TRB

TRANSPORTATION RESEARCH BOARD

CONFERENCE PROCEEDINGS ON THE WEB 6

Transportation Systems for Livable Communities

Summary of a Conference

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

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Transportation Systems for Livable Communities

Summary of a Conference

Katherine F. Turnbull, Rapporteur

October 18–19, 2010
Keck Center of the National Academies
Washington, D.C.

Sponsored by
Research and Innovative Technology Administration,
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Transportation Research Board

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

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This report has been reviewed by a group other than the authors according to the procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

This project was sponsored by the Research and Innovative Technology Administration, U.S. Department of Transportation, and the Transportation Research Board.

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Preface

Transportation plays a key role in creating livable communities. Transportation systems create livability by working with land uses to give individuals multiple travel choices for meeting their daily needs affordably, safely, conveniently, and efficiently. The Transportation Research Board (TRB) hosted the Transportation Systems for Livable Communities Conference at the Keck Center of the National Academies in Washington, D.C., in October 2010.

This meeting was the fifth in a series of spotlight conferences funded by the university transportation centers (UTC) program of the U.S. Department of Transportation's Research and Innovative Technology Administration (RITA). The UTC program awards grants to universities across the country to advance the state of the art in transportation research, to conduct technology transfer activities, and to educate the next generation of transportation professionals.

TRB assembled a planning committee, appointed by the National Research Council (NRC), to help organize and develop the conference program. The planning committee was chaired by Lisa Aultman-Hall of the University of Vermont. Committee members provided expertise in bicycle and pedestrian transportation, transit planning and operations, land use, urban street design, and management of transportation organizations.

The planning committee was responsible solely for organizing the conference, identifying speakers, reviewing submitted poster abstracts, and developing topics for the breakout group discussions. Katherine Turnbull of the Texas Transportation Institute served as the conference rapporteur and prepared this document as a factual summary of what occurred at the conference. Responsibility for the published conference summary rests with the rapporteur and the institution.

Implementers of livability projects joined faculty, students, and researchers from UTCs and other universities to explore transportation approaches for livable communities. In addition, the conference considered the unique role UTCs can play in undertaking research to advance transportation for livable communities.

Through a series of presentations, panels, and discussion groups, conference attendees and panelists considered case studies, research needs, and the challenges of incorporating livability into transportation programs and projects. On the basis of expert panels and facilitated discussion, attendees identified promising directions for research that could help implement the state of the practice and advance the state of the art.

The conference attracted more than 170 participants from a variety of organizations, including universities; transportation agencies; and other public, private, and nonprofit organizations. The conference was characterized by broad and active participation and discussion, with nearly half the attendees participating in the program via a panel or poster presentation.

The views expressed in this summary are those of the speakers and discussants, as attributed to them, and are not the consensus views of the conference participants or of the conference planning committee members. Any opinions, conclusions, or suggestions

discussed in this summary are solely those of individual participants and do not necessarily represent the views of all conference participants, the planning committee, TRB, or NRC.

This conference summary has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise in accordance with procedures approved by NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published summary as sound as possible and to ensure that the summary meets institutional standards for clarity, objectivity, and responsiveness to the project charge. The review comments and draft manuscript remain confidential to protect the integrity of the process.

TRB thanks the following individuals for their review of this report: Cindy Carlsson, Minnesota Department of Transportation; Roderick Diaz, Los Angeles County Metropolitan Transportation Authority; and Jennifer Dill, Portland State University.

Although the reviewers listed above have provided many constructive comments and suggestions, they did not see the final draft of the conference summary before its release. The review of this summary was overseen by C. Michael Walton, University of Texas at Austin. Appointed by NRC, he was responsible for making certain that an independent examination of this summary was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this summary rests entirely with the author and the institution.

These proceedings consist of presentation summaries from the opening sessions and panels and summaries of key research needs and possible performance measures identified in the discussion groups. An appendix contains short summaries of the poster session presentations.

The conference included general sessions and breakout discussion sessions. The first day of the conference included four general sessions. The conference began with a welcome from the chair of the conference planning committee and the RITA administrator. Conference participants then discussed the draft working definition of transportation and livable communities developed by the conference planning committee before comments from the Deputy Assistant Secretary of Transportation for Policy at the U.S. Department of Transportation. Other general sessions on the first day provided perspectives from practitioners, summarized cross-disciplinary activities, and highlighted recent research projects. The day concluded with an interactive poster session. A total of 50 posters were presented, with the authors available for discussion.

The second day began with presentations by transportation agency representatives on research supporting implementation of livable systems. Conference participants had the opportunity to discuss research needs in breakout sessions. The conference concluded with a summary of the breakout sessions and comments from UTC representatives.

The proceedings follow the conference format with two exceptions. First, the discussion of the working definition is summarized after the general session presentations. Second, the poster summaries prepared by the authors are presented in the appendix. A list of attendees is provided at the end of the document.

The conference planning committee thanks Katherine Turnbull for her work in preparing this conference summary report and extends a special thanks to RITA for providing the funding support that made the conference possible.

Conference Overview and the Vision for Livable Communities

Lisa Aultman-Hall, *University of Vermont Transportation Research Center, presiding*
Peter H. Appel, *Research and Innovative Technology Administration*
Beth Osborne, *U.S. Department of Transportation*

The opening session began with an overview of the conference by the chair of the conference planning committee, Lisa Aultman-Hall, University of Vermont Transportation Research Center. Peter H. Appel, Administrator, Research and Innovative Technology Administration (RITA), provided a welcome, and Beth Osborne, Deputy Assistant Secretary for Transportation Policy at the U.S. Department of Transportation (U.S. DOT), provided an overview of the U.S. DOT vision for transportation for livable communities.

CONFERENCE OVERVIEW

Lisa Aultman-Hall

It is a pleasure to welcome you to the Keck Center of the National Academies and the U.S. DOT Conference on Transportation Systems for Livable Communities. The conference is sponsored by RITA of U.S. DOT and organized by the Transportation Research Board (TRB).

My name is Lisa Aultman-Hall, and I am the Director of the University Transportation Center (UTC) at the University of Vermont. It has been my privilege to chair the planning committee for this spotlight conference over the past year.

This spotlight conference is the fifth sponsored by RITA in conjunction with its UTCs and TRB. Prior conferences focused on freight, demographics, and infrastructure. I recognize and thank RITA's Curt Tompkins, Robin Kline, and Tom Bolle for their participation on the planning committee and their ongoing assistance. Tom Palmerlee and Matt Miller of TRB also deserve special recognition for their assistance to the planning committee and with the conference logistics.

For those of you who might not know, the UTC program was created in 1987. The program has grown and now includes 60 centers and 125 universities. It provides universities with the opportunity to pursue research, education, outreach, and workforce development in the field of transportation, which, as we all know, crosses traditional university department boundaries.

I thank the members of the conference planning team, which included representatives from UTCs, state departments of transportation, local and federal agencies, transit agencies, and other organizations. The members include Susan Handy, University of California, Davis; Shawn Turner, Texas Transportation Institute; Martin Tuttle, California

Department of Transportation; Gabe Klein, District of Columbia Department of Transportation; Diana Bauer, U.S. Department of Energy; Roderick Diaz, Los Angeles County Metropolitan Transportation Authority; and Bob Dunphy, a consultant formerly with the Urban Land Institute. Bill Carr of the District of Columbia Department of Transportation also provided valuable assistance to the planning committee.

This amazing and diverse group is a testament to the nature of livability—it requires nontypical groupings; interdisciplinary thinking; and different solutions for different communities, from the most rural to the largest urban areas. The executive director of our local transit system said last week that livability is what so many of us have been demanding for a long time. I agree with this statement. Livability is making transportation about more than capacities, volumes, and levels of service on highways—it is about making transportation more integrated with land use, housing, and jobs and about preserving landscapes, the environment, quality places, and the quality of life.

I am guilty, as are many of you, of demanding this "more" from transportation. It is easy to demand, but it is hard to implement and hard to know what research to conduct next. Our goal here together for 2 days is to identify promising directions for research to advance transportation for livable communities one step further.

To take on this challenge, the planning committee has recruited volunteer leaders to work throughout the conference. I thank them for their eager agreement to help. We have plans already to disseminate the conference results—two volunteers are taking notes in preparation for a session at the 2011 TRB Annual Meeting in January. The PowerPoint presentations will be posted on the TRB conference website, and conference proceedings are being prepared.

Our goal is to honor the tradition of the spotlight conferences to create an interactive program aimed at identifying research needs by including not only the UTC community but also other diverse interested stakeholders. In exchange for your active participation, the planning committee has made a commitment to share the resulting products widely to move the national discussion on transportation and livability forward.

