Briefing Materials

*For a*

Roundtable on Urban Transportation Corridor Development

October 17, 2001

Task 1 of

“International and National Benchmarking for Urban Transportation Corridor Development”

A research project by the
State and Local Policy Program
Hubert H. Humphrey Institute of Public Affairs
October 2001

Dear Roundtable Participant,

Thank you for your interest in participating in our Roundtable on Urban Transportation Corridors. We look forward to hearing your thoughts about the best practices for developing corridor areas and to learn about obstacles and opportunities for such areas in the Twin Cities. In preparation for this event, we are providing you with these materials, which we hope will provide useful background information.

The first few documents are related to the Roundtable itself, that is, a draft agenda, and brief description of the goals for the day, and for this project. Then, as additional background, we have included a copy of the “scope of work” for this study, which is being led by the Humphrey Institute’s State and Local Policy Program.

You may recall that this Roundtable is the result of interest generated at a similar forum held in March 2001. To provide you with information about that forum, and further set the context for this session, the proceedings from that day are included next.

A recent study from the General Accounting Office is included next, as it covers a number of the technical points in a current debate about urban transit corridors: the merits of Light Rail Transit (LRT) versus Bus Rapid Transit (BRT).

The ensuing documents then are designed to provide you with information about the remarks from key speakers for the day, Tom Horan and Ken Kriz.

Dr. Horan will be speaking on the topic of: "The Architecture of Place in the Information Age: Implications for Regional and Corridor Development." He will draw from his recent book, Digital Places: Building Our City of Bits, to outline the impact that technological driven change is having on regional development, including implications for integrated corridor development. The article included here is also drawn from this book.

Dr. Kriz will then present the framework that provides the basis for the Humphrey Institute project, and discuss how innovations within the areas described in the framework can help urban transit projects become reality. In his remarks, Dr. Kriz will present these in the context of the city of Denver, and discuss how lessons from that case might be applied in the Twin Cities.

Thank you again for your interest. We hope you find these materials to be useful, and look forward to a successful session on October 17!

Sincerely,

Frank Douma
Research Fellow
Table of Contents

1 Agenda and goals for roundtable and project
2 Project scope
3 March proceedings
4 A report from the United States General Accounting Office
5 Keynote address by Professor Tom Horan
6 Framework overview by Professor Ken Kriz
   Framework for transportation corridor development
   Financing approaches
AGENDA And GOALS

For

ROUNDTABLE and PROJECT
Urban Transportation Corridor Development Roundtable
Wednesday, October 17, 2001

Preliminary Agenda

7:45  Sign-in and Continental Breakfast

8:00  Welcome and Convening
      Robert Johns, Director, Center for Transportation Studies, University of Minnesota.

8:15  Keynote Address
      Tom Horan, Associate Professor, Claremont Graduate School

9:15  Framework Overview
      Ken Kriz, Assistant Professor, Hubert H. Humphrey Institute, University of Minnesota.

9:45  Response
      Carol Becker, Regional Transit Finance Coordinator, Metropolitan Council

10:00 Break

10:15 Panel- Twin City Transit Corridors- What obstacles exist? What has been done well?
      Connie Kozlak, Manager, Transportation Systems Planning and Programming, Metropolitan Council;
      Sandra Vargas, County Administrator, Hennepin County;
      Dick Stehr, Division Engineer, Minnesota Department of Transportation;
      Peter Lambur, IBI Group.

      Frank Douma, Research Fellow, State and Local Policy Program, Moderator

11:00 Facilitated Discussion
      Darryl Anderson- Minnesota Department of Transportation

11:45 Lunch and Voting on Key Issues

12:30 Closing Panel- Elected and Appointed Officials- Where do we go from here? What can be done?
      Peter McLaughlin, Hennepin County Commissioner;
      Mary Hill Smith, Board Member, Metropolitan Council;
      Carol Flynn, former Minnesota State Senator;
      Dave Jennings, CEO, Greater Minneapolis Chamber of Commerce.

      Lee Munnich, Senior Fellow and Director, State and Local Policy Program, Moderator.

2:00  Adjourn
Goals and Objectives

Goals for October 17 Roundtable:

Consider the "state of the art" in urban transportation corridor development

Develop a common understanding of what constitutes an urban transportation corridor,

Learn about obstacles and opportunities for such areas in the Twin Cities.

Receive guidance and direction for future research into corridor development.

Identify national and international examples of how to address the following topics as they relate to transportation corridors: financing mechanisms, design principles, economic effects, citizen involvement, and telecommunication and information technologies.

Goals for entire project:

Answer the following:

- What governance structures and financing mechanisms are common to the most successful urban transportation corridors?

- What design principles are common to successful urban transportation corridors? What changes occurred as these corridors developed or redeveloped?

- What are the economic effects and opportunities have been realized in successful urban transportation corridor developments, and what is the best way to measure them?

- How were citizens involved in the development of these corridors? Did they support the corridor concept before it was completed? After? Why or why not?

- Have telecommunication and information technologies been used to enhance these urban transportation corridors? If not, how could they be used in the future?

- Can the lessons from these corridors be applied in the Twin Cities? In Minnesota?

Propagate a potential strategy for implementing these solutions.

Develop policy recommendations for the development of transit corridors in the Twin Cities.
Project Scope

for

“International and National Benchmarking for Urban Transportation Corridor Development”

(2001 State and Local Policy Program Project)
2001 Hennepin County Proposal: International and National Benchmarking for Urban Transportation Corridor Development

Background

Since 1997, the State and Local Policy Program has worked with Hennepin County on a number of different transportation corridors. During this time, significant progress has been made in learning about the challenges faced by corridors, and in developing innovative solutions for those challenges.

One of the common themes tying these projects together is the continual development of a framework for identifying, understanding and addressing corridor-level challenges. A policy forum was held at the University of Minnesota in March 2001 to continue development of this framework and focused on five research categories:

- Citizen Preferences,
- Governance,
- Financing,
- Economic Effects, and
- Design.

The attendees included elected officials and staff from the Minnesota Department of Transportation, the Metropolitan Council, Metro Transit, several local governments, and private businesses. The forum included lively audience discussion, which centered on the need to develop identify and address issues raised in each research category.

This project proposes continuing the work started in the March 2001 forum by examining the particular nature of the challenges in each area as they exist in the Twin Cities, identifying national and international examples of the best practices for addressing these challenges, and synthesizing the lessons from these areas into a potential strategy for implementation. This project will also begin to examine how these corridors can enhance the surrounding communities through increased use of telecommunication and information technologies.

Research Questions:

1. What governance structures and financing mechanisms are common to the most successful urban transportation corridors?

2. What design principles are common to successful urban transportation corridors? What changes occurred as these corridors developed or redeveloped?

3. What are the economic effects and opportunities have been realized in successful urban transportation corridor developments, and what is the best way to measure them?

4. How were citizens involved in the development of these corridors? Did they support the corridor concept before it was completed? After? Why or why not?

5. Have telecommunication and information technologies been used to enhance these urban transportation corridors? If not, how could they be used in the future?

6. Can the lessons from these corridors be applied in the Twin Cities? In Minnesota?
Proposed Research Tasks:

Task 1: Policy Forum to define issues

This task will refine the issues identified at the March 7, 2001 Roundtable, related to the five areas identified in the corridor planning framework presented at that forum: Citizen Preferences, Governance, Financing, Economic Effects, and Design. Local participants from the previous forum, plus others identified since then, would be invited back to:

1. Consider the “state of the art” in urban transportation corridor development
2. Develop a common understanding of what constitutes an urban transportation corridor, and
3. Refine the issues related to citizen involvement, governance, financing, economic effects, design and the potential opportunities presented by telecommunication and information technologies.

Deliverables: Policy forum to develop a common understanding of urban transportation corridors, refine current and new issues in each subject area, and identify opportunities, including potential best-practice areas, pre-conference briefing book, and written proceedings.

Duration: July – September 2001
Task manager: Frank Douma

Task 2: Issue Research

This task will include background research on each issue area, including state of the practice generalized research, which will identify and evaluate benchmark areas and best practices, including but not limited to those identified in Task 1, and specific background research discussing the nature of the problems in the Twin Cities identified by the issues in Task 1.

Deliverables:
(1) Subtask reports identifying and evaluating potential benchmark areas and best practices, as follows:

<table>
<thead>
<tr>
<th>Subtask 2.1: Citizen Preferences</th>
<th>Subtask manager: Will Schroer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtask 2.2: Governance</td>
<td>Subtask manager: Frank Douma</td>
</tr>
<tr>
<td>Subtask 2.3: Financing</td>
<td>Subtask manager: Ken Kriz</td>
</tr>
<tr>
<td>Subtask 2.4: Measurement of Economic Impacts and Opportunities</td>
<td>Subtask manager: Lee Munnich (and Tom Horan)</td>
</tr>
<tr>
<td>Subtask 2.5: Design</td>
<td>Subtask manager: Tom Horan</td>
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</table>

Each subtask will consider whether telecommunication and information technologies were used in the best practice area, and if not, whether such technologies could enhance these activities in the future.
(2) Subtask reports on issues these issues, as they exist in the Twin Cities, as follows:

Subtask 2.6: Citizen Preferences  
Subtask manager: Frank Douma, Tom Horan

Subtask 2.7: Governance  
Subtask manager: Gary Barnes

Subtask 2.8: Financing  
Subtask manager: Gary Barnes, Ken Kriz

Subtask 2.9: Economic Impacts and Opportunities  
Subtask manager: Lee Munnich

Subtask 2.10: Design  
Subtask manager: Frank Douma, Design Center for the American Urban Landscape

As with the previous subtasks, the potential use of telecommunication and information technologies will be noted.

Duration: September 2001 – March 2002  
Task Manager: Frank Douma

Task 3: Data and Findings Integration

The findings from the subtasks will be integrated and data relevant to the tasks will be synthesized, as possible into a common GIS database for discussing each issue area.

Deliverables: Initial report summarizing research findings from task 2  
Duration: March – April 2002  
Task Manager: Frank Douma, Tom Horan, and Will Schroeer, in conjunction with Hennepin staff.

Task 4: Benchmarking forum, expert panel discussion

This task will bring together experts from the identified benchmark and best practices areas as identified in Task 2, along with the group convened in Task 1, plus other selected Twin Cities area leaders, to present the best practice areas and engage in a dialogue regarding whether these practices would work in the Twin Cities.

Deliverables: Policy forum showing best practice areas and suggesting how these lessons might be applied in the Twin Cities, pre-event briefing book and written proceedings  
Duration: May – July 2002  
Task Managers: Barbara Rohde, Lee Munnich, Frank Douma, Will Schroeer

Task 5: Draft Final Report

This task will bring together the subtask reports from Task 2, plus the suggested best practice applications from Task 4 into a final report that includes a recommended strategy for
implementation. The suggested applications from task 4 will be evaluated before potentially being included in the strategy.

Deliverables: Final report, including evaluation of suggested best practice applications and proposed strategy for implementation

Duration: August 2002 – October 2002
Task manager: Frank Douma

Task 6: Forum to propose strategy for best practice implementation

In this task, draft final reports will be sent to the group from Task 1, which will then be convened for a last time to comment on and endorse principles stated in the strategy. The State and Local Policy Program will then incorporate these comments into a final strategy, and also identify areas that require further research before action can be taken.

Deliverables: Pre-event briefing book including draft final report, policy forum to consider the findings, written proceedings from presentation of strategy, final report
Duration: November 2002 – February 2003
Task manager: Frank Douma

Proposed Principals:

Lee Munnich, HHHI
Frank Douma, HHHI
Barbara Rohde, HHHI
Ken Kriz, HHHI
Gary Barnes, Center for Transportation Studies, HHHI

Tom Horan, Claremont Graduate University

Will Schroeer, ICF Consulting

Dan Marckel, Design Center for the American Urban Landscape
Proceedings

From

Roundtable for Transportation Corridor Redevelopment

March 7, 2001
The Roundtable for Transportation Corridor Redevelopment
March 7, 2001

Introduction

On March 7, 2001, the State and Local Policy Program of the University of Minnesota’s Humphrey Institute of Public Affairs (SLPP) hosted a roundtable discussion at the Carlson School of Management. The purpose of the roundtable discussion was to explore new models for transportation planning in corridor redevelopment. This event was organized as a roundtable, wherein SLPP invited experts in transportation and community development to gather with representatives from government agencies, area businesses, and other stakeholders from local corridors to listen and interact with one another while sharing important planning and policy information, which could shape the future of the metropolitan area. The conference also provided a platform to present case studies from around the world that addressed the opportunities of corridor development.

The agenda for the roundtable included morning and afternoon sessions. The morning session was responsible for discussing topics related to developing a framework for assessing corridor development opportunities by using examples of events and programs at the local level designed to positively influence corridor development. The morning session featured Professor Robert Cervero, an expert on transportation corridor development planning from the University of California, Berkeley, as the keynote speaker. Other speakers represented the Federal Transit Administration, the Minnesota Department of Transportation, the Humphrey Institute, Claremont Graduate University, and the Design Center for the American Urban Landscape. The afternoon session was responsible for discussing the merits of focusing on corridors in community development. The afternoon session included representatives from the Metropolitan Council, Hennepin County Highway 81, Hiawatha Avenue, North 35W Coalition, and Hennepin County. The roundtable ended with a wide-ranging discussion that included the entire audience, including the speakers from the morning session.

After the panelists had an opportunity to voice their views and experiences regarding the prescribed subject matter, the audience, which consisted of approximately 55 people, was encouraged to ask questions and list their concerns with the issues related to transportation corridors. Opening the conversation up to the audience produced new ideas and thoughts as to developing a framework for assessing corridor development opportunities. The audience members were enthusiastic about the concept of developing a framework for transportation corridors in the Twin Cities metro area.

