the United States and Canada through the implementation of image campaigns. The report documents and presents how the image of transit can be strengthened by building on existing positive perceptions. The research provides a communications strategy to guide national, regional, and local efforts to enhance the image and visibility of transit in order to create a more positive and supportive environment.

The findings of the research suggest that communications strategies should build on the following powerful themes: (a) providing opportunities for people from every walk of life; (b) making lots of choices and options available; (c) providing easy access to things people need in everyday life; and (d) offering the mobility and freedom to do what people most want to do. The dominant theme identified was “Community Benefit Built on Personal Opportunity.” The report consists of two stand-alone sections. The

first section documents market research conducted in the United States. The second section provides similar information based on research conducted in Canada.

Notes

[1] Transtech Management Inc. (2003). *Financing capital investment: A primer for the transit practitioner* (TCRP Report 89). Washington, DC: Transportation Research Board. Retrieved Feb. 4, 2004, from http://gulliver.trb.org/publications/tcrp/tcrp_rpt_89a.pdf.

[2] Transtech Management Inc (2003)

[3] Transtech.Management Inc (2003) p. 8.

[4] Abstract obtained from *Journal of Planning Literature* 10 (4), p.434.