The interactive program requires your participation. There are so many of you—170 registered participants. The conference has been sold out for a month with a waiting list. We had double the poster proposals that we have space for tonight at our reception. We are pleased that you are here. Of the 170 participants, approximately 40 percent are from universities; 22 percent are from federal agencies; 18 percent are from the private sector; and 11 percent are from state, regional, and local agencies.

The conference includes general sessions and breakout sessions. We will begin this morning by hearing from leadership at RITA and U.S. DOT. We will also provide you with the opportunity to comment on the definition of livable communities developed by the planning committee to guide the organization of the conference. Speakers in the general sessions today and tomorrow morning will provide various perspectives and experiences on transportation and livable communities. The poster session and reception this evening will provide additional opportunities to learn about current projects and research studies and to interact with fellow participants. Most of tomorrow will be spent in breakout sessions discussing transportation and livability research needs, potential performance metrics, and related topics. The key points from the breakout groups will be summarized in the closing session.

I look forward to a lively and interesting conference. I encourage you to participate in the discussion actively and to help identify research needs to advance transportation and livable communities.

WELCOME

Peter H. Appel

On behalf of U.S. DOT, it is pleasure to welcome you to this important conference. We are pleased to continue sponsoring these conferences in partnership with the UTCs and TRB.

This conference is the result of the hard work of a number of people. Lisa and the conference planning committee did an excellent job, and their efforts are greatly appreciated. I thank Tom Palmerlee and Matt Miller of TRB for their assistance in organizing this conference. I also recognize Curt Tompkins, Robin Kline, and Tom Bolle of RITA for their active involvement and ongoing assistance to the conference planning committee.

The topic of this conference—livability—is important. I had the opportunity to represent Secretary LaHood and U.S. DOT at the Annual Meeting of the International Transport Forum in Europe 5 months ago. The transport ministers from about 50 countries participated in the forum. The Ministerial Plenary Session was held at the end of the conference. The session, which was formal, was held in a large room, with the 50 representatives seated at a round table.

All the ministers, or their representatives, made formal comments. The first speaker was the vice minister of transport of Japan. The translation of her closing comment was that providing a good transportation system "comes down to happiness and good living." When it was my turn to speak, I discussed the department's five strategic goals—safety, livable communities, environmental sustainability, economic competiveness, and the state of good repair—and why they are important. I noted that these goals are key to improving our country and our economy and to making the United States a better place to live. I concluded by echoing the Japanese vice minister's comment that it all "comes down to good living."

If that mantra were held by all transportation professionals, we would be in good shape. The department's five goals all relate to "happiness and good living." Safety is the highest priority at the department. Safety, saving lives, and preventing injuries certainly focus on "happiness and good living." What could be more about good living than saving lives? What could be more about happiness than preventing injuries? The livable communities goal focuses on making our country a great place to live, which also relates to "happiness and good living."

The department's five goals all are important. They are also consistent with each other. At RITA we focus on crosscutting issues, and we work across all modes to advance research to support the department's goals. Our intelligent transportation systems program advances safety. Our alternative fuels programs advance environmental sustainability. Our Bureau of Transportation Statistics helps promote economic competitiveness by providing accurate data and metrics.

The goals also overlap. The livable communities goal has much in common with the other four goals. Safety is important for livable communities. Environmental sustainability is consistent with livable communities. Environmentally friendly communities are more livable. Economic growth and economic opportunities are important for livable communities.

This conference is important for RITA. The UTCs are a great resource for research, education, and outreach. In looking forward, we need to align priorities so that the UTCs focus on research that will ensure that the department, the U.S. transportation system, and the UTCs all thrive. Ensuring that the UTCs focus on topics that are relevant to the department, relevant to state transportation agencies, and relevant to each other is important. The UTC research, education, and outreach activities related to livable communities are relevant. The UTCs are playing a critical role in helping develop metrics for livable communities in urban and rural areas.

The UTCs are a critical source of innovation for advancing livable communities. We need creative approaches to make the transportation system more supportive of livable communities. A new light rail transit (LRT) line in an urban area provides improved access and mobility. We need to work hard to identify creative solutions to enhancing mobility and accessibility for residents in rural areas and smaller communities.

Universities, UTCs, and researchers can also play important roles in transportation workforce development. Planning, designing, building, and operating the transportation system of the future will require new skill sets. We need professionals with expertise in energy, housing, public policy, technology, and other diverse skills. Rob Bertini, RITA's Deputy Administrator, is leading the effort for the department to ensure that we are able to meet the workforce needs of the future. The UTCs are critical to this effort.

I am always amazed by the expertise and enthusiasm at these conferences. I know you will have a productive 2 days. I thank you for participating in this important conference, and I look forward to seeing the results of your discussions.

U.S. DOT VISION OF TRANSPORTATION FOR LIVABLE COMMUNITIES

Beth Osborne

I greatly appreciate the opportunity to participate in this conference. The discussion on defining livability was interesting. One of the first things I do when I talk about livability is present the U.S. DOT definition. We have kept our definition simple to capture the key points of livability. If you try to include too much in a definition, it ends up meaning nothing, and you lose people because of its length.

U.S. DOT defines livable communities as having transportation options, housing options, and destinations close by. I suggest that having destinations close to home is the most important of the three elements. Transportation is a means, not an end.

We have found that this simple definition resonates with the public and with policy makers throughout the country. We did not develop this definition in isolation. The definition is in response to the typical way we develop communities, which keeps land uses separate and is automobile dependent.

The design of modern neighborhoods is not very livable. Trips are longer than necessary in many neighborhoods because of the circuitous street system, and there are few travel options. This type of street network is unfriendly to a pedestrian or a bicyclist, especially a small one. Transportation options begin with the way we design our streets. Transit is not a viable option if someone cannot walk to the stop.

It is not enough to build just any sidewalk. You have all seen bad examples of sidewalks that no one could use. Sidewalks need to be taken seriously, and walking needs to be treated as a legitimate form of travel and commuting. Walking is incredibly cost-effective.

U.S. DOT's livability definition relates to urban areas, smaller communities, and rural areas. When we discuss transportation options, we often focus only on transit. Bicycling and walking are also important transportation options supporting livability. I grew up in a small town in West Virginia. We walked everywhere—to school, to church, and to the store. Rural America knows what livability is, they live it every day. We can enhance livability in rural America, however, by providing appropriate transit options and supporting elements.

Livable communities have housing options. One of the elements in Envision Utah focuses on providing options to allow families to live near each other. One of the unintended consequences of separating different types of housing is that we often separate families.

Livable communities provide housing for people of all incomes and all stages of life. Housing is available so that families can stay close together. The young millennial just out of college will rent. And he might want to live in the same neighborhood as his sister, who has kids and wants a detached house with a yard. They both might want to live near their empty nester parents, who no longer want to mow a lawn and have moved into a condominium.

Livable communities have destinations close by. In livable communities, getting to these destinations is safe. Livability is more than just providing a safe sidewalk; there is someone who actually wants to use it. Place-making provides vibrancy to areas, with people traveling to destinations, which enhances personal safety and security. I remember my father telling me as a teenager that being alone on a street is unsafe. If there is no place to go, people will not be using the streets. Place-making supports personal security. Livable communities save families money. Department of Housing and Urban Development (HUD) Secretary Donovan notes that the average family spends approximately 55 percent of its income on housing and transportation. This percentage is lower for families that live in transit-rich neighborhoods and higher for families in automobile-dependent neighborhoods. Families living in transit-rich neighborhoods spend approximately 41 percent of their income on housing and transportation, while families in automobile-dependent neighborhoods spend 57 percent.

Automobile ownership is the biggest transportation expense for most families, averaging $5,000 per year per car before gasoline and repairs are counted. Reducing automobile ownership translates into considerable household savings. Access to good transit service can also reduce automobile ownership per household.

Between 2005 and 2008, passenger vehicle and motorcycle registrations in Washington, D.C., decreased by 11 percent, and per household vehicle ownership decreased by 16.8 percent. During the same period, the district experienced a 3.5 percent increase in population and a 40.9 percent increase in per capita income. At that time, gasoline prices increased and the economy fell—district residents had the flexibility to save money on transportation. Livable communities save people money and enhance the economic competitiveness, efficiency, and resiliency of the area.

The Center for Neighborhood Technology website provides information on housing plus transportation affordability. The latest release in March 2010 expands the analysis to more than 330 metropolitan areas in the country, providing coverage for more than 80 percent of the population in the United States. Transportation costs range from 12 to 32 percent of household income but generally fall between 18 and 21 percent. This information is important for policy development. The interaction of housing and transportation has not been considered in public policies. As a result, affordable housing is often located on the fringe of cities—away from jobs, from transit, and from shopping.