Welcome and Convening: Olin Moore, Representative for Congressman Martin Sabo:

Mr. Moore set the context for the day by providing an overview of the importance of transportation corridor development in the metro area. Moore stated that transportation corridors, as a stimulus for community development, are important issues for Congressman Martin Sabo, and highlighted the Congressman’s efforts to increase transportation corridor development activity at the community and the legislative levels. Moore closed by emphasizing that increased commitment at both levels strengthens financial and public support for overall corridor development in the metro area.
Keynote: “What Makes Corridors Unique?” Professor Bob Cervero, University of California, Berkeley

Professor Bob Cervero, an expert on transportation planning from the University of California, Berkeley, described the uniqueness of corridors in his presentation. Transportation corridors are multi-jurisdictional, have infrastructure driving growth, and various political and financial opportunities. When planning for development along transportation corridors, planners should recognize opportunities that favor corridor growth, such as maintaining a balance between the ability to quickly travel a corridor with the ability to easily access the corridor and developing a strong vision of the corridor that can shape economic development in the region. Public perception should also be considered from the start, in order to shift the planning process from reactive to proactive, thus creating long-term benefits for the community. Proactive policies can catalyze financial investments up-front, which strengthens development planning.

Many examples from around the world demonstrated various avenues of transit, from Curitiba, Brazil to Stockholm, Sweden. Both Bus Rapid Transit and Light Rail Transit have benefits to the community and, rather than choosing the “corridor of least resistance,” a transit system must be carefully developed to fit the needs of the community. Cervero stated that evaluators of economic development should consider opportunities to market the project, coordinate policies, and work with various sectors on the project, especially the private sector.

Federal and State Views of Transportation Corridors

Elaine Dezinski, Manager for the Joint Partnership Program in the Office of Research, Demonstration and Innovation at the Federal Transit Administration, spoke on the role of the federal government, which is to provide incentives, align departmental actions in support of local smart growth initiatives, supply information on tools, and offer resources to empower citizens and communities to lead development projects. Corridor development is enhanced with livability and transit-oriented development. This includes smart growth, combined finances, and more choices for the community. These programs work with current institutions to make a project work, which allows flexibility at the local level. There are also options to use various models for transportation, even at the incremental development process. To gain ridership, the community must actively market the availability, the ease of usage, and the new technology opportunities of the transportation system. Ms. Dezinski discussed Bus Rapid Transit as one viable transit alternative gaining interest in the United States.

Richard Bautch, an Inter-Regional Corridor Manager with the Minnesota Department of Transportation (Mn/DOT) spoke on the development and anticipated impacts of the Mn/DOT Inter-Regional Corridor initiative (IRC). Since connecting urban centers are a large priority, Mn/DOT has identified a network of Interregional Corridors to focus on the effects of speed limits, congestion, and traffic lights within corridors. Mn/DOT’s current investments are targeted at improving corridors with below and near-below rankings to improve overall state transportation. Furthermore, Mn/DOT is promoting the IRC system as an opportunity for alternative transportation and land use stewardship throughout state, including the metro region. Bautch stated the key planning concepts for transportation corridor development includes the partnership of various organizations to formulate a corridor vision with a sound action plan and ongoing corridor management. As part of the governor’s “Big Plan”, the Inter-Regional Corridor has been rolled into the governor’s smart growth initiative.
Developing a Framework for Assessing Corridor Development Opportunities

Ken Kriz, an Assistant Professor at the Humphrey Institute, spoke on designing a sound framework for corridor development. He stated that a framework should consider the challenges for corridor planning and development including citizen preferences, financing, potential impacts, design, and governance. Reviewing travel patterns, housing, commerce, and open space will also strengthen the framework by directing development to occur in patterns that are congruent with transportation system designs. The planners should also keep in mind successful corridors, like Curitiba and Stockholm, as discussed by Professor Cervero.

Tom Horan, Associate Professor at the Claremont Graduate School, offered an initial response, noting the differences between new corridor development and existing corridor redevelopment. He noted that the redevelopment of existing corridors is particularly immersed in political, economic, and social context of the project. Horan raised the following questions to the roundtable: “Can the corridor be thought of as a as a place?” and “How do you develop an integrated approach that respects both the mobility and community aspects of the corridor in mind?” These questions involve analyzing public sentiment and corridor development in terms of assets and liabilities.

Dan Marckel, a Research Fellow at the University of Minnesota’s Design Center for the American Urban Landscape, introduced the different approaches to in-fill versus re-fill opportunities in economic development. Marckel raised the issue to foster discussion of corridor development, using the 8 communities on the Hennepin County Highway 81 project as an example. Since Highway 81 passes through urban, 1st and 2nd ring suburbs, there are redeveloped, developing, and new development phases that need to be coordinated. As various sectors work on the corridor redevelopment project, the coalition needs to consider public needs and wants for the corridor.

Audience discussion: How do we maximize the role of corridors in the urban development and redevelopment process?

Various speakers and members of the roundtable advocated developing a framework by emphasizing design, additional research, informing the public with marketing campaigns, or getting the community involved. Gail Dorfman, a Hennepin County Commissioner, noted that St. Louis Park’s current plans to develop a downtown area have increased community involvement as well as created economic development opportunities. By planting flowers and trees along roads and lighting the streets at night, citizen interest in community centers and bike paths have been generated as well.

Connie Kozlak, from the Met Council, proposed using a strategic planned vision for economic development. She noted that since economic development and transportation planning are two moving targets that are difficult to coordinate, planners could stabilize one target according to the vision and then develop the other target to complete the vision. Furthering the conversation, Tom Horan described this as a way to compare the opportunities of BRT versus LRT in transportation planning.

Other topics explored transit stop opportunities, dedicated right of way, and permanency in development. Tom Horan described the potential for proper development to increase pedestrian activity and secure investment dollars. Elaine Dezenski spoke on the opportunities to create incremental improvements within existing transportation infrastructure. Karen Chapple raised the work of local grassroots campaigns like the 35W corridor as an example of a project that brought businesses and governmental agencies together for the community. Natalio Diaz concluded the
discussion by emphasizing the importance of the community foreseeing future problems of transportation and demanding alternative transportation modes.

**Plans to Increase Transit Corridors: Natalio Diaz, Metropolitan Council**

Natalio Diaz, Transportation Director at the Metropolitan Council, described the three most important parts of corridor development:

- An evolving vision of growth,
- A theory of corridor development, and
- Transportation design.

He also described three goals of the Metropolitan Council for transportation development in the region:

- Double capacity of bus system,
- Develop network of transit ways, and
- Provide incentives for integration for development purposes.

Long-term success of transportation is represented by heavily traveled corridors, opportunities for development, and enthusiastic political support. The practical application of creating a framework needs a number of things including partnerships, resources, and flexible solutions that create a good interchange of suburban and urban policies. Mainly, multi-modal transportation needs to have public and financial support, especially in the legislative bodies.

**Transportation Corridor Development in the Twin Cities:**

Representatives from three developing transportation corridors in the Twin Cities discussed the challenges that they have faced in the process, and how they are addressing them.

*Hennepin County Highway 81:* Larry Blackstad, the Director of Hennepin County’s Community Works Division, described the need to create a framework that respects the challenges in the implementation of the project. There are many complicated issues that have shared responsibilities and a strong structure is needed to provide for coordinated action. Under Commissioner Opat, there is a partnership-led initiative to bring private and public opinion together under a common vision. Blackstad stated that there is a need for a smart growth development framework fueled by the enthusiasm from the local communities.

*Hiawatha Avenue:* Hennepin County Commissioner Peter McLaughlin described the many obstacles to various development projects along this corridor, including lack of investments, deadspaces, micro details, and political opposition. The Hiawatha corridor has been in various planning and construction stages for nearly 40 years, and a structure is needed to speed up the development process. McLaughlin stated that such a process would require up-front financing and the support of the public. Investments need to target infrastructure, and civic leaders need to work with the community to make a vision, raise finances, and deal with opposition.

*North Metro I-35W:* Bob Benke described the efforts of the North Metro I-35W Corridor Coalition, a seven-city joint powers organization. The Coalition was formed to provide the framework for coordinating economic development, housing and transportation infrastructure investments. Initial priorities were the development of an extensive common database and assessments of growth related issues. The Coalition is currently conducting a "Build Out" Study that will form the base for future investment priorities.
Lessons learned from the coalition are:

- The need for dedicated people,
- The need for leaders with a vision, and
- The need for community participation.

The Vision Statement for the North Metro I-35 Corridor Coalition is “To jointly and cooperatively plan for and maximize the opportunities for regional community development, quality growth, and diversification through a system of collaboration.” The desires of the coalition are weighed with the abilities of the coalition to build a living community.

Audience Discussion: Merits of Focusing on Corridors?

Serving as moderator for this session, Tom Horan invited discussion on aspects of the model framework. Beginning with financing, he referred back to the heavy allocations of funds to highways, rather than a balanced approach between highways and mass transit. Sandra Vargas noted that cities do not have the resources and need more flexible dollars; Mark Garner offered the possibly of a grant-coordinated project. Another member of the audience mentioned that given the need for constant highway upgrades, transportation dollars cannot be diverted away from current budgets. A larger allocation of funds from the state to transit needs to occur instead. Peter McLaughlin reiterated his point that an adequate funding mechanism was key to the success of corridors, and that keeping it as a sub-regional initiative meant that major capital funds would generally not be available.

Horan then introduced the topic of public opinion. Mark Garner noted that public infrastructure needs to support redevelopment of land and recycled areas. Robert Cervero encouraged creative fundraising with the private sector. Economic clusters would support with transit alternatives to ensure efficient corridor use in the future, noted by Lee Munnich.

In regards to public opinion, Commissioner McLaughlin noted the issue of the public’s current negative perceptions of mass transit. Bob Benke noted the need for the government to correlate transportation policies with the wants of the people. Karen Chapple noted that despite initial reluctance to support transit corridors, proactive development policies can contribute to the growth of livable communities. Dan Mareckel remarked on the impact of positive marketing campaigns and extensive community involvement in transportation planning. Another member of the audience noted the need to bridge the gap between views of rural legislators and urban legislators in the transportation legislative bodies, in order to strengthen statewide transportation policy.

Tom Horan discussed the topic of successful consensus building at the corridor level includes private and public interests. The consensus needs to recognize the larger regional goals and work with other corridor development projects. Connie Kozlak described how a plan carefully developed at the regional level could alleviate in fighting between corridors and allow development projects to occur, even if they are developed, funded and implemented one project at a time.

Reaction:

A framework for transportation corridor development needs to be designed and include proper means of implementation. This framework needs to have committed support across various parties represented at the roundtable to heighten financial and public support of the program. There are many examples of successful transportation corridors around the world, from which we can adapt the structures, technology, and development to benefit the local transit system. Benefits from the
system may include invigorated urban centers, attractive housing, and well-planned communities. Opportunities for long-term investments in land purchases can be reinvested into the transit system.

Themes that emerged from the roundtable, applicable as lessons for current and future corridor planning efforts are:

- For corridors that affect multiple jurisdictions, it is important to get leaders from each place into the room to discuss issues and opportunities of development.
- Open communication between bureaucrats/planners and citizens is critical to project development and eventual success. There is often a difference between what citizens are saying and what government thinks citizens are saying. Planners and politicians should carefully listen to what those affected by development really want from and in their communities. There may be difficulties in communication between planners and citizens because citizens may not understand what different types of development might look like when built. For this reason, showing a picture or otherwise presenting concepts might be more effective for some people, convincing them that density can be attractive, than merely using words to describe concepts such as transit oriented design.
- Funding for transit is difficult to piece together. For this reason, cooperation between communities and representatives from different (city, county, state, federal) governments is essential to get projects moving forward.

In order to create such successes, local corridors need to compromise to focus energy on certain corridors in certain stages. Success also depends upon more developed funding and growth models. There were some questions raised:

- How to integrate the transportation corridor development plans?
- How to best serve the present and future transit customers in the metro area?
- How to finance these plans at the state and federal levels?
- How to develop a political constituency to support integrated corridor development?

These and other questions are very important in developing a framework for transportation corridor development. With these questions in mind, it would be useful to reconvene this group to further discuss building a framework for transportation corridor development in the near future.
MASS TRANSIT:

Bus Rapid Transit Shows Promise

A report from the
United States General Accounting Office
September 2001

MASS TRANSIT

Bus Rapid Transit Shows Promise
# Contents

## Letter

- Results in Brief .................................................. 1
- Background .......................................................... 2
- Federal Funding Available for Bus Rapid Transit Projects, but Use Is Constrained ................................. 5
- Capital Costs Appear to Favor Bus Rapid Transit, While Results Are Mixed for Operating Costs ................. 8
- Bus Rapid Transit and Light Rail Have a Variety of Advantages and Disadvantages ................................. 16
- Conclusions ............................................................ 28
- Agency Comments and Our Evaluation .............................. 32

## Appendixes

- **Appendix I:** Scope and Methodology ......................... 36
- **Appendix II:** Bus Rapid Transit Demonstration Projects 40
- **Appendix III:** Capital Costs of Light Rail Systems ........ 50
- **Appendix IV:** Capital Costs of Bus Rapid Transit Systems 52

## Tables

- **Table 1:** Capital Costs for Selected Bus Rapid Transit and Light Rail Projects .............................. 4
- **Table 2:** New Starts Program Funding for Bus Rapid Transit Fiscal Year 2001 ................................. 10
- **Table 3:** Elements of Bus Rapid Transit in the FTA Demonstration Projects .................................. 16
- **Table 4:** Capital Costs of Bus Rapid Transit Busways ................................................................. 52
- **Table 5:** Capital Costs of Bus Rapid Transit Using HOV Lanes ....................................................... 53
- **Table 6:** Capital Costs of Bus Rapid Transit on Arterial Streets ...................................................... 54

## Figures

- **Figure 1:** Example of Bus Rapid Transit System .......... 2
- **Figure 2:** Examples of Bus Rapid Transit Facilities in Los Angeles and San Diego .......................... 6
- **Figure 3:** Light Rail Transit in San Diego .................... 7
- **Figure 4:** Initial Bus Rapid Transit Demonstration Projects and Consortium Members ..................... 14
- **Figure 5:** Artist Renderings of Planned Bus Rapid Transit System in Eugene, Oregon ......................... 15
- **Figure 6:** Capital Cost Per Mile for Light Rail and Bus Rapid Transit ............................................. 17
Abbreviations

FTA  Federal Transit Administration
GAO  General Accounting Office
HOV  High-Occupancy Vehicle
September 17, 2001

Congressional Requesters

Each day millions of Americans face traffic congestion as they commute to work in automobiles. The impact from this congestion is substantial in time, resources, and pollution. For example, it is estimated that in 68 urban areas congestion cost U.S. travelers 4.5 billion hours of delay, 6.8 billion gallons of wasted fuel, and $78 billion in 1999. In an attempt to present buses as a more reliable and effective high-speed transit alternative, a concept involving the improved use of buses—Bus Rapid Transit—has emerged. Bus Rapid Transit includes operating buses on exclusive bus highways, High-Occupancy Vehicle (HOV) lanes, or improving service on busier routes on city streets. Bus Rapid Transit may also include a variety of technological and street design improvements, including traffic signal prioritization for buses; exclusive lanes; better stations or bus shelters; fewer stops; faster service; and cleaner, quieter, and more attractive vehicles.