Livability also saves the taxpayers money. For example, the population of Cuyahoga County, Ohio, remained relatively constant at almost 1.4 million people from 1950 to 2002. The same population was spread out over a much larger area in 2002, however, costing the taxpayers more for providing infrastructure, police and fire protection, and other services.

Envision Utah found that the "quality growth strategy" required $4.5 billion less investment in transportation facilities, water and sewer facilities, and utilities over a 10-year period. Furthermore, by focusing development where infrastructure already existed and including a more market-driven mix of housing, Salt Lake City would reduce mobile source emissions by 7.3 percent and experience less traffic congestion.

Reducing costs for individuals and communities is especially important in these tough economic times. We need to provide communities with the tools to analyze the costs associated with various development patterns and to maximize existing infrastructure to promote livability.

People understand and support livability. People want to discuss the topic with Transportation Secretary LaHood during his visits to communities throughout the country. He has received a strong positive response to U.S. DOT efforts, and the level of interest is high.

A study by the Environmental Protection Agency (EPA) examining consumer surveys found that at least one-third of the consumer real estate market prefers mixed-use, transit-oriented development. We currently have enough large-lot housing developments to meet projected future needs. We need more small-lot housing and attached housing to meet future needs. We need to examine policies at all levels of government to ensure that they are responsive to market conditions.

The needs and desires of the U.S. home buyer are changing. The demographics of the United States are changing to reflect a population that will be seeking smart growth and compact development. By 2025, the number of households without children will grow by

88 percent, compared with 12 percent growth in households with children. Surveys indicate that many consumers prefer walkable communities—communities characterized by pedestrian access and a sense of connection, community, and diversity. Single people and empty nesters want walkable, transit-accessible communities. Realtors, developers, and investors recognize that an increase in walkability translates into higher home values. As Secretary LaHood has noted, we are focusing on providing options for people and getting supply to meet demand.

Recent experience indicates that developers quickly purchase property around proposed LRT lines. Property values skyrocket once the LRT line is open. As a result, individuals most in need of transit are the least able to move into these communities. We need to provide enough housing to meet the demands of all groups.

Livable communities also reduce energy consumption. We tend not to focus on community design when we consider methods to save energy. Our experience with the corporate average fuel economy (CAFE) program shows that we cannot reduce oil use through fuel efficiency standards alone. Fuel economy rose in the wake of the CAFE standard set in 1975, but so did our fuel usage because of an increase in vehicle miles traveled (VMT) of approximately 150 percent. Population accounted for only 13 percent of the increase in VMT. Most of the increase was caused by dispersed development patterns and a lack of viable alternatives to driving.

Since 1980, the number of miles Americans drive has grown three times faster than the U.S. population and almost twice as fast as vehicle registrations. A large portion of our energy demand is the result of land use patterns that require more driving. More than 60 percent of the growth in driving and associated forms of energy consumption is due to land use factors.

The partnership with HUD, U.S. DOT, and EPA is based on the six partnership principles listed below. The principles were developed jointly by representatives from all three agencies. It is interesting that we all shared the same vision on most principles.

1. Provide more transportation choices.
2. Expand location- and energy-efficient housing choices.
3. Improve economic competitiveness of neighborhoods by giving people reliable access to employment centers, educational opportunities, and other basic services.
4. Target federal funding toward existing communities—through transit-oriented development and place-based policies.
5. Align federal policies and funding to remove barriers to collaboration, leverage funding, and increase the effectiveness of existing programs.
6. Enhance the unique characteristics of all communities, whether rural, suburban, or urban.

The last principle is important. Livability means focusing on the unique characteristics of a community. Rural, suburban, and urban communities all have different wonderful qualities that should be protected and enhanced. There are great differences between urban livable communities—Washington, D.C., is different from Denver, Colorado—but both areas provide transportation choices, housing choices, and access to destinations.

The Transportation Investment Generating Economic Recovery (TIGER) grant program focused on projects addressing safety, economic competitiveness, community livability, environmental sustainability, and state of good repair. Twenty-two of the 51 projects funded focused on livability. Examples of projects included a new transit system in Tucson, Arizona; reconnecting a community to its waterfront in Burlington, Vermont; and modifying a truck route in White Fish, Montana, into more of a main street that supports tourism and local businesses.

A new program providing $100 million for regional planning grants was recently implemented by HUD. These grants focus on better planning for coordinating housing, transportation, land use, water, and other infrastructure elements. The Community Challenge Planning grants represent a second HUD program. The TIGER II program includes some funding for planning, which was combined with the $40 million in the HUD program. The two programs fund different elements but are part of the same project. Examples of related EPA projects include the brownfield planning grants and the smart growth technical assistance program.

We expect to continue and expand these programs in 2011. U.S. DOT has also asked for $20 million to establish an Office of Livability and capacity enhancement grants. We have learned from HUD's experience that enhancing the capacity of local communities to implement and maintain plans is important, along with providing planning funds.

We have many other activities focusing on livable communities under way at the three agencies. I hope you will have a productive conference, and I look forward to hearing your suggestions for needed research and outreach.

Integrating Transportation and Livability

Perspectives from Practitioners

Joseph Alfandre, *Joseph Alfandre Homebuilding Company and the Kentlands Company*
Marcy McInelly, *SERA*
Gabe Klein, *District Department of Transportation*
Roderick B. Diaz, *Los Angeles County Metropolitan Transportation Authority, presiding*

Implementing transportation systems to support livability involves multiple entities, agencies, and stakeholders. The challenges in making places more livable most often reflect the need for integration—integration of various sensibilities (transportation, land use, development) in system design, integration of planning processes and work efforts, and integration of actual transportation facilities and services. Speakers in this session discussed particular physical and planning challenges and institutional issues that arise in addressing those challenges.

INTEGRATING TRANSPORTATION WITH LAND USE AND DEVELOPMENT PLANS

Joseph Alfandre

I am pleased to be asked to participate in this session and to provide a developer's perspective on livability. I was a home builder for many years and then had the opportunity to develop Kentlands in Maryland, which has been the zenith of my career so far. Kentlands represents a response to a market-driven demand. I purchased an expensive piece of property, and I wanted to do something that would capture a part of the market in the competitive Washington, D.C., area. I am proud of Kentlands, which became the example for both good and bad elements associated with livable communities.

It is important to remember that developers focus on what the market wants and deliver products that are popular and that make a profit. If that is not at the core of developments, then livability will be hard to achieve. Kentlands is being overshadowed by more recent developments that have enhanced many of the concepts we initiated. I am optimistic that the three legs of the development stool—the public, the private, and the civic—are becoming more educated on good development principles and are finding the courage to undertake innovative projects. The terms new urbanism, smart growth, transit-oriented development, and smart sprawl have all been used to refer to more livable developments. It comes down to the developer, however, to make these concepts a reality.

Montgomery County, Maryland, covers 400 square miles and has a population of nearly 1 million people, and 0.5 million jobs are located there. The county has been experiencing a 1 percent annual growth rate. The county has experienced six decades of progressive land use policies. Approximately 4 percent of the land area remains developable. As a result, we focus on redevelopment in areas already served by public infrastructure. The planning department's focus most recently has been on communities in the I-270 corridor, and specifically along MD-355, which is considered the county's main street. This corridor is anchored by Metrorail on the south end and the Corridor Cities Transitway on the north end.

In the past 2 years, the county has updated four of our master plans to build on the past investment in Metrorail and to maximize the potential success of the Corridor Cities Transitway in Germantown and Gaithersburg. Twinbrook and White Flint are two stops on the Metrorail Red Line. The Twinbrook master plan was completed a few years ago. The most recent of the I-270/MD-355 master plans to be undertaken is White Flint. White Flint is ideally located within the corridor to become a vibrant mixed-use center. The plan focuses on intensifying land use around the Metrorail station and expanding mixed-use developments. Among the White Flint Plan Vision elements are enhancing mobility, including a reconfiguration of MD-355 to create space for bus rapid transit and bicycles. The plan envisions the placement of new buildings as a means for defining the public realm and public open space system while ensuring compatibility and sustainability. Discrete and connected neighborhoods create distinct residential areas along MD-355. Approximately one-third of the 430 acres is currently devoted to surface parking. The existing superblocks will be reconfigured to form a robust street network with enhanced space for pedestrians and bicyclists.

The plan recommends an increase in total development of more than threefold. The mixed-use community will have an improved jobs-to-housing balance. Today this balance is approximately one-third residential space. In the future it will be more than one-half residential. A better balance of jobs and housing allows more development for the same number of peak vehicle trips.