Bus Rapid Transit as a comprehensive transportation option is exemplified in Curitiba, Brazil. Curitiba’s Bus Rapid Transit system is an extensive commuter bus system that includes exclusive busways and a number of other features designed to increase speed, such as traffic signal prioritization, rail-like stations with level-floor boarding, and advance fare collection. In the United States at least 17 cities are planning to incorporate aspects of Bus Rapid Transit. The Department of Transportation’s Federal Transit Administration (FTA) has begun to support this concept and expand awareness of new ways to design and operate high capacity Bus Rapid Transit systems as an alternative to building Light Rail systems. Light Rail systems generally are electric trains that may operate on streets with other traffic.

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You asked us to (1) examine the federal role in supporting Bus Rapid Transit; (2) compare the capital costs, operating costs, and performance characteristics of Bus Rapid Transit and Light Rail systems; and (3) describe the other advantages and disadvantages of Bus Rapid Transit and Light Rail.

To address these questions, we identified where Bus Rapid Transit is being used extensively in the United States and determined how FTA supports Bus Rapid Transit projects. In addition, we visited transit agencies in Dallas, Denver, Los Angeles, Pittsburgh, San Diego, and San Jose to obtain capital and operating cost information on Bus Rapid Transit and Light Rail systems in those cities. We also interviewed FTA officials and industry experts to identify the advantages and disadvantages of Bus Rapid Transit and Light Rail systems. Appendix I provides a detailed discussion of our scope and methodology.

Results in Brief

Federal support for Bus Rapid Transit projects may come from several different sources, including FTAs New Starts, Bus Capital, and Urbanized
Area Formula Grants programs, but its use is constrained. Two Bus Rapid Transit projects have received funding commitments from the current New Starts Program, totaling about $831 million. Few additional Bus Rapid Transit projects will likely receive funding commitments under the current New Starts Program, which expires in 2003, because (1) few Bus Rapid Transit projects are ready to compete for funding, (2) there are a large number of projects eligible to compete for the approximately $462 million that is projected to remain available for fiscal year 2003, and (3) certain types of Bus Rapid Transit projects are not eligible for New Starts funding due to the requirement that projects operate on separate right-of-ways for the exclusive use of mass transit and high-occupancy vehicles. FTA also supports Bus Rapid Transit through a demonstration program that began in 1999. Under this program, $50,000 was provided to each of 10 initial grantees to improve information sharing among transit agencies about issues pertaining to Bus Rapid Transit. The demonstration program is designed to determine the extent to which Bus Rapid Transit can increase ridership, improve efficiency, and provide high-quality service. The grantees’ projects include dedicated busways, bus lanes on city arterial streets, improved technology on buses, and other innovations.

The Bus Rapid Transit systems generally had lower capital costs per mile than the Light Rail systems in the cities we reviewed, although neither system had a clear advantage in operating costs. Adjusting to 2000 dollars, the capital costs for the various types of Bus Rapid Transit systems in cities that we reviewed ranged from a low of $200,000 per mile for an arterial street-based system to $55 million per mile for a dedicated busway system (see table 1). Light Rail systems had capital costs that ranged from $12.4 million to $118.8 million per mile.
Table 1: Capital Costs for Selected Bus Rapid Transit and Light Rail Projects

<table>
<thead>
<tr>
<th>Project type</th>
<th>Number of facilities examined</th>
<th>Cost range</th>
<th>Average cost</th>
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<tr>
<td>Bus Rapid Transit</td>
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<td></td>
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<tr>
<td>Busways</td>
<td>9</td>
<td>$7 million to $55 million</td>
<td>$13.5 million</td>
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<tr>
<td>HOV lanes</td>
<td>8</td>
<td>$1.8 million to $37.6 million</td>
<td>$9.0 million</td>
</tr>
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<td>Arterial streets</td>
<td>3</td>
<td>$200,000 to $9.6 million</td>
<td>$680,000</td>
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<td>Light Rail</td>
<td>16</td>
<td>$12.4 million to $118.8 million</td>
<td>$34.8 million</td>
</tr>
</tbody>
</table>

Source: Our analysis of data supplied by FTA and local transit agencies. We did not independently verify this information. See appendix I for additional details on the methodology used.

Precise operating cost comparisons for Bus Rapid Transit and Light Rail systems within and between cities are difficult due to differences among transit agencies, transit systems, and how they account for costs. We found mixed results when we compared the operating costs for Bus Rapid Transit and Light Rail systems in the cities we reviewed that operated both types of systems. Bus systems generally had lower vehicle operating costs. However, we found no clear pattern for operating cost per trip. In some cases Light Rail had higher operating costs per trip than Bus Rapid Transit, and in other cases the reverse was true. The performance characteristics of Bus Rapid Transit and Light Rail systems also varied widely, with the largest Bus Rapid Transit system ridership about equal to the largest Light Rail ridership. Finally, Bus Rapid Transit routes showed generally higher operating speeds than the Light Rail lines in these cities.

Bus Rapid Transit and Light Rail systems offer various advantages and disadvantages. Bus Rapid Transit provides a more flexible approach than Light Rail because buses can be routed to eliminate transfers; operated on busways, HOV lanes and city arterial streets; and implemented in stages. However, transit officials repeatedly noted that buses have a poor public image. As a result, transit planners are designing Bus Rapid Transit systems that offer improved service from standard bus service. Transit officials believed that because Light Rail is permanent in a given corridor it could influence economic development over time. Such long-term changes, they said, help justify the higher capital cost of Light Rail.
Background

Bus Rapid Transit involves coordinated improvements in a transit system's infrastructure, equipment, operations, and technology that give preferential treatment to buses on urban roadways. Bus Rapid Transit is not a single type of transit system; rather it encompasses a variety of approaches, including buses using exclusive busways or HOV lanes with other vehicles, and improving bus service on city arterial streets. Busways—special roadways designed for the exclusive use of buses—can be totally separate roadways or operate within highway rights-of-way separated from other traffic by barriers. Busways currently exist in Pittsburgh, Miami, and Charlotte. Buses on HOV lanes operate on limited-access highways designed for long-distance commuters. Dallas, Denver, Houston, Los Angeles, and Seattle provide examples of extensive HOV lane use by buses.² Bus Rapid Transit on busways or HOV lanes is sometimes characterized by the addition of extensive park and ride facilities along with entrance and exit access for these lanes. Bus Rapid Transit systems using arterial streets may include lanes reserved for the exclusive use of buses and street enhancements that speed buses and improve service. Los Angeles recently instituted a Bus Rapid Transit type of service on two bus arterial corridors.

Bus Rapid Transit may also include any of the following features:

- Traffic signal priority. Buses receiving an early or extended green light at intersections reduce travel time—in Los Angeles, for example, by as much as 10 percent.
- Boarding and fare collection improvements. Convenient and rapid fare collection through prepaid or electronic passes and low-floor and/or wide-door boarding results in timesavings.
- Limited stops. Increasing distances between stations or shelters improves operating speeds.
- Improved stations and shelters. Bus terminals and unique stations or shelters differentiate Bus Rapid Transit service from standard bus service. (See fig. 2.)
- Intelligent Transportation System technologies. Advanced technology can maintain more consistent distances between buses and inform passengers when the next bus is arriving.

²Los Angeles and Houston originally built part of their systems as exclusive busways and later converted them to HOV facilities.
• Cleaner and quieter vehicles. Improved diesel buses and buses using alternative-fuels are cleaner than traditional diesel buses.
• Exclusive Lanes. Traffic lanes reserved for the exclusive use of buses help buses pass congested traffic.

Figure 2: Examples of Bus Rapid Transit Facilities in Los Angeles and San Diego

Source: Los Angeles Metropolitan Transportation Authority and San Diego Metropolitan Transit Development Board.

Light Rail transit is a metropolitan-electric railway system characterized by its ability to operate in a variety of environments such as streets, subways, or elevated structures. (See fig. 3 for an example of a Light Rail System.) Since Light Rail systems can operate on streets with other traffic, they typically use an overhead source for their electrical power and boardings take place from the street or platforms. According to a transportation consultant, because Light Rail systems operate in both exclusive and
shared right-of-way environments, they have stricter limits on their length and the frequency of service than heavy rail systems.³

Figure 3: Light Rail Transit in San Diego

Source: San Diego Metropolitan Transit Development Board.

Light Rail systems gained popularity as a lower-cost option to heavy rail systems, and a number of cities have constructed Light Rail projects over the past 20 years. Since 1990, Light Rail systems have opened in 13 metropolitan areas: Baltimore, Buffalo, Dallas, Denver, Northern New Jersey (Hudson and Bergen counties), Los Angeles, Pittsburgh, Portland, Sacramento, San Diego, San Jose, St. Louis, and Salt Lake City. Several other cities, including Minneapolis and Seattle, are in the process of planning Light Rail systems.

³Heavy rail transit systems, such as in New York City, Chicago, and Washington, D.C., are defined by their operation on a totally separated right-of-way, and use a third rail on the ground to power the trains. Heavy rail systems require platform boarding, typically have longer distances between stations, and have greater capacity than Light Rail systems.
Federal Funding Available for Bus Rapid Transit Projects, but Use Is Constrained

While there is no federal program specifically designed to fund Bus Rapid Transit, several FTA programs can be used to help fund these projects. FTA provides funding for new Bus Rapid Transit projects primarily through its New Starts Program but eligible projects face stiff competition from Light Rail, Heavy Rail, and Commuter Rail projects. Funding for additional New Starts projects of all types is constrained—FTA projects little remaining authority to make funding commitments to new projects and the Transportation Equity Act for the 21st Century (TEA-21) identified a large number of projects eligible for funding under the program. In addition to the New Starts Program, transit agencies may use other FTA funds, such as those from the Bus Capital Program and the Urbanized Area Formula Grant Program, to fund Bus Rapid Transit projects. However, the Bus Capital Program grants tend to be relatively small, thus limiting this program as a significant contributor to large projects. In addition, some Bus Rapid Transit projects may qualify for certain types of federal highway funding, notably Surface Transportation Program and Congestion Mitigation and Air Quality Improvement funds administered through the Federal Highway Administration. Since these funds are provided to state governments, local transit agencies must compete with many other state needs for these funds. In addition to providing capital funding, FTA began a demonstration program in 1999 to highlight the benefits of Bus Rapid Transit. Under this program, FTA awarded $50,000 grants to 10 transit agencies to share information and data on new Bus Rapid Transit projects. The program provides workshops and information-sharing opportunities for the transit agencies, but no capital funding. The grantees' projects include a wide variety of busways, arterial bus lanes, and bus technologies.
New Starts Funding Provided to Few Bus Rapid Transit Projects

FTA's New Starts Program is the primary federal program to support construction of new transit systems and extensions to existing systems. Projects for bus and rail systems that operate on exclusive rights-of-way compete for FTA grants of up to 80 percent of their costs.\(^4\) To obtain funds, a project must progress through a local or regional review of alternatives, develop preliminary engineering plans, and meet FTA approval of final design. FTA proposes New Starts projects to the Congress for funding on an annual basis based on an evaluation of their technical merits, including mobility improvements and cost effectiveness, and the stability of the local financial commitment. In making its funding proposal each year, FTA gives preference to projects with existing grant agreements. Following that, consideration is given to projects with overall ratings of "recommended" or "highly recommended" under the evaluation criteria. The Transportation Equity Act for the 21st Century authorized about $6 billion in "guaranteed" funding over 6 years for New Starts transit projects.\(^5\)

\(^4\)A Full Funding Grant Agreement establishes the terms and conditions for federal participation, including the maximum amount of federal funds to be made available to the project. The administration has recommended reducing the cap on new starts funding to 50 percent of a project's cost starting in 2004 to ensure that local governments play a major role in funding these transit projects. As under the current program, transit agencies could supplement New Starts funds with other federal funds for a total federal contribution of up to 80 percent.

\(^5\)Those funds are subject to a procedural mechanism designed to ensure that minimum amounts are provided each year. In addition, TEA-21 authorized FTA to make contingent commitments subject to future authorizations and appropriations. This contingent commitment authority is designed to allow FTA to execute grant agreements that extend beyond the 6-year authorization period.
Bus Rapid Transit projects compete with many other projects for New Starts funding, including Light Rail, Heavy Rail, and Commuter Railroads. In total there are over 200 projects in various stages of development. As shown in table 2, for the 26 projects with Full Funding Grant Agreements in fiscal year 2001, two projects with Bus Rapid Transit components have commitments of about $831 million in New Starts funds.\(^6\) The total New Starts commitment for these 26 projects is about $8.3 billion, which includes $4.67 billion for Light Rail, $2.69 billion for Heavy Rail, and $111 million for Commuter Rail projects.\(^7\)

| Table 2: New Starts Program Funding for Bus Rapid Transit Fiscal Year 2001 |
|-----------------------------|-----------------|-----------------------------|-----------------|----------------|
| Category of projects        | Number of New Starts projects | Actual or proposed funding* | Number of Bus Rapid Transit projects | Actual or proposed funding* |
| Projects with Full Funding Grant Agreements | 26 | $8,296 | 2 | $831 |
| Projects pending Full Funding Grant Agreements | 2 | 157 | 0 | 0 |
| Projects in final design | 9 | 1,456 | 1\(^b\) | 23 |
| Projects in preliminary engineering | 31 | 8,350 | 6\(^c\) | 400 |
| Other projects authorized | 137 | N/A | 5\(^d\) | N/A |
| Total | 205 | $18,259 | 14 | $1,344 |

Legend: N/A = Not applicable.

*For projects with Full Funding Grant Agreements, figures represent amounts committed while figures for other categories represent amounts being proposed by transit agencies for New Starts funding.

\(^b\)Miami, FL; South Miami-Dade Busway Extension project.

\(^c\)Specifically identified Bus Rapid Transit projects are in Cleveland, OH; Hartford, CT; Los Angeles, CA; Miami, FL; Stamford, CT; and Washington, D.C.

\(^d\)The five locations that have identified projects with aspects of Bus Rapid Transit are Bridgeport, CT; Chicago, IL; Honolulu, HI; and two in Boston, MA.

\(^h\)Houston received a commitment of $500 million in New Starts funds for systemwide bus improvements, including Bus Rapid Transit elements. It is not solely a Bus Rapid Transit project.

\(^i\)Funding commitments for some of the projects were made under prior authorizations.
For a number of reasons, few Bus Rapid Transit projects are likely to be considered for New Starts funding in the final year of the period covered by TEA-21. First, few Bus Rapid Transit projects are ready for funding consideration. Only 1 of the 11 projects with pending grant agreements or in the final design stage is a Bus Rapid Transit project. Further, of the 31 projects in the preliminary engineering stage that have proposed about $8.3 billion in support from the New Starts program, only 6 Bus Rapid Transit projects proposing about $490 million are included. Reasons for the relatively few projects being ready for funding consideration include the newness of the Bus Rapid Transit concept and the decisions of local transit agencies, which are responsible for conducting analyses of various alternatives and proposing projects for funding. Second, FTA's authority to make new funding commitments for projects of any type will be highly limited through 2003 if FTA makes the funding commitments proposed in its fiscal year 2002 New Starts report and funding request. It projects about $462 million in remaining commitment authority for the last year of the current program. Lastly, some Bus Rapid Transit projects are not eligible for New Starts funding because projects must operate on separate rights-of-way for the exclusive use of mass transit and high-occupancy vehicles. While some Bus Rapid Transit projects, such as busways, would fit this requirement, some would not. For example, the Wilshire-Whittier Bus Rapid Transit Service in Los Angeles operates on city streets in mixed traffic; it is not, therefore, on a separate right-of-way.

Agencies Can Use Other Federal Funds for Bus Rapid Transit Projects

Local transit agencies may use other types of federal funds, in addition to New Starts funds, to build Bus Rapid Transit and other systems. For example, transit agencies can apply funds obtained through FTAs Urbanized Area Formula Grant program to Bus Rapid Transit and rail projects. This program provides capital and operating assistance to urbanized areas with populations of more than 50,000. However, areas with populations over 200,000 may only use the funds for capital improvements. For example, in fiscal year 2001, one Bus Rapid Transit project, Boston's Silver Line project, planned to use $150 million from the formula grant program, about $331 million from the New Starts Program, and $120 million in Massachusetts state bond funds. In addition, one commuter rail, one heavy rail, and six Light Rail projects planned to use about $629 million in formula grant funds, in addition to New Starts funds, as part of their overall funding.
An additional potential source for bus system improvements is the Bus Capital Program, which provides funds to states and local transit agencies for bus improvements. This program is characterized by a large number of relatively small grants. For example, for fiscal year 2001 the Congress appropriated about $574.1 million for 314 grants, ranging from $39,000 to $15.5 million; the largest amounts typically were provided for statewide bus grants. While these funds can be combined with funds from other programs, such as New Starts, they are generally not sufficient to fund a major Bus Rapid Transit project alone.

Bus Rapid Transit and other transit projects can qualify for certain types of federal highway funds administered by the Federal Highway Administration. For example, transit agencies have used Surface Transportation Program and Congestion Mitigation and Air Quality Improvement funds to help pay for transit projects. Neither of the two Bus Rapid Transit projects with Full Funding Grant Agreements in fiscal year 2001 planned to use federal highway funds. Six of the Light Rail projects with Full Funding Grant Agreements plan to use about $171 million in federal highway funds. The South Miami-Dade Busway Extension project in Final Design plans to use about $30 million in these funds.

FTA Supports Bus Rapid Transit Concept Through Demonstration Program

From FTA’s perspective, Bus Rapid Transit is a step toward developing public transit systems that have the performance and appeal of Light Rail transit, but at a lower capital cost. FTA contends that using technological advancements will allow buses to operate with the speed, reliability, and efficiency of Light Rail. FTA promotes the Bus Rapid Transit concept with the slogan “think rail, use buses.”

Among other things, Surface Transportation Program funds are provided to states to be used for the capital costs of transit projects. Congestion Mitigation and Air Quality Improvement Program funds are generally available to states for transportation projects designed to help them meet the requirements of the Clean Air Act.
In 1999, the FTA initiated a demonstration program to generate familiarity and interest in Bus Rapid Transit. The goal of the program was to promote improved bus service similar to model systems in Curitiba, Brazil; Adelaide, Australia; and Ottawa, Canada, as an alternative to more capital-intensive rail projects. The program initially provided $50,000 to 10 transit agencies to share information and data on new Bus Rapid Transit projects. FTA wanted the Bus Rapid Transit program to show how using technological advancements and improving the image of buses would allow buses to increase ridership and operate with the speed, reliability, and efficiency of Light Rail. The grantees in the demonstration program may be eligible for federal capital funds such as New Starts, Bus Capital, and Urbanized Area Formula Grant funds. FTA has held workshops for consortium members focusing on developing Bus Rapid Transit's component features, such as vehicles, image, marketing, fare collection, and traffic operations. (See fig. 4.)

FTA recently added Los Angeles to the Demonstration program and provided funding. The program includes six additional members of the Bus Rapid Transit consortium. These consortium members do not receive direct funding, but attend workshops and support the program goals.
Some locations participating in the demonstration program have more extensive elements of a Bus Rapid Transit system than others. For example, Miami and Charlotte have busways for the exclusive use of buses, while San Jose is implementing technological and service improvements such as signal prioritization on a high-ridership HOV lane arterial corridor. In Eugene, plans are to purchase buses that will have a train-like
appearance and operate on special bus lanes (see fig. 5). In Cleveland, an extensive Bus Rapid Transit project is planned that involves the extensive reconstruction of Euclid Avenue, including signal prioritization, bus station structures, and reconstruction of the sidewalks along the corridor. Table 3 illustrates the variations in the Bus Rapid Transit concept among the 10 initial demonstration projects.

Figure 5: Artist Renderings of Planned Bus Rapid Transit System in Eugene, Oregon

Source: FTA.
Table 3: Elements of Bus Rapid Transit in the FTA Demonstration Projects

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<tr>
<th></th>
<th>Boston</th>
<th>Charlotte</th>
<th>Cleveland</th>
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<th>Eugene</th>
<th>Hartford</th>
<th>Honolulu</th>
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</tbody>
</table>

Note: Individual elements may change as demonstration projects evolve.

*Washington, D.C., includes the use of a limited-access airport road.

Source: FTA.

FTA plans to conduct evaluations of each project participating in the demonstration program after the projects are implemented. FTA also plans to evaluate Pittsburgh’s Bus Rapid Transit project. Through these evaluations, FTA wants to determine the most effective Bus Rapid Transit elements so that other transit agencies can model similar systems. The Department of Transportation’s Volpe Center will conduct the first evaluation on Honolulu’s CityExpress! bus program. FTA does not plan to include all the consortium members’ projects in the evaluation.

Capital Costs Appear to Favor Bus Rapid Transit, While Results Are Mixed for Operating Costs

Bus Rapid Transit capital costs were generally lower than Light Rail capital costs in the cities we reviewed, when compared on a cost-per-mile basis. We found mixed results when we compared the operating costs of Bus Rapid Transit and Light Rail systems. In examining performance characteristics, we found that the ridership and operating speeds of Bus Rapid Transit and Light Rail systems were similar in many respects.
Bus Rapid Transit Capital Costs Per Mile Generally Lower Than Light Rail

The Bus Rapid Transit projects that we reviewed cost less on average to build than the Light Rail projects, on a per-mile basis. As shown in figure 6, Bus Rapid Transit capital costs averaged about $13.5 million per mile for busways, $9.0 million per mile for buses on HOV lanes, and $8.9 million per mile on city streets, when escalated to 2000 dollars. For 13 cities that built Light Rail lines, since 1980, capital costs averaged about $34.8 million per mile, ranging from $12.4 million to $118.8 million per mile, when escalated to 2000 dollars. On a capital cost per-mile basis, the three different types of Bus Rapid Transit systems have average capital cost that are 39 percent, 26 percent, and 2 percent of the average cost of Light Rail systems we reviewed.

Figure 6: Capital Cost Per Mile for Light Rail and Bus Rapid Transit

<table>
<thead>
<tr>
<th>Type</th>
<th>Dollars in millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Rail</td>
<td>34.79</td>
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<tr>
<td>Busways</td>
<td>13.49</td>
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<tr>
<td>Bus on HOV Lanes</td>
<td>8.97</td>
</tr>
<tr>
<td>Bus on Arterial</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Notes: Cost escalated to fiscal year 2000 dollars.
Average Light Rail capital costs are for 13 cities that built 16 Light Rail lines since 1983. Busway capital costs are for nine busways built in four cities; in two cities these facilities were subsequently

Project capital costs typically include the costs to plan, design, and construct a project.
opened to private vehicles as HOV lanes. Capital costs for buses using HOV lanes are for eight HOV facilities in five cities. Capital costs for buses on arterial streets are for three lines in two cities.

Source: GAO analysis of FTA and transit agency data.

Bus Rapid Transit capital costs vary considerably, depending on the type of system built. Costs of Bus Rapid Transit projects include the cost of the roadway—busways or bus lanes, station structures, park-and-ride facilities, communications and improved traffic signal systems, and vehicles, if additional or special buses are needed for the project. Given the variety of ways in which Bus Rapid Transit may be designed, we classified the systems into three broad categories: busways, bus-HOV lanes, and Bus Rapid Transit on arterial streets. Appendixes III and IV provide information on the Bus Rapid Transit and Light Rail systems that we analyzed.

Exclusive busways, which are essentially separate highways for buses, generally had the highest capital cost per mile for those systems we analyzed, averaging $13.5 million per mile in 2000 dollars. The capital costs of nine busways in four cities ranged from $7 million to $55 million per mile. The most expensive one was the Pittsburgh West Busway, which cost significantly more than other busways we analyzed. However, according to local transit agency officials, they needed to construct only 5 miles of busway to achieve their goal of rapid transit to the airport because the buses could exit the busway and use existing highways. They added that an alternative Light Rail system would have been longer, cost two to three times as much to construct and significantly more to operate and maintain, while attracting essentially no additional passengers.

Other types of Bus Rapid Transit systems had lower capital costs. For HOV facilities where buses used HOV lanes in five cities we reviewed, capital costs ranged from $1.8 million to $37.6 million per mile. For bus-HOV facilities we considered the capital cost of HOV lanes, bus stations, park-and-ride facilities, and additional vehicles. See appendix I for additional details.

Bus Rapid Transit improvements on arterial streets can have the lowest cost per mile. For example, Los Angeles completed the Wilshire Boulevard and Ventura lines at a cost of about $200,000 per mile. These two lines operate on major arterial streets, but without a dedicated right-of-way. The Bus Rapid Transit Improvements included in this cost were signal

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11Because the current bus-HOV lanes in Houston and Los Angeles were initially built as bus-only facilities, we include them as examples of busways for this analysis.
prioritization, improved stations, and real-time information systems informing riders of bus arrival times. While this type of surface street treatment was the least expensive Bus Rapid Transit option in the cities we reviewed, Bus Rapid Transit lines on arterial streets can have higher costs if they involve more extensive construction, such as building special bus lanes. In Orlando Bus Rapid Transit on arterial streets included lane construction and vehicle costs, and averaged $9.6 million per mile.

Light Rail systems we reviewed also vary considerably in their capital cost per mile. Included in capital costs are the stations, structures, signal systems, power systems, utility relocation, rights-of-way, maintenance facilities, transit vehicles, and project oversight. Again, we adjusted the historic capital cost of the projects to fiscal year 2000 dollars to provide a better basis of comparison. For the systems we reviewed the cost per mile for Light Rail averaged $34.8 million per mile, ranging from $12.4 million to $118.8 million per mile.

The higher capital costs per mile for Light Rail systems compared with Bus Rapid Transit arise from several factors. First, Light Rail systems contain elements not required in Bus Rapid Transit systems. Light Rail systems typically require train signal, communications, and electrical power systems with overhead wires to deliver power to trains. A consultant study of eight Light Rail lines in five cities (Dallas, St. Louis, Denver, Salt Lake City, and Portland) found the average costs of these elements to be $2.8 million per mile. Light Rail systems also require additional materials needed for the guideway—rail, ties, and track ballast. In addition, if a Light Rail maintenance facility does not exist, one must be built and equipped. Finally, Light Rail vehicles, while having higher carrying capacity than most buses, also cost more—about $2.5 million each. In contrast, according to transit industry consultants, a typical 40-foot transit bus costs about $283,000 and an articulated, higher capacity bus costs about $420,000. However, buses that incorporate newer technologies for low emissions or that run on more than one fuel can cost more than $1 million each. For

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12Generally, the seating capacity of a single Light Rail vehicle is about 110 passengers while a 40-foot bus would seat about 50 passengers and an articulated bus can seat about 70 passengers.
example, the Boston Silver Line low-floor, articulated, compressed natural gas-hybrid electric buses will cost $1.5 million each according to FTA officials.

Another factor that can affect the cost of the systems is the amount and availability of required right-of-way. Right-of-way costs are affected by the design requirements of Bus Rapid Transit and Light Rail. Transit planners told us that a basic busway required a wider right-of-way than Light Rail. They estimated a two-lane busway required a right-of-way about 30 feet wide, compared with 24 feet wide for a double-track Light Rail system.14 Regardless of the transportation mode—bus or rail—the basic design has a major effect on the capital costs. Specifically, projects that use tunneling or elevated structures are more expensive than those with surface level construction. For example, the Boston South Piers Transitway, a 1-mile tunnel with three stations built adjacent to the Boston Central Artery/Tunnel project, has an estimated cost of $601 million. Tunneling can be three to six times more expensive than surface construction, regardless of the type of system—bus or rail.

Operating Costs Vary for Bus Rapid Transit and Light Rail Systems

We found mixed results when we compared the operating costs for Bus Rapid Transit and Light Rail in each of the six cities that operated both types of systems.15 We used three measures to examine operating costs: cost per vehicle revenue hour, cost per vehicle revenue mile, and cost per passenger trip.16 We also compared these measures, correcting for vehicle capacity. Each measure resulted in somewhat different relative operating cost levels.