The plan includes three particularly innovative implementation elements. The first is the commercial–residential zone, a new mixed-use zone that relies on incentive density provisions to promote public benefits provisions. The second is a staging plan ensuring that time-critical public facilities will be brought online in sync with private development. The third is establishment of a taxing district that creates a public–private partnership to coordinate the implementation of the robust street grid more effectively.

The ink on the master plan is barely dry, yet several developers have submitted applications for the first phase of plan review. We have a long way to go to implement the White Flint plan, but I believe we are headed in the right direction.

PRIORITIZING PHYSICAL SPACE

Marcy McInelly

I am grateful to be asked to participate in this session. I am a licensed architect. For the past 25 years my work has focused on urban design. My comments today address envisioning livable streets, which requires a new set of values and new priorities. It is important to remember that transportation is about people. Streets should be designed to be safe and attractive to all user groups, not just drivers.

Streets and roadways account for approximately 40 percent of the land area in many cities. As a result, streets are a major part of the public realm or the public space in a community. We need to value this space more and not neglect it.

I was asked to chair the Congress for New Urbanism (CNU) Transportation Task Force 7 years ago. One of the first things I did was change the name of the task force to the Project for Transportation Reform. I am proud of the work we are doing. I will highlight two recent efforts—the Sustainable Street Network Principles developed by the Project for Transportation Reform and the new *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach: An ITE Recommended Practice*.

The Sustainable Street Network Principles provide overarching values for considering the street system. When CNU began its collaboration with the Institute of Transportation Engineers (ITE), we realized that we did not have a set of values for defining the street network. We spent the past few years developing these values, which are reflected in the Sustainable Street Network Principles. The principles reflect some fundamental new ways to consider the street system.

We decided to step back from viewing the transportation system as a science, which other groups are much more qualified to do. CNU is devoted to promoting better physical spaces, so we focused on the physical space of streets, not the transportation system or the modes. We focused on the space of streets and the place-making functions of streets. We discussed these topics numerous times. We use the term "networks" for a reason. There have been recent efforts focusing on the design of individual streets. Less attention has been paid to how streets fit together in a network. The network approach is better for property values, emergency response, public health, and other reasons. A network approach also means that not every street has to contain all of the mobility options.

A draft of all the principles will be available soon. I will highlight a few of the principles. One is that "street networks support communities and places." A second is that "street networks attract and sustain economic activity." A third is that "street networks maximize opportunity for transportation choice." Part of the subtext for this principle is that the environment of the street network, as well as the routes and modes, is important. Bicycling provides a good example of providing physically different environments. Bicycle lanes are fine for people who are comfortable riding in traffic. Bicycle boulevards, which are streets that are calmed for bicycle use but are not exclusively for bicycles, are better for other user groups. In Portland, Oregon, we are finding that different riders choose different physical environments. A mix of environments should be provided to meet the needs of various user groups. Two other principles are "all streets are safe and walkable" and "the activity of walking is the fundamental unit for building the street network." We apply these principles to all types of areas, not just urban areas.

Designing Walkable Urban Thoroughfares: A Context Sensitive Approach: An ITE Recommended Practice represents a collaborative effort between CNU and ITE. The document, which includes a number of significant changes from past practices, took 6 years to complete.

The ITE manual replaces design speed with target speeds. This change means that the design of the thoroughfare encourages the desired operating speed. The design can better ensure that actual speeds will match the target speeds. The manual includes detailed information on the design factors that influence target speeds.

In terms of location, currently street design is dictated by urban or rural context, which is part of the highway engineering legacy. The new ITE manual broadens the choices for context. It introduces the concept of the urban transect, which includes context zones ranging from suburban to high-density urban. The new manual uses an urban transect, which uses context status to determine the engineering and design of roadways. The land uses and area govern the level of activity, and the level of activity in turn governs the street design. I believe that this new approach represents a radical departure from past practices.

The manual changes the traditional design vehicle approach. The design vehicle has been used to dictate lane width and curb-return radii. Currently, the design vehicle usually represents the largest vehicle that may use a thoroughfare, regardless of the frequency of use. The new ITE manual recommends the evaluation of trade-offs in urban areas and acknowledges that selecting the largest vehicle may be undesirable and impractical. Selecting the largest vehicle also affects pedestrians and other modes in ways that are usually inconsistent with the community vision.

The fourth area of change from traditional practices relates to functional classification, which describes a street's theoretical function and role in the network. Functional classification also governs certain design parameters. The new ITE manual acknowledges that the function of a street may be different from its functional classification. For example, a street in a historic downtown area may be classified as an arterial, which often limits consideration of certain features. The new manual determines the physical design of a thoroughfare by the street type (thoroughfare type) designation.

Research is important in developing and implementing the livable street principles and the guidance provided by the new manual. The research done by Eric Dumbaugh at Texas A&M University examining street design and traffic safety has been useful. That research correlated crash data and certain types of street design. The results indicate that a well-designed street is safer for all users—pedestrians, bicyclists, and motorists.

Recent studies by Matthew Trowbridge, a medical doctor and a community health professional, have examined safety and public health. He analyzed the impact of nonconnected street networks, including culs-de-sac, on the response times for emergency medical vehicles. He found that nonconnected street networks increase response times for emergency vehicles. He is also examining street design speeds. We have accepted that 25 mph is an appropriate speed for residential streets. His work indicates that a 20-mph speed is safer, especially as we encourage more walking by children and other groups. Lowering speeds from 35 to 25 mph may also be appropriate on main streets.

Recent studies examine economic health and economic competitiveness of cities and the link to good transportation systems, good transportation planning, and good transportation policies. Joe Cortright and CEOs for Cities present recent examples of these efforts.

Among other obstacles to implementing more livable streets are institutional, organizational, and cultural barriers. There is often competition for funding with other priorities. There may be issues with streets located in multiple jurisdictions and technical challenges relating to adapting livability to different contexts. We need more research on all these topics.

Engineers and planners bring various perspectives to the design and operation of the street network. Both groups use different terms and even use different definitions for the same terms. On multidisciplinary project teams we often need two engineers—one who has

credibility with the state department of transportation and one who has knowledge of the latest research on livability.

Funding priorities can also be a problem in many areas. Project priorities may be defined by incomplete or flawed data. The dedicated funding for safety improvements tends to focus on projects that benefit vehicles, not necessarily pedestrians or bicyclists. For example, the Oregon Department of Transportation Safety Priority Index System, which is in the state statute, misses simple, low-cost solutions for bicyclists and pedestrians.

Examples of jurisdictional boundary issues include level of service (LOS) for vehicles at intersections and the use of different methods by different jurisdictions. For example, many states use the volume–capacity ratio, while cities and counties use LOS.

There are also technical challenges in adapting livability to different contexts. Examples of different contexts include linking towns and main streets by rural highways, urbanizing highways in cities, humanizing big streets, and rehabilitating main streets from "highwayization." I think that urbanizing highways in cities is the most difficult for implementing changes. These situations typically include trying to bring ingrained highway engineering requirements and a new community vision together. We encountered this situation recently in Oregon on Highway 213. We identified a number of small steps that could be taken initially.

In summary, I think that a new vision for streets and roadways is emerging from a number of groups. There is also new research that shows the safety, human health, and economic health benefits of more livable streets. We need more research, however, on the design, operation, safety, and institutional issues associated with the new context for streets. We need research to address other barriers. I believe that livability can be adapted to a wide range of contexts in urban and rural areas.

OVERCOMING CHALLENGES TO MULTIMODALISM

Gabe Klein

It is a pleasure to participate in this session. My comments focus on the roles, responsibilities, and programs at the District of Columbia Department of Transportation. I joined the department about 20 months ago after working in the private sector, so I bring a slightly different perspective. We recently redefined the department's mission statement to reflect a broader vision than just moving people and goods around the city. The new mission statement is to "develop and maintain a cohesive, sustainable transportation system that delivers safe, affordable, and convenient ways to move people and goods—while protecting and enhancing the natural, environmental, and cultural resources of the district."

We also developed the following vision statement to provide more detail. The department "is committed to achieving an exceptional quality of life in the nation's capital through more sustainable travel practices, safer streets, and outstanding access to goods and services. Central to this vision is improving energy efficiency and modern mobility by providing next generation alternatives to single-occupancy driving in the city."

The district lost population during the 1960s, the 1970s, and the 1980s. We want to make the district an attractive place to live and work. One of our messages focuses on promoting a healthier, happier workforce in the district. Discussing the benefits of living in the district is part of this message. We have seen an increase in young residents and empty nesters moving into the district.