Part of the reason for the variation in results is that the Bus Rapid Transit systems in our example cities operate in different ways. The systems

14Pittsburgh officials noted that a 30-foot busway requirement was not uniform and that busways can be narrowed to Light Rail standards for short sections to fit through tunnels or accommodate obstructions. In Pittsburgh, for example, buses share a tunnel with Light Rail vehicles.

15The six cities with both Bus Rapid Transit and Light Rail systems in our study are Dallas, Denver, Los Angeles, Pittsburgh, San Diego, and San Jose.

16These three measures, while not the only possible measures of operating cost, are commonly used in transit. We also attempted to determine operating cost per passenger mile as a measure of comparison; however, we could not obtain sufficient data for such an analysis. See appendix I for details on the methodology used.
ranged from arterial bus routes in Los Angeles to freeway express buses on barrier-separated HOV lanes in Denver, Dallas, and San Diego to exclusive busways in Pittsburgh. In addition, the Light Rail systems in these cities also serve different functions in different ways. The Light Rail systems range from local distributor systems sharing downtown city streets with cars and trucks, as in Dallas and Denver, to commuter-type service along tracks separated from all other traffic, such as the Los Angeles Green Line. The route, type of service, size of vehicles, and function of the systems—long haul commuter service or downtown circulator—each have an impact on the operating cost. Greater speed can also lower operating and capital costs by permitting a bus route or rail line to be serviced with fewer vehicles.

Operating costs for Bus Rapid Transit systems included such costs as driver's salaries, fuel, vehicle maintenance, and maintenance of the busway or HOV lane. In Dallas it also includes the cost to move 5.2 miles of road barriers twice each day to change the direction of an HOV lane that the Bus Rapid Transit system and other HOVs use as well as the cost to provide daily enforcement of lane restrictions and motorist assistance. Light Rail operating costs include driver's salaries, electricity, and maintenance of the vehicles and track system. Light Rail systems require at least one repair facility and specialized maintenance staff, while Bus Rapid Transit vehicle maintenance is often done at existing maintenance facilities by current employees whose costs can be spread over the regular bus service.

Operating Cost Per Vehicle Hour

To determine operating cost per vehicle hour, the annual operating costs are divided by the number of hours the buses or trains operate in that year. This measure shows the average cost to operate a vehicle for 1 hour, regardless of the number of passengers carried. As shown in figure 7, using this measure, Bus Rapid Transit had lower costs in five cities and Light Rail in one.
Operating Cost Per Revenue Mile

Operating cost per revenue mile is another way of measuring the cost of operating individual vehicles. Operating cost per revenue mile is a vehicle's annual operating cost divided by the total annual number of miles traveled while actually in passenger service. It calculates the average cost of the vehicles to travel 1 mile. As shown in figure 8, all six cities' Light Rail systems showed higher costs per vehicle mile than Bus Rapid Transit routes. According to one transit expert, Bus Rapid Transit lines often run only during the busiest rush hour periods while Light Rail systems typically offer all-day service, which may in part explain this result.
Operating Cost Per Passenger Trip

Transit operating costs can also be measured on a per passenger trip basis. Operating cost per passenger trip measures the total annual operating cost divided by the total annual passenger boardings, regardless of whether the passenger is transferring from a bus to a Light Rail vehicle, or vice versa. Thus, it shows how much it costs to carry a person on a trip, regardless of the length of that trip. Using this measure, four of six Bus Rapid Transit routes had lower operating costs per passenger trip than did Light Rail systems, as shown in figure 9.
Figure 9: Operating Cost Per Unlinked Passenger Trip, 1999

Dollars

<table>
<thead>
<tr>
<th>City</th>
<th>Light Rail</th>
<th>Bus Rapid Transit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dallas</td>
<td>$2.68</td>
<td>$0.31</td>
</tr>
<tr>
<td>Denver</td>
<td>$1.68</td>
<td>$1.21</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>$2.40</td>
<td>$1.06</td>
</tr>
<tr>
<td>Pittsburgh</td>
<td>$3.79</td>
<td>$2.16</td>
</tr>
<tr>
<td>San Diego</td>
<td>$5.60</td>
<td>$1.19</td>
</tr>
<tr>
<td>San Jose</td>
<td>$5.10</td>
<td>$4.07</td>
</tr>
</tbody>
</table>

Source: National Transit Database and six transit agencies.
The wide disparities in operating costs and ridership levels are likely due to the variety of Bus Rapid Transit and Light Rail systems we reviewed. For example, our evaluation of Bus Rapid Transit service in Dallas included the costs to move 5.2 miles of barriers twice a day to allow Bus Rapid Transit and other HOV lanes to use the lanes, as well as enforcement and roadway assistance costs. In Los Angeles, the Bus Rapid Transit service on the Wilshire-Whittier line has very high ridership—about as high as the highest ridership levels achieved by Light Rail lines in the United States. High ridership generally reduces the cost per rider. In contrast, both San Diego and San Jose have lower Bus Rapid Transit ridership, which contributes to higher costs per rider. In addition, vehicle sizes and passenger capacity can vary greatly between Light Rail and bus vehicles, which can affect vehicle-based comparisons. The Light Rail systems also have varied functions that can affect operating costs. For example, Denver’s initial Light Rail system operated as a slower local circulator system on city streets shared with vehicular traffic, while San Diego’s system is used more for longer commuting trips.

Ridership and Speed of Bus Rapid Transit and Light Rail Vary Widely

Two elements of transit system performance are ridership and system speed. We found that while ridership varied considerably, the largest ridership on Bus Rapid Transit and Light Rail systems were quite similar. We also found that speed varied but that Bus Rapid Transit projects in our review were generally faster. This was likely due to the nature of the Bus Rapid Transit systems that we visited; express bus operations or operations with longer stop spacing have higher speeds.

We found that ridership on Bus Rapid Transit and Light Rail systems varies widely and depends, in part, on frequency of service, number of stops,

---

9Light Rail vehicles had a capacity about double that of the Bus Rapid Transit vehicles used on the routes we examined. To account for these differences, we also compared cities’ operating costs per passenger space per hour and operating costs per passenger space per mile. These measures, based on the actual seating and standing spaces of the rail and bus vehicles used on the routes we examined, compared the cost of carrying enough room to carry a passenger for 1 hour and for 1 mile. The analysis again showed a mixed pattern of costs; Light Rail was less expensive in four of six cities in cost per passenger space per hour and in half the cities in terms of cost per passenger space per mile.

10The slower Central Corridor was the first completed section of the Denver Light Rail system. The Southwest Corridor, which opened in 2000, does not operate on city streets because it is grade-separated and runs on exclusive tracks, allowing it to achieve higher speeds.
hours of operation, and customer demand. For example, ridership on 4 busways ranged from 7,000 riders per day to about 30,000 per day and averaged about 15,600 riders per day. For 13 bus lines on HOV lanes, ridership ranged from 1,000 to about 25,000 riders per day, with an average ridership of about 8,100. In addition, the ridership on the two arterial street Bus Rapid Transit lines in Los Angeles was about 9,000 to 56,000 per day, with an average of 32,500 per day. The highest Bus Rapid Transit ridership was on Los Angeles' Wilshire-Whitter line, which runs buses about every 5 minutes and operates all day. Light Rail system ridership also varies widely. For example, ridership on 18 Light Rail lines ranged from 7,000 riders to 57,000 daily riders and averaged about 29,000 per day. The largest Light Rail ridership was also found in Los Angeles on its Blue Line.

According to a transportation consultant, system speeds generally depend on characteristics such as the distance between stops, fare-collection methods, and the degree to which the tracks or roadway are exclusive to transit vehicles or share right-of-way with cars and other vehicular traffic, as both buses and Light Rail lines typically do in downtown areas. In the cities with both Bus Rapid Transit and Light Rail, Bus Rapid Transit speeds were higher than Light Rail in five of six cities. The high-speed Bus Rapid Transit lines, as shown in figure 10, are generally commuter bus routes that run much or their entire route on highway HOV lanes.
Bus Rapid Transit improvements to service such as exclusive bus lanes, skipped stops, dual bus lanes, and busways each may provide incremental improvements in vehicle speeds. Improvements such as bus traffic signal priority, level boarding onto low-floor buses, schedules based on time between buses rather than set schedules, fewer stops, and active management of bus spacing and traffic signal priority from a bus operations control center, can also each contribute to better service. For example, the Los Angeles Wilshire-Whitter Rapid Bus route made many of these improvements, resulting in a 29-percent improvement in average bus speeds. According to transit officials, one-third of the speed improvement along the Wilshire Avenue route was from the bus signal priority system and the rest from the other improvements.
Bus Rapid Transit and Light Rail Have a Variety of Advantages and Disadvantages

Besides cost and performance characteristics already discussed, Bus Rapid Transit and Light Rail each have a variety of advantages and disadvantages. Bus Rapid Transit generally has the advantage of (1) having more flexibility than Light Rail, (2) being able to phased in service rather than having to wait for an entire system to be built, and (3) being used as an interim system until Light Rail is built. Transit operators with experience in Bus Rapid Transit systems told us that one of the challenges faced by Bus Rapid Transit is the negative stigma potential riders attach to buses regarding their noise, pollution, and quality of ride. Light Rail has advantages, according to transit officials, associated with increased economic development and improved community image. On the negative side, building a Light Rail system can have a tendency to provide a bias toward building additional rail lines in the future.

Bus Rapid Transit Is Generally More Flexible Than Light Rail

Bus Rapid Transit systems operate more flexibly than Light Rail systems. Bus Rapid Transit can respond to changes in employment, land-use, and community patterns by increasing or decreasing capacity. Bus Rapid Transit routes can also be adjusted and rerouted over time to serve new developments and dispersed employment centers that may have resulted from urban sprawl. For example, an official in San Jose noted that because of development outside the city center, there are now eight employment centers that need to be considered in its transit analysis. On the other hand, Light Rail lines are fixed and cannot easily change to adjust to new patterns of housing and employment. For example, the western portion of the Los Angeles Light Rail Green Line was built in part to provide mass transit service for workers in defense production facilities in Los Angeles. However, by the time the Green Line opened these facilities had been closed. As a result, projected ridership levels were not achieved.

Although Bus Rapid Transit sometimes uses rail-style park-and-ride lots, Bus Rapid Transit routes can also collect riders in neighborhoods and then provide rapid long-distance service by entering a busway or HOV facility. Transit agencies have considerable flexibility to provide long distance service without requiring a transfer between vehicles. This is a significant

1Urban sprawl is often characterized as a form of growth that is low-density, auto-dependent development that rapidly spreads on the fringes of existing communities. Community Development: Extent of Federal Influence on "Urban Sprawl" is Unclear (GAO/RCED-99-87, Apr. 30, 1999).
benefit, because some research has shown that transit riders view transferring to be a significant disincentive to using mass transit. In contrast, Light Rail systems frequently require a transfer of some type—either from a bus or a private automobile. When Light Rail lines are introduced, transit agencies commonly reroute their bus systems to feed the rail line. This can have the effect of making overall bus operations less efficient when the highest-ridership bus route has been replaced by Light Rail; the short feeder bus routes can be relatively costly.

Finally, bus-based systems’ ability to operate both on and off a busway or bus lane provides Bus Rapid Transit the flexibility to respond to operating problems. For example, buses can pass disabled vehicles, while Light Rail trains can be delayed behind a stalled train or other vehicle on the tracks. Thus, the impact of a breakdown of a Bus Rapid Transit vehicle is limited, while a disabled Light Rail train may disrupt portions of the system.

**Bus Rapid Transit Operation Can Be Phased in**

Bus Rapid Transit systems differ from Light Rail systems in that they provide greater flexibility in how they can be implemented and operated. In constructing a Bus Rapid Transit system, it is not necessary to include all the final elements before beginning operations; it is possible to phase in improvements over time. Improvements such as signal prioritization and low-floor buses, which improve capacity and bus speed, can be added incrementally. These incremental changes can have significant effects. For example, one Los Angeles Bus Rapid Transit route increased its speed and cut 10 percent off its schedule time, by installing signal priority for buses to provide several additional seconds to allow buses to pass through intersections before the signal changed. Overall, the line was able to reduce travel time by 29 percent with all the improvements. In contrast, a transit expert noted that a Light Rail line segment must be fully completed and tested before starting operation and realizing benefits.

**Bus Rapid Transit Can Be an Interim System**

Bus Rapid Transit also has the advantage of establishing a mass transit corridor and building ridership without precluding future changes. The development of a busway secures a transit right-of-way for the future. Some cities have identified Bus Rapid Transit as a means of building transit ridership in a travel corridor to the point where investment in a rail alternative becomes a cost-effective choice. For example, one of the projects in FTAs’ demonstration program, the Dulles Corridor Bus Rapid Transit project in Virginia, hopes to build transit ridership in this fashion. However, converting a bus facility to Light Rail involves additional capital
costs. The idea of converting a Pittsburgh busway to rail was studied by the Port Authority of Allegheny County, and the agency concluded that the $401 million capital cost of the conversion was too high.

Bus Service’s Negative Image Can Be Overcome With Equal Service Characteristics

Officials we interviewed from FTA, transit agencies, academia, and private consulting stated that a negative image exists for bus service, particularly when compared to rail service. Communities may prefer Light Rail systems to Bus Rapid Transit in part because the public sees rail as faster, quieter, and less polluting than buses, even though Bus Rapid Transit is designed to overcome those problems. While transit officials noted a public bias toward Light Rail, research has found that riders have no preference for rail over bus when service characteristics are equal.

While environmental benefits have helped justify Light Rail systems, the gap in environmental benefits between rail and buses may be narrowing. FTA and bus manufacturers have focused on improving the design of buses not just to increase their attractiveness, but also to reduce their noise levels and emissions. In December 1999, we reported that diesel buses are becoming much cleaner.29 We noted that according to the EPA, emissions from individual buses declined substantially between 1988 and 1999. Improvements in diesel technology have resulted in heavy-duty diesel engines that are more reliable and less polluting than their predecessors. In addition, we found that newer buses can use alternative fuels, such as liquefied natural gas, fuel cells, and hybrid technologies, which may have some beneficial effect on urban air quality as they are adopted into bus fleets.

In commenting on a draft of this report, FTA officials said that the poor image of buses was probably a result of a history of slow bus service due to congested streets, slow boarding and fare collection, and traffic lights. Bus Rapid Transit is essentially designed to eliminate delays and provide faster service on better vehicles. FTA believes that the image of buses can be improved over time through bus service that incorporates Bus Rapid Transit features. This change could replicate the improved image that Light Rail systems experienced when modern Light Rail systems began to be built in the 1980's.

Light Rail Seen as a Stimulus for Community Economic Development

Transit agency officials told us that Light Rail provides the opportunity for improved economic development along the rail lines. Several city transit officials and transit consultants told us that communities see Light Rail as a mark that a city is "world-class," and could help a city improve its image and ability to attract economic development. According to transit agency officials, because Light Rail systems have permanent stations and routes, developers are more likely to locate new business, residential, or retail development along a Light Rail line than along a bus route. For example, Dallas transit officials cited $800 million in commercial development along its Light Rail line. The Light Rail line itself cost $860 million to build in 1994, so these officials saw the Light Rail line as an excellent investment. On the other hand, San Jose transit officials noted that while some residential development had occurred along its Light Rail line, the expectation is for changes in land use over a longer period of time, perhaps over 20 years, resulting in a more densely developed corridor.

Transit officials we interviewed disagreed on the extent that Bus Rapid Transit could spur economic development. For example, officials in Dallas said they had not experienced development near their Bus-HOV stations that they could trace to the Bus Rapid Transit service. However, the Director of the Cleveland Bus Rapid Transit project cited development already occurring in the Euclid Avenue corridor in anticipation of the Bus Rapid Transit line. Here the Bus Rapid Transit line would operate much like a Light Rail system, with the same kind of fixed route on city streets and identifiable station structures that allow for transit-oriented development on Light Rail routes.

In commenting on a draft of this report, FTA officials said that Light Rail's economic development impact comes about, in part, because of the high capital investment that gives a sense of permanence. Rail's economic development impact at stations also results from a pattern of rail service where there is excellent service to rail stations but much poorer service requiring a transfer beyond the stations. According to FTA officials, most development attributed to rail service occurs within walking distance of the rail station. In contrast, bus service that can leave the guideway and eliminate the need for a transfer places less emphasis on the stations as a

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21Transit experts noted that it is difficult to determine how much of investment is additional investment that would not have otherwise occurred, and how much investment is redirected from somewhere else in a city to areas near the transit facility.
focus for economic development. This may diffuse the economic development impact of Bus Rapid Transit guideways and stations.

<table>
<thead>
<tr>
<th>Light Rail Systems Are Usually Expanded Over Time</th>
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<tr>
<td>Most cities that built Light Rail systems did not end construction with the first rail line. Rather, the early Light Rail lines were often later extended or additional lines added. Of the 13 cities that built Light Rail systems since 1980,</td>
</tr>
<tr>
<td>• 5 cities already have more than one Light Rail line operating,</td>
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<tr>
<td>• 4 cities have already extended their initial Light Rail lines,</td>
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<tr>
<td>• 3 cities are doing initial expansions of earlier systems, and</td>
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<tr>
<td>• Buffalo is the only city of the 13 that has not expanded or is not expanding its initial Light Rail system.</td>
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In addition, of the 13 cities,

• 9 cities have current Full Funding Grant Agreements amounting to over $2.6 billion and have construction under way on 10 projects to expand existing Light Rail systems. Overall, the cost estimates for these projects range from $19.5 million per mile to $238.3 million per mile with an average cost of about $54 million to construct a mile of Light Rail line.
• 10 cities have proposed 15 additional New Starts Light Rail projects that are in various levels of design or development.

Two transportation experts told us that Light Rail systems, once installed, tend to expand because of the ease of making rail to rail connections, as opposed to bus to rail connections. In addition, they said that expansion also occurs because once a system has incurred the initial costs of building rail maintenance and repair facilities and training a new labor force of drivers and specialized maintenance workers, the initial costs can be spread over a larger system.

<table>
<thead>
<tr>
<th>Conclusions</th>
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<tr>
<td>A number of transit options are available to communities to help address growing traffic congestion. One such option is Bus Rapid Transit. Bus Rapid Transit is an emerging approach to using buses as an improved high-speed transit system. By employing innovative technologies such as signal prioritization, better stations or shelters, fewer stops, and faster service on more attractive vehicles, Bus Rapid Transit shows promise in meeting a</td>
</tr>
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variety of transit needs. In addition, in many communities Bus Rapid Transit systems can have lower capital costs than Light Rail systems yet can often provide similar performance. Further, Bus Rapid Transit's flexibility may be a potentially valuable feature for many communities with sprawling patterns of development, where public transportation needs can be more complex and difficult to address than focusing on a single central business district.

While Bus Rapid Transit shows promise, the primary federal program to support new and expanded transit systems, the New Starts Program, will provide little capital funding for Bus Rapid Transit over the next 2 years. First, the New Starts Program is stretched to its capacity to respond to the growing number of eligible projects and few projects of any kind will receive funding for the remainder of the current program. In addition, some of the Bus Rapid Transit projects do not fit the exclusive right-of-way requirements of the New Starts Program and thus would not be eligible for funding consideration. Further, since Bus Rapid Transit is a relatively new concept, some of the projects have not reached the point of being ready for funding consideration and there are many other rail projects further along in development with which they will ultimately have to compete.

FTA is encouraging Bus Rapid Transit through a Demonstration Program. This program does not provide funding for construction but rather focuses on obtaining and sharing information on projects being pursued by local transit agencies. The evaluations of the Bus Rapid Transit projects, which are under way and planned, will hopefully provide additional needed information on the effectiveness of this transit option.

The future of Bus Rapid Transit in the United States largely rests with the willingness of communities to consider it as they explore transit options to address their specific situations. Such decisions are difficult and made on a case-by-case basis considering a variety of factors including cost, ridership, environmental impacts, and community needs and attitudes. No one transit option is right for all situations. However, given the merits of Bus Rapid Transit and its potential cost advantages, we believe that it should be given serious consideration as options are explored and evaluated.

Agency Comments and Our Evaluation

We provided a draft of this report to the Department of Transportation for review and comment. Officials from the Department generally agreed with the report. Officials from FTA's Office of Research, Demonstration, and
Innovation; Office of Planning; and Office of the Chief Counsel provided observations on the public's poor image of bus service and the economic development impact of rail and bus service, which we included in the report. These officials also provided technical comments, which we incorporated into the report as appropriate.

As arranged with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies of this report to the Secretary of Transportation and the Administrator of the Federal Transit Administration. We will also make copies available to others upon request.

If you or your staff have questions about this report, please call me at (202) 512-2834 or write to heckerj@gao.gov. Key contributors to this report were Samer Abbas, Robert Ciszewski, David Ehrlich, and Glen Trachelman.

JayEtta Z. Hecker  
Director, Physical Infrastructure Issues
List of Congressional Requesters

The Honorable Tom DeLay
Majority Whip
The Honorable Don Young
Chairman, Committee on Transportation and Infrastructure
The Honorable Thomas Petri
Chairman, Subcommittee on Highways and Transit
Committee on Transportation and Infrastructure
The Honorable Tom Tancredo
House of Representatives
Keynote Address

Digital Places:

Design considerations for Integrating Electronic Space with Physical Place

By Professor Thomas A. Horan
Digital Places
Design Considerations for Integrating Electronic Space with Physical Place

While less visible than the artifacts of the industrial era, digital technologies and infrastructures represent a major new force in the design of homes, communities and cities. Drawing upon an interdisciplinary design orientation, the author outlines several principles for creating digital places that are both wired and livable. After first defining the concept of digital places and the scales at which they operate, the author suggests how these digital places should be designed to embrace multiple uses, connect with traditional space, link to community networks, and involve diverse parties. Based on these principles and supporting case applications, the author then outlines several specific actions that can be taken to support digital places at the setting, community and regional scale. These actions include enhancing wired live-work designs, creating collaborative and seamless work environments, linking “bricks to clicks” through local e-commerce, creating connected learning communities, ensuring community access through local institutions, pushing local government to offer e-services and e-forums, and linking high-tech growth to smart growth designs. The author concludes with comments about the need for policy leadership to forge public-private partnerships in enacting new digital place designs.

1 Introduction
The flight into a major city airport provides a visual occasion for detecting the impact of industrial infrastructure on urban design. If the airport is on a seacoast, the rugged machinery of goods shipping can usually be seen nearby; if inland, similar industrial apparatus stands near railroad yards. Invariably there is a highway system, with homes of various densities dotting the nearby landscape. As the airport approaches, the cargo and commercial elements of the terminal become clear. The plane touches down, and you complete the journey by getting into your car, traveling over the highway, by or around the downtown and into your home. The industrial infrastructure — designed to deliver atoms rather than bits — has performed its duty. Its impact is readily detectable in both what you see and what you do.

But what about the information revolution? Can the impact of this emerging and more invisible set of technologies and infrastructures be detected? And perhaps more importantly, can their impacts be guided to produce a physical landscape that satisfies our various demands for places? In this article, I review the concept of “digital places” as an organizing construct for detecting the intersection of electronic and physical place, and then proceed to several high-level design considerations (as well as some specific actions) that can be taken to produce satisfying digital places at various scales.

2 Emerging Places
In Digital Places: Building Our City of Bits, I introduced the concept of a “digital places” — these are hybrid places that have both physical and electronic characteristics [Horan 2000] [1]. I envision these to be not stable end-states but rather dynamic settings that evolve over time. At one end of the digital place continuum are “unplugged” designs that manifest little or no digital technology in their appearance and construction. Toward the middle of the continuum are various “adaptive” designs, representing modest attempts to visibly incorporate electronic features into physical spaces. Occupying the far end of the spectrum are “transformative” designs: rooms, buildings or communities composed of truly interfaced physical and electronic spaces.

Despite what cyber-enthusiasts may proclaim, “unplugged” places are still quite common and enjoyable, as digital technology has yet to significantly impact many settings. For example, the bustling cafes that line the streets of Paris remind us of the enduring social and cultural value of such “unplugged” settings. Moving across the continuum of digital places, we find many designs that have been modestly altered to incorporate some level of technology, but which retain their original organization and atmosphere. A common example of “adaptive” design would be a modest reconfiguration of an office or classroom to accommodate personal computers. A defining feature about this modest design adjustment is that it typically does not attempt to integrate a full social and electronic program; that is, very little thought has been given to how the activities conducted using the digital technology can best be supported through a supportive physical design (re)arrangement.

But the introduction of digital technology into the physical environment does indeed necessitate a more fundamental rethinking of the set of activities to be conducted in the setting. At the far end of the digital place spectrum are such “transformative” designs, which are fundamentally organized around the demands of digital technology systems. Still relatively new, and occasionally provocative, these are comprehensive designs that interweave electronic and physical components specifically in response to ongoing and emerging social interests and market demands for a more unified physical and electronic interface.

Because these arrangements are new, there is value in developing models that can inspire integrated design. One such model has been the Office of the Future in Seattle, Washington [2]. This exhibit has featured state of the art physical and electronic designs. Key features include informal “village green” space for face-to-face interaction, convertible executive offices into high-tech workrooms and dedicated space for heads down work. All of these elements are supported by a high-bandwidth electronic architecture that includes seamless wireless connectivity (both inside and outside of the office) and seamless wireline connectivity to support telework. During the initial three-year installation of the exhibit, several thousand visitors explored the exhibit and considered the
concepts for their own commercial office design. While these new reconfigurations have been advocated for some time by architects such as Francis Duffy, only now are they beginning to emerge in the high-technology landscape [Duffy 1997] [3]. Innovative digital place designs are emerging not only in the office environment, but also in residential and civic environments. A central objective of this article is to outline directions and principles that can guide these more transformative approaches to digital place design so as to ensure comprehensive integration of technology, people and place.

3 The Scales of Digital Places

Before proceeding with a discussion design guidelines, it is important to clarify the scales at which digital places operate. While the above vignettes of digital space design are at the scale of setting (e.g. workplace) digital places occur on multiple scales: homes and workplaces, communities, entire cities. And the scales interrelate; a digital setting can be part of larger digital community located within a digital region.

The most intimate scale that concerns us, as in the case of the classroom, is known to ecological psychologists as a "behavioral setting." At the scale of the setting, a key design consideration is between people and their immediate built environment. Alternative configurations can be devised to address the relationships of these spaces to the activities within them, the overlay of digital technology, and the social desires of the users of the spaces. A key objective is achieving, through function and aesthetics, a "sense of place." Despite the rise of intoxicating virtual places, social science research continues to find that the built environment plays a key role in defining our sense of self identify [Stokols 1999]. We have our favorite spots and they mean a great deal to us.

At the scale of a neighborhood or community, the design emphasis moves from fostering a sense of place to enhancing a sense of community. The critical role for digital technology at this level is to enhance the effectiveness of various community institutions (e.g. schools, libraries, community centers) as they seek to meet community needs and enhance the fabric of local interactions [Horan, 2000]. Electronic community networks can better link residents to these institutions and their services. More provocatively, these digital villages can provide new agoras for encouraging cultural, educational and social interactions among community members [Wellman 1999]. Early examples of electronic communities suggest that they can be deployed in a manner that stresses community building. For example, the Blacksburg Electronic Village in Blacksburg, Virginia, provides a well-documented example of how a local university (in this case, Virginia Polytechnic Institute) can foster a local community network that connects schools, businesses and residents and help to build a sense of community through its educational, social and neighborhood-based content [Cohill and Kavanaugh, 2000].

Digital places at the regional scale are tremendously influenced by the overall character of the region's economic performance, digital infrastructure, amenities and supporting public policies. Not every region has the same technical, financial and educational infrastructure as in Silicon Valley, California. Rather, high-technology development tends to identify the comparative "regional advantage" of an area (such as economic assets in banking, technology or new media) and then forging public-private partnerships to enhance high-bandwidth infrastructures and supportive "soft" infrastructures such as education [Saxenian 1996]. Based on their analysis of several cities, the Collaborative Economics group, for example, has also found that successful regions exploit not only their unique economic and technological assets, but also aggressively develop their business networks, their "regional culture" and the quality of the community in which the technological and economic development is to occur [4].

In short, the digital technology revolution is creating new digital places at the setting, community and regional levels. The challenge before us is to move from a passive observance of this phenomenon into a more active role in their design and development. Based on a review of approximately two dozen developments, principally but not exclusively in North America, I offer the following as general design guidelines [5].