We want to show people that the district offers alternatives to driving alone, including Metrorail, buses, bicycling, and walking. To encourage changes in behavior we focus on marketing and communications, promoting the cost savings of alternative modes, and making alternative modes easy and safe to use. Ownership and operation of a personal vehicle in the district are expensive.

We want to take advantage of the beautiful built environment that Washington, D.C., has to offer by providing travel options for residents, workers, and visitors. We have aligned the department's vision with the concepts of sustainability, livability, heath, congestion management, and safety.

The District of Columbia Department of Transportation developed an action agenda on the basis of input from numerous stakeholders. We have made some bold statements related to sustainability. The six major statements include making walking and bicycling the mode of choice for trips of less than 1 and 3 miles, respectively. Second, we want to prioritize the $1.5 billion streetcar system. Third, we want to minimize traffic congestion and promote efficient vehicle operations. Fourth, we want to encourage development projects that promote and support nonvehicle mobility. Fifth, we want to minimize the environmental impacts of the transportation infrastructure. Sixth, we want to use technology to improve traveler information, choice, and convenience.

We want to provide people with a wide range of travel options that mesh well by layering different modes and technologies. Merging older technologies and infrastructure with newer technologies is an effective approach. Our solar modular mobile bike share program provides one example of this approach.

We have a new transportation demand management (TDM) program in partnership with Arlington County, Virginia, which focuses on strategies to change travel behavior—including how, when, and where people travel—to increase transportation system efficiency and to achieve specific planning objectives. The TDM program focuses on regional strategies, local marketing, employer outreach, and development review. Examples of TDM strategies include carpool and guaranteed ride home programs, carsharing, bicycle infrastructure and facilities, and parking pricing. Alternative work schedules and telework are also TDM strategies. Examples of financial incentives include SmartBenefits and carshare memberships. Elements of the regional TDM program include commuter connections, guaranteed ride home, bicycle to work day, and carpool and vanpool programs. Local marketing focuses on promoting the circulator, smartbikes, carsharing, bicycling, and walking. Employer outreach includes working with employers to implement trip reduction programs. Information on these programs is available at www.godcgo.com.

Parking is an interesting issue in Washington, D.C. The district is the center of the region's economy. The population of the district doubles every day with federal and other workers. Providing parking for these employees and for residents is an ongoing challenge.

We are addressing this issue with a real-time parking availability and pricing system. We are testing six technologies as part of this program, which links to the larger intelligent transportation system. Ultimately, we want to link the parking management system to the bicycle-sharing stations and the transit modes to provide the public with real-time information on all options via cell phones, via the Internet, and at bus stops.

A number of factors contribute to congestion in the downtown area, including signal delays, blockage of intersections by vehicles, street closures, motorcades, drivers circling looking for a parking spot, and double parking for loading and unloading. We are working on all these issues, but we also want to encourage the use of other modes.

I began to promote the multimodal station concept when I joined the department to help address traffic congestion and to promote the use of alternative modes. For example, at 14th and U Streets near our offices, there is access to carsharing, the bicycle-sharing program, a circulator bus, and a Metro bus route. A Metrorail station is one block away. We need to link all these systems to provide real-time information on all modes.

We will be testing new technology in bus shelters that will tell riders when the Metrorail train will be arriving at the nearby station. These types of devices could also be located in stores and restaurants. We are expanding the bicycle-sharing program and providing modular bike lockers at major Metrorail stops. A carsharing program is being implemented through a partnership with Zipcar, Hertz, Connect, and Daimler. We will also be implementing electric vehicle charging stations at the multimodal stations.

Elements of the marketing program include a more robust website, a social media strategy, and an employer outreach program. BikeBrand Your Biz represents one component of the employer outreach programs. We allow businesses to select their own bike racks from about 100 different designs. Thus, a bike rack in front of a coffee shop may feature a coffee mug. These strategies support place-making, economic development, and public art.

We use pilot projects as a way to test new concepts and programs. Pilots are a great way to gain experience, obtain feedback from users, and let the private sector assume much of the risk. We have used this approach on the parking meter program, and we will be using it on other projects.

We are also marketing our livability program. We experienced a backlash to the installation of speed bumps in many areas. Speed bumps were installed to slow traffic on neighborhood streets. We experienced strong vocal opposition in some areas. As a result, we are meeting with neighborhood groups and the public to discuss the full range of projects and programs that contribute to livability, safe passages, sustainable living, and progressive places. We have 24 projects and programs that neighborhoods can use.

Public education is an important part of our marketing program. We do a lot of partnering marketing campaigns with the Metropolitan Police and other agencies. We have a new education campaign aimed at promoting all modes of transportation and tolerance for other modes.

Capital Bikeshare was launched successfully a few weeks ago. It is a regional program of the District of Columbia and Virginia that will soon be expanding to Maryland. We are launching 100 stations and 1,000 bicycles in the district. Signing up and using the system are simple. The system is solar, modular, and mobile. Users can get real-time information on the number of available bicycles at a station via a cell phone.

Our migration path focuses on building components of a larger intelligent transportation systems infrastructure and moving from asset-intensive programs to “asset lite” solutions. We are migrating from coin transactions to virtual transactions by phone and other technologies. We are moving from noncommunicating assets to networked “smart” assets. We are moving from reactive maintenance to proactive maintenance. We are moving from fixed-rate structures to dynamic pricing, with the parking meters as the first pilot. We will continue to pilot, test market, assess, launch, and market programs to drive behavioral change with price and ease of use.

Research can play an important role in many of these activities. I am not as concerned with yes or no questions—for example, whether we should launch the bicycle-sharing program—but I am concerned with how it is working. Incremental validation of the concepts and pilot projects would be beneficial in promoting widespread use and permanent applications. Marketing and segmentation studies would also be of benefit, especially examination of the characteristics of early adopters versus the mainstreaming of users. Research on public–private partnership opportunities is needed, especially identification of viable approaches. Finally, research on performance measurement and performance management would be beneficial.

Livability Research Across Disciplines

Sandra Rosenbloom, *University of Arizona*
Angie Cradock, *Harvard Prevention Research Center, Harvard University*
Jonathan Levine, *University of Michigan*
Matthias Ruth, *University of Maryland*
Diana J. Bauer, *U.S. Department of Energy, presiding*

This panel presented livability case studies illustrating methods and results from several disciplinary perspectives, touching on drivers and motivators, models, and cobenefits of livability. The session provided food for thought for transportation professionals and illustrated the complex interplay among diverse factors that set the context for designing livable communities.

WHAT WOULD A LIVABLE, INTERGENERATIONAL COMMUNITY REALLY LOOK LIKE?

Sandra Rosenbloom

My comments focus on three concepts of livability—mobility, accessibility, and walkability—and how these concepts together affect older individuals. The three concepts are often seen to be in conflict. Mobility relates to the ability to reach far-flung destinations by using modes of transportation that are not necessarily energy efficient or good for the environment. Accessibility is the ability to reach destinations such as shopping or medical care in your own neighborhood. Walkability is the ability to walk around your own neighborhood easily, safely, and securely, for recreation or socializing even if not to reach a specific destination.

The balance between mobility, accessibility, and walkability in a livable community may be different for different groups of people. It is common to make gross assumptions that anything that is good for the community is also good for older people and that anything that is good for older people is also good for the community. This type of thinking is too simplistic. The issues are much more complex. Conflicts between age groups are likely to arise as we examine various approaches and designs for livable communities. We need to acknowledge these differences and work together to address and resolve potential conflicts.

Researchers are often frustrated that policy makers and politicians do not listen to them. There is a lot of political science research examining what influences policy makers. As one example, the Americans with Disabilities Act (ADA) was approved overwhelmingly by a conservative Congress. Researchers found that members of Congress were influenced by knowing individuals with disabilities—family members, neighbors, and constituents. They knew people in wheelchairs, they knew people who had difficulty finding jobs because they could not get to employment locations, and they knew people who had trouble boarding a bus. As a result, they supported the passage of the ADA.

Because stories are powerful and because policy is often made on the basis of what we know about specific individuals and our own experiences, I will use four stories to illustrate the differences between mobility, accessibility, and walkability. I will also present a few facts from recent studies and discuss what I think they mean. I will close by suggesting a few points for you to think about in the breakout group discussions.

My first story is about accessibility. Approximately one-third of a mile from my house is a strip mall with a Japanese restaurant. The restaurant served the best sukiyaki in the area, so I frequently went there. One day, I went to have my favorite dish and found that a new owner had taken over. I ordered the sukiyaki and I hated it. I ordered it again on another occasion and I still hated it. What did I do? I now drive 12 miles across town to go to another Japanese restaurant that serves sukiyaki that is almost as good. So, while I have tremendous accessibility to a Japanese restaurant, I do not want to go there.