4 Designing for Multiplicity

Digital technologies are changing the spatial locations of where we work, play and engage in civic activities. The fluid nature of electronically-mediated activity highlights the importance in understanding how these arrangements change and complicate the notion of distinct places for distinct activities. This fluidity is expected to only increase, with the advent of new wireless services promising an era of digital ubiquity. One consequence of this electronic blanket of access is the need to design for a more complex assortment of activities across the spectrum of building and community types — in other words, "designing for multiplicity".

Beginning with the home, the range of homebuyer demands have grown to include computer-related workspace as well as other leisure and entertainment function [6]. Some of these changes were featured in a recent exhibition by the Museum of Modern Art. Entitled the "Un-Private House", the twenty-six homes in the exhibit exemplify a redefinition of public and private space; a redefinition that can vary by client interests but that in general calls into question the notion of the home as simply places of private retreat [Riley, 1999]. Paralleling this rise in multiple function designs is the onset of residential networks to support access throughout the homes. Specific wiring guidelines are available to facilitate the installation of high-bandwidth residential infrastructure in new developments, and wireless networks are increasingly available existing homes and developments — all of which promote flexible use of residential space [7]. While the telecommunication industry has struggled to succeed in marketing home (retrofit) wiring products, the general trend is clear: as broadband becomes available to the
home (e.g. the “last mile” problem is solved), homes will increasingly include networks for distributing this bandwidth throughout the domicile.

For the workplace, the notion of designing for multiplicity suggests rethinking the functions of the office in light of new electronic possibilities and related knowledge-work demands for working and collaborating. New work arrangements need to facilitate different functions—concentrated work, small group discussions and informal collaborations. These arrangements can include seamless digital connections to the home office environment, because work or some form of computer/Internet use is spilling into the home. High bandwidth corporate Internets and Intranets facilitate a fluid connection between the home and work environments.

A noteworthy example of transformative office design is the Nortel Networks Headquarters outside of Toronto, Canada. Rather than looking to a virtual metaphor of electronic space, “the city” as served as an overarching metaphor for organizing Nortel’s space. Designed by Houston, Obata, and Hellmuth (HOK), the layout is organized around various urban landmarks (avenues, parks), with workspaces that are divided into color-coded neighborhoods and mixed with a number of functions including cappuccino and sandwich shops, a travel agency, and a full service bank branch. As Nortel’s Eugene Roman observed “the city draws people out and creates interactions that wouldn’t happen in our buildings” [8]. Moreover, this multi-faceted physical interaction is reinforced with a high-speed network that links the various corporate functions, as well as supports tele-working worldwide.

5 Designing with Traditional Place

Most places are meaningful for reasons that have little to do with digital technology. They evoke a subjective sense of place or community. They convey a circumstance, memory or purpose. Sometimes these are highly personalized, like a location that served as a setting for a personal life event. Sometimes these are widely shared, such as a major land mark—a bridge, a square or a promenade. Temple University’s Magali Sarfatti Larson observes the delicate balancing act that confronts the designer: “Architecture is a public and useful art. An art that cannot disguise its social and collective origins, for it must convince a client, mobilize the complex enterprise of building, inspire the public and work with the cultural... and symbolic vocabulary of the client only but of its time [9].”

Digital places represent functionality and a symbolic vocabulary that can be used for linking technology with broader design objectives for fostering a sense of place and community. Digital technologies should be introduced into the home in a manner that respects our “comfort” desires for decompressing, pursuing personal hobbies, or enjoying family time. Digital technologies can be introduced into the workplace in a manner that facilitates but does not replace the value of spaces for face-to-face encounters and group collaborations. Digital technologies can be introduced into the community in a manner that reaffirms the important role of institutions like libraries and schools in creating public spaces.

It is important to stress that, in terms of design, the concept of digital places does not erase the need for meaningful building types that pervade everyday life. Rather, the objective is to consider new combinations of electronic and physical space that can accent the various meanings of physical place while introducing a new layer of electronic presence. Homes become places of comfort and electronic engines of production; libraries become storers of print knowledge and community entry points to the electronic world; downtowns become vibrant mixed-use environments and electronically mediated entertainment zones. In terms of public policy, incentives should be enacted that support the adaptive reuse of historic buildings and districts so that the historical character of local communities can be preserved, while new economy development activities are pursued.

At this regional scale, the politics of place and fluidity mingle with each other, producing a complex relationship between traditional and emerging regional values. While the nature of high-technology business might suggest considerable spatial looseness, findings such as by Silicon Valley’s Joint Venture effort, reveals how dynamic of fluidity intersects with traditional place values. As indicated in the Figure 1, their Cluster Study found a region’s talent-base, the personal locational ties of the founder, other hard and soft infrastructures play a critical role in determining where high-tech businesses will locate [10]. Related studies by Richard Florida at Carnegie Mellon confirm this phenomenon: indigenous regional ameliorates and values play a pivotal role in attracting high-tech workers that in turn give rise to or attract high-tech companies (Florida, 2000).

6 Designing for Community

The widespread diffusion of internet access has given rise to concerns about the internet’s impact on community [Kraut, 1999]. However, there is reason to believe that technology systems can
be deployed in a manner that uses technology to build connections within local communities. Public spaces – both real and virtual – have the capacity to provide a perceptual and functional meeting grounds for friends and strangers alike. These unifying connections, both real and virtual, help transform a sense of place into a sense of community. Early community networks such as in Blacksburg, Virginia, have convincingly demonstrated how community technology infrastructures can aid in making these connections (Cohill and Kavenough 2000). And a number of community uses are being tested from connecting neighborhood streets to connecting cultural groups (Horan 2000).

By using digital technologies to reinvent public institutions, we can help overcome our increasingly fractionalized approach to urban design and planning [11]. A daunting challenge for planners is to use the digital technology to forge new alliances among schools, libraries, museums, and other civic entities in a manner that enhances local interaction. This can take several forms. Traditional civic institutions (libraries, schools, community centers) can facilitate local information exchange, communication and Internet access. In North America, several major cities (e.g. New York, San Francisco, Seattle, Vancouver) have embarked upon ambitious library building programs to link electronic and physical access for residents. Equally important are the many community groups that have created community access centers. For example, the Fuentente Learning Center in Boyle Height, California, provides Internet access, training and computer-based educational programs for approximately 2000 residents of this predominately Hispanic community (Wilson 1998) [12].

There is an important and continuing social purpose to creating accessible digital places. Similar to the geographically selective diffusion pattern of electricity and the telephone, not all communities are aggressively being wired by the private sector; telecommunications deregulation continues to disproportionately benefit the high-income sector. The provision of access to all income groups will be a public policy concern for the foreseeable future. Left strictly to market forces, innerurban and rural areas will be slow to receive high bandwidth, will not be a magnet for new economy jobs and risk lagging in related economic developments. The recent enactment of several public policies to encourage or subsidize the integration of digital technologies into schools and libraries is recognition by policymakers that some form of government intervention is required to fulfill a social compact on technological advancements [13].

7 Designing Across Architectures

We increasingly live our day-to-day lives by moving back and forth across the digital threshold between electronic and physical space. For the retail industry, business-to-consumer electronic commerce is providing the most visible interweaving of physical and electronic space. In some cases, points of sale have moved from physical stores to electronic locations, and marketing functions have moved from traditional electronic means to include physically based experiences. Retail purchasing has become an interspaced activity that includes electronic and physical browsing and electronic and physical buying – what real estate analyst Dale Anne Reiss refers to as "clicks and mortar" operations [14]. Educational activities are moving to the interspace as well, with distance learning and electronic discussions integrated into place-based activities.

While the electronic and physical layers of experience are moving together, there is no one design solution for this interweaving. Some, like product designer and writer Donald Norman, prefer simplified intelligent appliances – that is, making the technology "invisible" and as a part of each component of the build environment, whether it is the television, the refrigerator or the clock (Norman 1998). These stripped down single function devices tend to obviate the technology-aesthetic, focusing instead on the function to be accomplished. Others, like architects Gisele and Majgan Hariri, propose a transformative fusion between the physical and electronic aesthetic in their imagined Digital House; rather than a traditional design filled with smart devices, the entire house is designed as a billboard for the information age [15].

These competing views – one stressing the invisible nature of the technology and the other suggesting a distinctive information-age aesthetic – are but two approaches to designing a digital aesthetic. One thing is certain: there is no one stylistic approach that fits all situations. For every traditional library remodeling that quietly incorporates digital feature, there is a late-modernist office complex that visibly celebrates digital uses. For some traditional home additions that include an expanded office and home theater, there will be others that choose a new, completely wired digital house. The concept of digital threshold connections does not advance a particular design aesthetic but highlights the need to think through the electronic-physical interface to achieve a desired function and look.

The dot-com sector is grappling with this threshold within the context of “business to consumer (B2C)” e-commerce. During the initial wave of e-commerce activity, there was considerable speculation on the value of exclusive electronic transactions, such as had been successfully implemented by the Dell Computer corporation. However, the dot-com shakeout of 2000 has led to a reassessment of electronic versus physically based distribution channels,
Emerging out of this period is a renewed understanding of the role in traditional "bricks and mortar operations" in branding, marketing and (not to be understated) impulse buying and retaining. New combinations across the architectures are also emerging, whereby the retail location becomes the marketing arm in support on online transactions (see Fig. 2). In a related fashion the Chicago suburb of Evanston is taking advantage of the regions emerging network (see below) to feature a community electronic site – E-tropolis Evanston – that includes e-commerce with local vendors [16].

8 Designing in Collaboration

The experiences of place are not bound by academic or professional discipline; day-to-day activities are a manifestation of our individual and group interests, tastes and policies. Yet, a common characteristic of modern-day urban planning and public policy is specialization, with coordination across disciplines coming at considerable expense. Such is often the case for digital and telecommunications planning. Observers like University of New Castle’s Stephan Graham and Marvin Simon have found that the design of electronic networks often emanates from a perspective that is narrowly focused on technology, with little regard to related economic, community and infrastructure issues (Graham and Marvin, 1996).

What is needed is a reflective "design" approach to overcome these artificial barriers by focusing on the desired solution in an integrated manner. First advanced by Donald Schon and colleagues in books such as The Reflective Practitioner, the policy design approach is aimed at bringing together an interdisciplinary group of thinkers and practitioners – "reflective practitioners" – to create inventive solutions to complex situations (Schon 1983) [17]. Within the context of digital places, the policy design approach suggests the need to involve a range of orientations and constituencies in crafting innovative combinations of physical and electronic space, be it a residential design, a community center, a mixed use redevelopment or a greenfield master planned community.

For example, a recent "design studio" was undertaken to examine the planning of community digital places. As part of this effort, four electronic services (telework, telemedicine, distance education and smart travel) were considered, as was the range of infrastructures and service providers that were needed to deliver these services. Over the course of two focus group "design studio" meetings, stakeholders from various public and private organizations provided recommendations for implementing such high-bandwidth services and systems throughout the study area (Minnesota, US). A central recommendation of the group was isolated approaches would be insufficient, and that those communities that were succeeding or held promise had developed an "action oriented forum" for engaging stakeholders and implementers (Horan and Wells 2000).

Digital place planning can be done within the context of a master plan or a facilities or telecommunications plan. An important question to ask early in the process is the scale of the vision, as this will, among other items, determine the range of participants to be involved in the visioning process. The vision can be small scale, like a computer center in a campus facility, or large scale, such as the design of regional technology infrastructure. The corresponding visions can include, for example, creating a high-tech friendly, mixed-use development (including high-bandwidth connectivity), designing a college campus to feature ubiquitous Internet access and community face-to-face gathering, or developing a new housing mix that features streetside home offices to encourage informal gathering during the day.

9 Actions For Linking Space to Place

Regardless of scale, it is at the applications level that the attributes of desired physical places are salient. Digital place design should identify key sectors that will be affected (residential, commercial, civic cultural), and then work with those sectors to identify desired services and applications. While each community needs to arrive at their own priorities, the following actions are offered as a sampling of the actions that can be taken to enhance digital places at the setting, community, and regional level in a manner consistent with the design themes noted above.

Promote Wired Live-Work Options

Homeowners, developers and architects can consider how telecommuting or telework should be integrated into the design of residential housing and urban live-work projects. This would include the nature, size and location of space for conducting home-based computer work as well as the distribution of high-bandwidth access in the home. As one illustration, the placement of home offices in a manner that has greater street orientation can facilitate digital technology use and an informal public presence [18]. In terms of policy, there may be a need attend to issues or concerns about ubiquity of residential access across geographic locations and low-income areas so as to ensure "last mile" connectivity.

Create Collaborative and Seamless Working Environments

Knowledge work companies can reestablish the value of physical place by designing workplaces that take stress out of face-to-face activities, such as small group and informal collaboration. Heads-down, more private workspaces can complement these club-oriented designs. Information architecture, such as corporate intranets can enhance the collaborative dimensions and do so across corporate and residential locations. Innovative examples of collaborative environments and seamless electronic environments — such as Nortel networks noted above — represent the cutting-edge of thoughtful designs for work. Steps can also be taken to better link high technology work designs to the community fabric. Adaptive reuse of historic areas; such as is being done in...
several North America and European cities can help integrate the thriving new economy with the street economy of existing communities.

**Link Bricks to Clicks Through Local E-Commerce**

Local businesses need to determine the level of their e-commerce presence. The relationship of the "bricks" and "clicks" sales and supply channels need to be clarified in their business plans to articulate the role of each in advancing the business mission and sales goals. Local businesses and Chambers of Commerce need to consider innovative partnerships to enhance the local e-commerce. Developments such as e-Tropolis Evanston provide innovative examples of how local businesses can exploit the World Wide Web to gain local market share [19]. This will be helpful for many reasons, including the need to understand and plan for fiscal implications of retail e-commerce on local tax revenues.

**Create Connected Learning Communities**

School officials should consider the community connections that can be enhanced by combining school network development and lifelong learning to support regional competitiveness and other civic uses. The electronic architecture of the educational sector can represent an important cornerstone in the provision of high-bandwidth network services throughout the community. Teachers can exploit these new bandwidth connections to the home to enhance their connection with children and parents in the community. Institutions of higher education can explore new infrastructures, such as educational partnerships with businesses and students to reassess their role in providing service to the community in terms of extended training and learning.