My second story also deals with accessibility. A few months ago I noticed a sign saying that a new Korean Methodist church will be built on a lot about one-fourth of a mile from my house. My first reaction was "great, now I can walk to church." The problem is, I am not a Methodist and I am not Korean. While I could possibly change one of those things, I cannot change both. So, while I have great accessibility to a religious institution, sadly, I do not want to visit that religious institution.

Accessibility is also the focus of my third story. I was at a conference, and a colleague said he wanted to show me a well-built community that provides older residents with great accessibility to shopping opportunities; an independent living center was located directly across the street from a shopping center. Like good transportation researchers, we drove to the independent living complex in the community, parked, and waited for an older person to come out and walk to the shopping center. An older woman did emerge from the independent living complex, but sadly, her trip to the shopping center was not easy.

Since there was no street access from her independent living complex, she had to walk all the way to the gate at the front of the building, the opposite direction from the shopping complex, and then walk back the same distance on the street. Then she illegally crossed the street and disappeared into the parking lot. You could barely see her over the tops of parked cars as she walked through the parking lot, which was not designed for pedestrians. I thought the situation was terribly unsafe and fairly demanding on the older traveler. On a map, just viewing the physical location of the independent living complex and the shopping center parking lot, you might assume that people living there had good accessibility—but they did not.

My fourth story focuses on potential conflicts between the accessibility, mobility, and walkability needs of different age groups. A few years ago, the Massachusetts Institute of Technology (MIT), in conjunction with the Organisation for Economic Co-operation and Development, held a conference on mobility for older people. Dean Kamen, the inventor of the Segway, gave a demonstration and talk. Some members of the audience questioned whether older individuals would be able to balance on a Segway, while others worried that the elderly pedestrians would be endangered by Segways operating on sidewalks.

MIT students in the audience reacted strongly to these questions, arguing that if the "elderly are going to stand in the way of progress, they should just stay home." If it were the only time I have heard that type of comment expressed by younger people I might have

passed it off as a "Cambridge anomaly." I do not think it is an anomaly, however, which worries me. I have heard similar comments from my own students.

These experiences and these stories make it clear to me that the appropriate mixture of accessibility, mobility, and walkability is different for different people. A recently released study by five universities examined the types of neighborhoods elderly individuals lived in and how active those individuals were, primarily how much they walked. The study found that people living in neighborhoods with fewer destinations, lower densities, and more open space were more likely to walk and reported a greater sense of well-being. Another study examining seven urban areas hypothesized that the more modes of travel available to people, the more active they would be and the higher their social well-being would be. The study results were just the opposite at all seven sites. Older people who lived in the most suburban, lowest-density areas, where the only reasonable travel option was the personal vehicle, made the most trips and reported having the highest self-worth.

While these results sound typical of America, neither of these studies was conducted in the United States. The first study was conducted in Great Britain, and the seven sites examined in the second study were each in a different European country.

Recent studies in the United States and Australia show that people who live in formal and informal retirement communities walk more than people who live in denser urban areas. Most of these individuals walk for recreation, since there are few destinations in formal and informal retirement communities, which tend to be located in suburban areas.

I think these studies highlight the conflict between accessibility and walkability. Accessibility means that there are "purposeful" destinations to go to. Walkability means that a community presents individuals with attractive, safe, and secure opportunities to travel by foot around their community, even if they have no particular destination in mind. But walkability is affected by many things for older people. The gerontology literature shows that falls are a major cause of death and disability among the elderly, so for good reason older individuals are especially afraid of falling. As a result, older individuals are concerned about the existence, condition, and maintenance of sidewalks and other related pedestrian facilities.

There is evidence that older individuals, especially older women, assess how walkable a neighborhood is on the basis of safety and security concerns as well as aesthetics. What a neighborhood looks like, how buildings are maintained, and whether there is graffiti on the walls or garbage lying around is important to this group. The latest National Household Travel Survey indicates that almost 25 percent of all walking trips taken by people over 65 years of age are for exercise alone. This information emphasizes the influence of walkability in livable communities. But older people often drive to major shopping centers before they officially open in the morning to walk indoors in a highly controlled setting they consider walkable because they do not feel safe or secure walking in their own neighborhoods.

Part of walkability, and by extension accessibility, is enforcement. In the early 2000s, the Swedish government reduced the speed limit on all arterial roads in the country to make walking and cycling safer. Ten years later the government found that pedestrian crash rates had increased significantly. It appears that pedestrians and bicyclists thought motorists would slow down. Motorists, on the other hand, did not believe that the new speed limit would be enforced, so they did not slow down. But will improved walkability or accessibility substitute

for mobility for older people as many advocates imagine? I suggest that the answer may be no. Recent trends in the United States indicate that older individuals are making more and longer trips. Focus group research indicates that since older individuals are no longer constrained by the need to combine many shopping, social, and recreational trips with their work location, they are making longer trips of all sorts, to preferred destinations, rather than those constrained by their employment choices or by accessibility. In short, they are taking advantage of the mobility offered by our society.

Let me close by drawing a few conclusions from these stories and recent studies. First, I think it is important to accept that accessibility, walkability, and mobility are key features of livable communities, but that different people have different needs and values related to those features. I am not suggesting that the needs of older individuals should predominate when there are conflicts, but I am suggesting that we need to realize and accommodate different needs and values. For example, the potential conflict between pedestrians and cyclists is a crucial one for older people, one that is often overlooked. We need to deal with, not gloss over, these kinds of conflict.

Second, frequently, architects and urban designers are at the center of the discussion about livable communities. They often think that there is one design solution to a problem. As many of these stories suggest, the situation is far more complex, and the challenge of creating livable communities is far greater than finding "the right design solution." As the Swedish speed limit research shows, enforcement is critical to livable communities. I challenge my students to find photographs of things that negatively affect community livability. One student brought me a photograph of a police car parked on the sidewalk in front of the officer's home. What kind of message does this situation send to other neighborhood residents? This situation suggests that much more than just the appropriate design features are needed to create livable communities. Among other things, we need better public education and outreach to address these issues.

Rather than being nicer to traffic engineers, as suggested by a few speakers this morning, I think we need to be less nice and more practical. We need to educate engineers about key livability concepts and needs. We cannot "flower" them to death when they have numerous manuals outlining warrants and recommendations for street and traffic designs. We need to address them on their terms, and we have an obligation to offer viable alternatives to traffic engineers. We need more research to better define and present viable alternatives. Evaluation of new projects, development of new warrants and guidelines, assessment of the benefits and costs of different approaches, and details on specific approaches are all needed. These are possible topics for discussion in the breakout groups.

TRANSPORTATION AND PUBLIC HEALTH: ENSURING HEALTH AND EQUITY IN LIVABLE COMMUNITIES

Angie Cradock

I appreciate the opportunity to participate in this session. My comments focus on the links between transportation and public health. I will discuss transportation-related health effects in the United States. I will also describe recent research conducted at Harvard examining transportation investments and health, equity, and livability. I will conclude by providing a few ideas for further research.

My background is in public health. The transportation system does have a link to public health. Elements of the transportation system link to health exposure, which links to health effects. Characteristics of the trip, the individual, and the available modes influence mode choice. The available modes can be divided into motorized mobility and active mobility, which includes cycling and walking. Examples of health exposure from the transportation system include road traffic injuries, air pollution, noise pollution, and physical activity. Related health effects include the risk of disease, obesity, and other impacts, which can lead to morbidity and mortality. Public health focuses on these factors.

The World Health Organization has identified selected health end points for economic valuation of transport-related interventions and policies in adults. For example, mortality end points from traffic-related air pollution include cardiovascular–pulmonary and respiratory effects. Morbidity-related end points include hospital admissions for cardiac and respiratory conditions, lower respiratory symptoms, chronic bronchitis, and restricted activity. Road crashes may result in fatalities and nonfatal injuries. My area of interest is transportation-related physical activity and examination of cardiovascular disease, stroke, Type 2 diabetes, and colon and breast cancer. The top six cases of deaths in the United States in 2006 were heart disease, cancer, stroke, respiratory disease, accidents, and diabetes. All of these causes of death have some relationship to the transportation system.

Recent studies have also linked transportation, physical activity, and obesity. Travel-related walking and bicycling are associated with decreased adiposity, weight gain, and mortality. They also reduce cardiovascular health risks. Furthermore, transit use can promote regular activity. On the other hand, people drive more and walk less in automobile-oriented communities. There also tends to be a higher prevalence of obesity in automobile-oriented communities. It has been estimated that 1 extra hour in an automobile equates to a 6 percent increased likelihood of obesity. Providing safe and convenient places to walk or bicycle removes barriers to participation in physical activity.

The 1996 Olympic Games in Atlanta, Georgia, provided the opportunity to analyze the impacts of traffic reduction strategies. The number of citywide acute care visits and hospitalizations for asthma, called asthma events, were monitored. Major air pollutants and meteorological variables were monitored, and traffic counts were conducted on major freeways and roadways. The results of the study indicated that the decreased traffic during the Olympic Games was associated with a 28 percent decline in ozone and a 40 percent decline in asthma acute care events in children.

According to Federal Highway Administration (FHWA) data from 2010, bicyclist and pedestrian fatalities represented 13.6 percent of all traffic fatalities. A recent study indicates that there is a positive relationship between individual or area disadvantage and pedestrian

injury among children. Another study focusing on northern Manhattan found that children in disadvantaged areas are at a 2 to 3 times greater risk for pedestrian injury. These results have implications for livable communities.

Our research focuses on equity, livability, and transportation. We have examined recent infrastructure and program investments by using federal funds. For example, more than 10,000 bicycle and pedestrian projects were funded through the Intermodal Surface Transportation Efficiency Act and the Transportation Equity Act for the 21st Century from 1992 to 2004. These projects represent approximately $3.17 billion from multiple FHWA programs. We mapped the projects by county and examined the average annual per capita obligation for bicycle and pedestrian improvements by state. As you would expect, there are major differences by state. Approximately 62 percent of all counties in the country implemented a bicycle or pedestrian project from 1992 to 2004. Our analysis indicates that bicycle and pedestrian projects were less likely to be implemented in areas with persistent poverty and in those with lower educational attainment levels, however. From a public health perspective, these areas also have the greatest health burden.

We recently examined implementation of the Safe Routes to School program. One of the goals of the program is to make funding available to diverse participants. We examined the location of implemented programs and analyzed the geographic distribution by population and demographic characteristics. We calculated the average annual per student Safe Routes to School funding by state for the period 2005 to 2009. The results indicate great variability among states.

We found that states with a prior history of federal funding for bicycle and pedestrian projects were more successful in implementing the Safe Routes to School program. We estimated that for every $1 per capita investment before 2005, an additional $0.33 per student in kindergarten through eighth grade was invested from 2005 to 2009. Within states, we found that low-resource counties were less likely to implement Safe Routes to School projects. Low-resource counties include areas of high child poverty and areas with low educational attainment. Also, as I noted, Safe Routes to School programs were less likely in counties with no prior history of using federal funding for bicycle and pedestrian projects.

Our experience in examining investments in bicycle and pedestrian projects and implementation of the Safe Routes to School program indicates a number of areas for improvement and future research. First, our experience highlights the need for improved data-tracking and monitoring systems at the federal and local levels. Better tracking of federal funding, local investments, and outcomes is needed. Second, the results of our analysis indicate the need to integrate health and equity variables into transportation-related planning and data collection. Some metropolitan planning organizations are developing methods to capture health aspects in the planning and infrastructure decision-making process. Accomplishing this integration will require expanding data collection into diverse regions and domains. We will need to initiate new data collection efforts, such as community measures promoted by the Centers for Disease Control and Prevention. We also need to promote collaboration between and across disciplines. I have learned a great deal from transportation professionals, and they have learned more about what the public health impacts of transportation projects might be from me.

METROPOLITAN ACCESSIBILITY AND TRANSPORTATION SUSTAINABILITY: COMPARATIVE INDICATORS FOR POLICY REFORM

Jonathan Levine

I appreciate the opportunity to speak at this session. As did Sandra, I will begin with a story, but I will reach a different definition of accessibility than the one suggested by Sandra.

My story is about a business traveler from Australia. He schedules three meetings a day when he is in the United States, four meetings a day when he is in Australia, and five meetings a day when he is in Europe. He uses this schedule not because travel is faster in Europe and Australia—in fact travel in the United States is faster than in Europe and Australia—but because distances between meeting locations in the United States are much longer. Thus, he is able to accomplish less in the United States, even with higher levels of mobility here. The experience of this business traveler reflects transportation accessibility rather than mobility. We have talked a lot about livability at this conference. The theme of my presentation is that the first thing we should be talking about with livable communities is shifting from a focus on mobility to a focus on accessibility.

The traditional transportation paradigm presents mobility at the top. Presenting mobility at the top and evaluating transportation capacity expansion, land use planning, travel demand management, and other projects in terms of their impact on traffic mistakes means for ends. It imagines a world where the purpose of transportation planning and transportation engineering is movement. The purpose of transportation is not movement, but access. The demand for transportation is derived from the demand for reaching destinations.

We should turn the hierarchy on its head and demote mobility to a means. Mobility, proximity, and connectivity are the three means, and accessibility is the end. Rather than thinking of mobility as being in conflict with accessibility, we should think of it as a means to accessibility. One way of getting what we want is ensuring that we have the ability to move in order to get there. There are other means of getting what we want, however. Connectivity is getting what we want remotely through the Internet or other means. Proximity is also a means to getting what we want. When we focus on a world where mobility is an end unto itself, we neglect the value of proximity.

There is a tension with this approach, however. Tension exists between mobility and proximity. Surface travel tends to be faster when destinations are further apart and slower when destinations are close together. My comments focus on the tension between mobility and proximity.

As an urban planner, I am interested in how people live and the form of urban areas. I am especially interested in urban form and accessibility. I am interested in the impact of compact cities versus low-density cities on accessibility. Mobility and proximity are battling to determine which provides the more accessible urban form. A number of metrics can be used in defining urban form. Metrics of centralization and metrics of concentration can be used. In the study I will describe, we tested metrics of centralization and metrics of concentration for their impact on regional accessibility. The analysis indicated that these two metrics did not explain accessibility. The one metric of urban form that regularly predicted accessibility was average density. We termed the metric “dumb density” because it was the simple measure of total population divided by the land area.

We also examined metrics of travel behavior for the largest 50 metropolitan areas in the country. Plotting daily vehicle miles traveled (VMT) per capita by population density for the 50 areas highlights the close relationship between these two metrics. The results also raise interesting questions. For example, are people in low density–high travel metropolitan areas—which include Houston, Texas; Atlanta, Georgia; Oklahoma City, Oklahoma; Tucson, Arizona; Nashville, Tennessee; and Charlotte, North Carolina—traveling a lot to numerous destinations, or are people traveling a lot simply to meet their ordinary needs? The metropolitan areas with high VMT may have high accessibility or they may have low accessibility.

To answer this question, we developed metrics of accessibility and applied them to 38 of the 50 metropolitan areas. We used gravity-based metrics of accessibility that were developed in the 1950s. The gravity-based metrics are indexed on the basis of destinations that can be reached weighted by the difficulty of reaching those destinations.

We used a path analysis to test the strength of the relationships between various factors. The total effect of two different paths is the sum of the two paths. The effect of a single path is the product of the coefficients among the paths. We can derive paths that can explain relationships among multiple variables, and we can identify the stronger and the weaker paths.

We examined the impact of density on accessibility, which included both positive and negative paths. As density increases in an urban area, origins and destinations tend to be closer together, resulting in closer proximity and increased accessibility. This positive path results in increased accessibility. On the other hand, urban areas with higher densities have slower travel speeds, thus reducing accessibility.

We examined the effect of increasing speed on accessibility and the effect of increasing density on accessibility. One way to measure accessibility is to count the number of destinations that can be reached in a given amount of time, such as 30 minutes. If we double travel speeds, the size of the circle of destinations that can be reached in a specific amount of time quadruples. We have doubled speed but quadrupled accessibility, which would indicate that anything that increases travel speed—including low density—would increase accessibility.

In contrast, if the number of destinations within the original travel circle is doubled, accessibility will also double. Thus, while density increases accessibility, this analysis suggests that speed has a larger impact on accessibility. We decomposed the relationship between density and speed for a better understanding of the potential effects of both on accessibility. Density influences the VMT–lane miles ratio. A higher-density area will probably have a higher VMT–lane miles ratio, which will lower travel speeds. Higher density also increases lane miles per capita and decreases VMT per capita. While a relationship between density and speed exists, it is the weakest of these relationships. Thus, the link between density and speed is weaker than the link between density and proximity.