**Build Community Through Local Community and Cultural Institutions**

Local libraries can consider how new and innovative designs can help these institutions assert their spatial and electronic presence in the community, including providing universal access to all community members. The library has evolved from a repository of basic print information to a disseminator of a complex assortment of print and electronic information, the latter requiring a digital planning process of its own. To devise innovative new electronic and physical digital places, this process would need to include a range of partnerships with other community resources such as museums, schools, and community centers. These community resources can become important "third places" for enhancing access to digital technology services and resources (Oldenberg 1997).

Community and cultural centers can develop new interactive aspects of their programs to enhance local electronic cultural presence and community. Many museums have already taken the first step toward developing a digital connection to their exhibitions and collections. Less common is expanding these networks to feature the work of local artists and topics of interests to arts enthusiasts. This can include taking an active role in getting local artists represented on the Internet as well as connecting citizens and visitors to local cultural museums and organizations.

**Push City Hall to Offer E-Services and E-Forums**

Digital Technologies provide a host of opportunities for local government to make the land-use and related policy decision process more interactive. Many local units of government now utilize visualization software such as geographic information systems. These platforms, especially when combined with digital bulletin boards, can facilitate dialogue about new developments, including high-technology and mixed use developments. Due to the widespread growth of the Internet, online civic forums and other community networks can now be implemented in a wide variety of cities and towns.

Moreover, local governments should determine which of their services can be provided electronically. Unfortunately, a recent review of thirty-five cities in the U.S. by the Maxwell School at Syracuse University revealed that most cities have spent the last few years struggling with Y2K instead of conducting more strategic planning and applications development [20]. The timing is now right to extend a range of e-services to citizens, including community news, interactive forums, city council registration processes, ballot information and, in some instances, voting.

**Make Fast Growth Smart Growth**

Local economic development authorities and business interests have the opportunity to consider those high-tech segments that would complement the economic goals of the community. New partnerships could be explored with both telecommunication providers and regional planning organizations to coordinate economic growth with regional land-use plans. Possible improvements to the "soft" infrastructure (e.g., schools, housing stock, cultural amenities) as well as "hard" infrastructure (telecommunications, transportation) can be considered to enhance regional competitiveness for high-tech jobs. Smart growth policy can provide positive incentives for high-technology industries to locate in places that not only make economic sense, but environmental sense.

There are, unfortunately, few examples of major high-technology companies embracing such efficient land use. While downtown areas do provide attractive places for many start-up companies, major high technology corporations seem to prefer the campus park settings, albeit within major metropolitan areas. While such developments provide pedestrian-friendly environments (that is, once you are there), they appear less likely to embrace mixed-use and alternative-transportation friendly designs. Fortunately, a number of corporations such as starting to adopt a more land-use sensitive policy [21]. A major and exciting challenge exists to bring high-technology corporations into the fold of the smart growth policy movement.

**10 Need for Policy Leadership**

These actions are offered as sampling of how the general digital place design
principles can be translated into actions. To proceed with any of these applications, the vision must be squared with the reality of resources and opportunity. The vision and application provide the demands upon the system that citizens, businesses, schools and institutions bring to the technologists and information architects who will design our digital places consistent with our various and collective desires.

While many of the key actions to creating digital places reside in the hands of consumers, citizens and businesses, there is much that can be done in the public sector to facilitate innovative digital place design. The overriding public policy need is for leadership in creating a cohesive framework for public and private investment in digital technology systems for communities. Within this framework, various sectorial actions – in educational, infrastructure, and governance – provide opportunities for innovative urban design. Local communities may act for any number of reasons, including telecommunications regulation, Internet access, and transportation. While the circumstances vary, the need is the same: a desire for timely, accessible, and useful digital services and facilities.

While it is true that in the many countries the prevailing policy sentiment is that of telecommunications deregulation, there is still a need for policy leadership to ensure equal access, including supporting civic institutions in providing this access. While bandwidth availability will eventually make its way into most communities, the need for stewardship in ensuring fairness of access remains high. For at least the short term, the markets have expressed a very strong interest in focusing the design of digital places on those communities that can afford it. Consequently, public and private sectors need to cooperate in the planning and execution of broadband systems. A recent example of this public-private partnership approach is the Metropolitan Chicago initiative [22]. This Technology Development Plan builds on a previous study sponsored by the regional planning agency, and includes a set of actions to ensure high-bandwidth connectivity, as well as the development of parallel civic applications and networks [see Fig. 3].

11 Conclusion: Wired and Livable

Digital technology systems are now being planned with several design objectives in mind: reliability, scalability and affordability, to name a few. The idea of digital place design is a new objective: livability. While implicit in many strategic telecommunications planning efforts, these guidelines bring this quality-of-life issue to the fore. And it does so with special attention to the relationship between the electronic and the physical interface.

While the flurry of electronic space (e.g. e-commerce) development makes it tempting to dismiss the physical arena, there is every reason to believe that functional, enjoyable, and meaningful places will continue to be valued. Indeed, ongoing research on the psychological impact of the Internet suggests that we must pay close attention to nurturing social interaction and overcoming the isolating consequences of the technology [Kraut, 1999]. Robert Putnam concludes his influential Bowling Alone with the following recommendation: "The key, in my view, is to find ways in which Internet technology can reinforce rather than supplant place-based, face to face, enduring social networks" [Putnam, 2000] [23].

In conclusion, the need for physical place and human activity is not going to vanish, but will evolve within the context of digital activities and technologies. Physical place settings can now play an important role in integrating technology-infused activities with the range of other place-based interactions. Multimedia learning environments can encourage electronic and face-to-face communications. Public library-based community access stations facilitate access to printed and electronic information for all residents. Innovative "telework" arrangements facilitate working online at home and spending more time with family and friends. In sum, the proper physical design can become an integral part of deliberately crafting a set of circumstances that facilitate social and community connections. There is no doubt that digital technologies will impact our social and community relations, but how well they integrate with these relations will depend on how well we build our city of bits.

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He has authored over a dozen articles and chapters on the impacts of digital technology and telecommunications. This article is adapted from his most recent book Digital Places: Building Our City of Bits (Washington, D.C. Urban Land Institute, 2000). Additional information about the book (including an interactive forum) can be found at www.digital-places.ului.org.

Notes


[5] These case studies are summarized throughout Digital Places: Building Our City of Bits (UU, 2000); the design guidelines presented here adapted from Chapter 5.

[6] According to the 1998 Consumer Preference Survey by the Professional Builders Association, the single most requested residential space was for preplanned space for home computer, followed by kitchen upgrade and integrated great room requests.

[7] Residential wiring guidelines are available from a number of commercial portals, such as http://www.electronichouse.com/, http://www.electronichouse.com/, http://home-automation.org/


[10] For additional information see Joint Venture, Internet Cluster Analysis (San Jose: Joint Venture), July 1999 at http://www.jointventure.org/


[12] Information on the PUENTE Learning Center can be found at: http://www.puente.org/

[13] Current information about public and foundation efforts to bridge the "digital divide" can be found at http://www.digitaldividenetwork.org/.


[16] Additional information on Etropolis Evanston can be found at http://www.evanston.lib.ill.us/community/technopolis/about_bkgd_01.html.


[18] An example of this home office design would be the live-work lofts at Oreno Stockton, Oregon where the home offices are located on the ground level and face the street. See: www.oronocostockton.com


[21] Examples would include the Computer Sciences in Austin, Amazon.com in Seattle, and Sun Microsystems in Burlington/Boston.

[22] Information about the initiative can be found at www.metroplanning.org.


References


Framework Overview

A framework for Transportation corridor Development

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Case Study of Innovative financing Approaches – Denver’s Southeast Corridor

By Professor Ken Kriz
A Framework for Transportation Corridor Development

One of the most pressing problems in the development and management of transportation assets is the multi-jurisdictional corridor problem. Corridors are the areas through which a transportation arterial runs. This definition includes both the transportation infrastructure (e.g., the roadbed, rails and stations) and the new and existing development that surrounds that infrastructure. Problems with corridor development are always large - the need to ensure access to transportation, provide high quality transportation, develop livable communities and provide for economic development along the corridor. One could develop a long list of potential corridor development problems.

However, these problems are exacerbated and new problems are created when a corridor crosses jurisdictional boundaries. When there are multiple jurisdictions involved, there are can be marked difficulties in planning and developing corridors. There is a need for a model that addresses the major problems in corridor planning and management.

The model developed here has roots in previous studies carried out by the State and Local Policy Program at the Hubert H. Humphrey Institute of the University of Minnesota. One previous report sketched the framework for similar transportation planning and management efforts. A more formal model of the corridor planning and management process is shown in Figure 1. Figure 1 shows that there are 5 major areas of concern with regard to the process.

One of the major new problems that is created in the planning of transportation corridors is in the area of governance. No longer can a single jurisdictional agent exert control over corridor development. Now many parties come to the problem of developing the corridor, each with their own needs and desires regarding design, construction, maintenance and operations of the transportation infrastructure.

There are several ways in which governance issues might affect the outcomes of the corridor design process. One of the most important is that the design of the corridor may not produce the highest possible economic impact for the corridor and its related jurisdictions as a whole. For example, if one city is able to exert significant enough pressure on the governing entity to produce their preferred design alternative, this may create a negative economic impact for other areas along the corridor that might outweigh the benefits to the city’s citizens. The notion of spillover effects of tax and spending decisions is well established in the economics literature. To help focus the discussion on corridor wide impacts, economic impact analysis should be conducted to weigh potential costs and benefits of various corridor design scenarios. There are many different types of economic impact analysis, ranging from complex benefit-cost analysis to easier to understand qualitative discussions of the ranges of potential costs and benefits.

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Both the governance problem and economic effects of corridor development have a bearing on the ease and method of *financing* a proposed solution. There are several different sources of funds available to finance a transportation infrastructure investment. However, some if not most require at least implicitly a governing body for the corridor that can be a sole authority. Also, the range of potential economic impacts and their monetary implications for the governing authority will help determine the range of and types of financing available for the initial capital investment.
The fourth major area of concern for corridor planning and management is the *design* of the corridor. This obviously has an impact on the economic impacts of the project. For example, a grade separated rail system may produce smoother, more efficient travel for passengers. However, a boulevard type roadway improvement is more likely to produce economic development along the entire length of the corridor. This difference in impacts also will translate into the most likely source of cash flows to the system that can be used for capital construction and maintenance of the system. Grade separated rail systems must be largely paid for through farebox revenue, subsidies from government units, and development revenue and property value increases derived around station nodes. Roadway improvements may produce gains in property value throughout the corridor that can be captured as a revenue stream for the corridor authority. Finally, governance may impact directly the choice of design in the corridor, having an effect on economic impacts and financing.

The last piece of the corridor planning and management model is *citizen preferences*. Citizen preferences are the foundation for all of the other pieces of the planning and development process. There are several ways in which these preferences can affect the rest of the process. In the area of governance, for instance, if citizens do not respond well to special districts (there are several reasons why this could be the case, from a feeling of loss of accountability to no experience in dealing with special districts) then even if the optimal institutional structure for administering the corridor is a special district, this recommendation is sure to meet with resistance. In the area of financing the preference problem can be marked. Though all of the citizens of the jurisdictions mentioned above are likely to benefit from implementation of an infrastructure improvement, it is unlikely to get support if property tax rate increases are necessitated by implementation.
Case Study of Innovative Financing Approaches – Denver’s Southeast Corridor

The Southeast Corridor has long been recognized as one of the Denver Region’s highest priority travel corridors. The corridor follows I-25, the only north-south freeway in the State, and I-225, which provides access to I-70, the region’s major east-west freeway. The Southeast Corridor connects the two largest employment centers in the region, the Denver central business district (CBD), with over 100,000 employees in the mid 1990s and the Southeast Business District, with approximately 80,000 employees in the mid 1990s. With employment centers at both ends of the corridor, traffic congestion occurs in both directions during the morning and evening rush hours. Traffic volumes continue to rise faster than increases in population and employment, and the length of the peak rush hours has grown over the years. All of these factors combine to make the Southeast Corridor the highest volume, most congested corridor in the region.

Culminating over 15 years of study on the corridor, the Southeast Corridor major investment study (MIS) was completed in 1997. The corridor investment, which was recommended for implementation and adopted by the Denver Regional Council of Governments (DRCOG) Board in 1997, consisted of a light rail element, highway improvements to address safety and operation problems, improved pedestrian/bicycle facilities, and transportation management elements. The project had received broad public support, but the final hurdle was financing. The costs seemed prohibitive (approximately $1.66 billion, with a state and local share of just over $1.1 billion). However, the Southeast Corridor initiative assembled a financing package that brought together four partners: the Colorado Department of Transportation (CDOT), the Regional Transportation District (RTD), FHWA, and FTA.

CDOT’s share of the funding will be provided through the issuance of $671 million of GARVEE bonds. These bonds were authorized by the Colorado legislature in 1999 as part of a funding package to finance nearly $5 billion in corridor projects throughout the state. In addition, the funding legislation transfers $200 million in sales and use tax revenues to CDOT annually to finance the projects. Because Colorado law requires voter approval for all tax increases and debt financing transactions, CDOT was required to seek voter approval in November 1999 for the issuance of its bonds. By a majority of 62 percent, Colorado voters approved the initiative to sell bonds to accelerate project completion. The first bonds were issued in June of 2000. They are 15-year direct GARVEE bonds repaid with future Federal and state matching funds.

RTD will also secure up-front financing for the Southeast Corridor project through the issuance of sales tax revenue bonds, since a pay-as-you-go approach will not provide sufficient cash balances for a project of this magnitude. RTD also sought voter approval in November 1999 for the issuance of debt to partially finance the transit portion of the Southeast Corridor project. Like the CDOT initiative, voters overwhelmingly approved RTD’s ballot measure. In addition, RTD and CDOT received a full funding grant agreement (FFGA) with FTA in November of 2000 for $525 million, which when
combined with the issuance of $320 million in sales tax revenue bonds and $30 million in local funds, will fund the light rail portion of the Southeast Corridor project. The Southeast Corridor financing package is recapped in Table 2. The project will be completed on a single design/build contract, which will save money through project acceleration and reduce the risks to the Corridor associated with price increases.

<table>
<thead>
<tr>
<th>Source of Capital</th>
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<th>CDOT</th>
<th>RTD</th>
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*Repaid with Federal Grant Funds and State Match (Sales and Use Tax Revenue)

**Repaid with Sales and Use Tax Revenue