In our analysis, the composite weight along the speed path was –0.064, while the composite weight along the proximity path was 0.429. This analysis indicates that more compact metropolitan areas are also more accessible metropolitan areas. We examined work accessibility by automobile and transit in pairs of metropolitan areas with different densities. For example, we analyzed work accessibility by automobile in the Washington, D.C., metropolitan area and the San Francisco, California, metropolitan area. The Washington accessibility density is 1,056 persons per kilometer, and that of San Francisco is 1,851 persons per kilometer. We analyzed accessibility by population percentile. Individuals with median accessibility, those in the first percentile, probably live in the periphery of the metropolitan areas. Indi-

viduals with the greatest accessibility probably live in the central city areas. San Francisco is considerably denser than Washington, D.C., and has higher accessibility scores across the population percentiles.

We can decompose the accessibility differences between the two metropolitan areas for a better understanding of the effects of speed and proximity. This analysis indicates that the Washington, D.C., area actually has a proximity advantage, but this advantage is lost because of slow travel speeds. These results could be viewed as suggesting that faster speeds are all that is needed in Washington, D.C., which might represent the traditional traffic engineering perspective.

The opposite case may also exist, as demonstrated by examining work accessibility by automobile in the Philadelphia, Pennsylvania, and Houston metropolitan areas. Philadelphia has higher accessibility than does Houston. When we decomposed the accessibility differences for speed and proximity effects, however, we see that Houston has faster travel speeds. The effects of these higher speeds are squandered because of poor proximity. If only mobility were considered, Houston would be judged to be the superior area. When we focus on accessibility, however, Philadelphia provides better transportation outcomes.

The analysis illustrates the positive relationship between density and accessibility. Accessibility is higher in denser metropolitan areas. This relationship holds true for larger and smaller metropolitan areas.

Progressive transportation practice has begun to consider accessibility and mobility as the twin goals of transportation. I suggest that we consider a different approach. As I noted earlier, mobility is a means and accessibility is an end. Pairing accessibility and mobility as if they were coequal goals neglects the role of connectivity and proximity. We should focus on accessibility as the goal of transportation, with mobility, proximity, and connectivity as the three means to achieve that goal.

This study also illustrates the feasibility of intermetropolitan assessment and comparison of accessibility. Most accessibility studies focus on a single metropolitan area. By examining 38 metropolitan areas, we were able to identify some lessons in the comparison. The study results highlight the two-part recipe for accessibility. The first element is creating accessible areas. The second is ensuring that people have the opportunity to be in those areas. Sometimes we make the mistake of creating highly accessible areas and then keeping the densities low through land use regulations.

In closing, I want to suggest an area for further research based on resolving numerous data conflicts in the 38 metropolitan areas we examined. If we are serious about using metrics of accessibility, we need to standardize the reporting of relevant data. Most of the relevant data are from the regional travel demand forecasting models, such as zone-to-zone travel times for highways and transit. We need a national database on accessibility if we are going to make meaningful comparisons among metropolitan areas. Accomplishing this standardization should be a high-priority research need.

HARNESSING COBENEFITS OF URBAN ADAPTATION TO CLIMATE CHANGE

Matthias Ruth

It is a pleasure to participate in this session. My comments focus on climate change, its implications for transportation, and its implications for livability in urban areas.

Until approximately 10 years ago, climate change research focused primarily on agricultural and forest areas. Only more recently has the impact of climate change on urban areas been examined. The importance of considering the consequences of climate change for cities is obvious. More than 50 percent of the world's population lives in cities. Furthermore, urban areas account for more than 80 percent of the gross domestic product and 90 percent of the infrastructure investments in many countries.

I will begin with an overview of climate mitigation and adaptation in the transportation sector. I will also discuss the ancillary cobenefits and cocost of mitigation and adaptation strategies. I will conclude by presenting a few policy and research agenda items.

Climate mitigation and adaptation in the transportation sector may include a number of strategies. They include changing transportation modes and using different transportation technologies to reduce our carbon footprint. The costs associated with investing in new technology, infrastructure, and modes can be significant. As a result, many changes have not been made. There is a cost associated with inaction, however. The cost of maintaining infrastructure, modes, and travel behavior that are not sustainable in the long run is significant.

The transportation sector has a major role to play in addressing climate change. The transportation sector is second to the electricity generation industry in greenhouse gas emissions. It is important to remember, however, that electricity generation, transportation, and industry support the residential sector, and without changes in consumption behaviors, efficiency improvements elsewhere will not achieve their full potential.

Even if we did everything we could to reduce the emissions of greenhouse gases as fast as we could, it will take 100 to 300 years for atmospheric carbon dioxide concentrations to stabilize and a few centuries for temperatures to stabilize. Sea level rise due to thermal expansion will take centuries to a millennium, and sea level rise due to melting glaciers will take several millennia. I do not mean to depress you with this information. I want to make the point that while there are costs today associated with taking action to address climate change, there are also significant long-term costs associated with inaction.

We need to consider the structure and infrastructure of our cities and the way we live so that they are in tune with the future climate conditions that we know will occur. For example, all 20 of the largest cities in the United States are located along a body of water—an ocean, lake, or river. Sea level rise is a concern for these areas.

In a major research project, colleagues of mine and I examined the impact of climate change, for example, on the Boston, Massachusetts, metropolitan area, which includes 101 communities. The direct damages to infrastructure in the area due to coastal and riverine flooding resulting from climate change can be estimated. The transportation system is obviously affected, and there is a loss of economic productivity. The coastline continues to recede inland, and the area becomes more vulnerable to flooding.

Of course, action would be taken to prevent massive flooding and loss of land. Some of these measures, such as building dikes and levees, are costly. The public sector would bear the burden of these costs, which could trigger a downward spiral of underinvestment, underperformance, increased risk, and economic decline. Such a situation would not reflect what we think of livability or sustainability.

There are numerous actions we can take now to prevent that scenario from happening. We have developed a list of mitigation strategies and a list of adaptation strategies. Some mitigation strategies help us become more efficient and help us use resources more effectively. Some strategies also change the structure of how, when, and what we do.

Mitigation strategies have often been considered as a way to meet our global responsibilities, with some minor local benefits. We motivate the investments in these strategies by highlighting the local benefits, however.

Adaptation strategies are often viewed as using local resources for the benefit of the local population. Hurricane Katrina and other disasters around the world have shown that the right adaptation at the local area helps avoid a national or global redistribution of wealth and resources, which can have global benefits.

There are clear linkages between land use and energy reliability. Low-density suburban sprawl development patterns often rely on highly centralized energy generation and long-distance transmission and distribution of electricity. Economics of scale have driven this development pattern and energy network. It does not take much—a snowstorm or a flood—to disrupt the energy system locally, which affects our emergency preparedness and disaster response. Significant costs are involved in restoring system functionality. These disruptions have large-scale and widespread economic and social implications.

There are many ways of breaking out of this situation. More compact urban areas with higher densities provide increasing economies of scale for new small-scale, on-site generation of electricity. These areas would be better able to maintain operations in future severe weather events. Thus, multiple benefits can be realized from mitigation strategies to reduce carbon emissions.

The role of ecosystems in urban areas—which include plants and animals and the interactions among them—in supporting our quality of life is frequently overlooked. The temperatures of urban areas can be monitored and displayed and are closely correlated with low vegetation cover and depressed biodiversity. The hottest parts of many cities are also the areas with the highest concentrations of poor, elderly, and socially disadvantaged population groups. Climate can be said to target those most vulnerable. Combining climate models and socioeconomic models with information on the morphology of urban areas can help us better prepare for future climate changes.

The discussion of mitigation and adaptation highlights many of the existing inefficiencies in development patterns, the transportation system, and urban areas. The inefficiencies are magnified as we consider climate change mitigation and adaptation. The need to mainstream institutional consideration of climate change in the planning and infrastructure investment decision-making process also becomes apparent.

In terms of harnessing the cobenefits of urban adaptation, we have been concentrating on specific benefits, such as health benefits or trip-time reliability benefits. One subject for

additional research is methods for linking more sophisticated climate models with socioeconomic models to improve the assessment of impacts on geographic areas. We also need high-resolution climate data. To move beyond the current state of the art, we need multicriteria approaches, and we need to evaluate case studies from around the world to identify lessons to transfer to other areas. We need new economic performance measures, and we need to advance policy discussions.

Research on Transportation for Livable Communities

Recent Findings and Research Needs

Susan L. Handy, *University of California, Davis*
Harvey J. Miller, *University of Utah*
Reid Ewing, *University of Utah*
Shawn Turner, *Texas Transportation Institute, presiding*

Presentations in this session focused on how community and street design affect safety, traveler behavior, and trip-making characteristics. The measurement of livability was addressed, and quantitative metrics were discussed as a way to measure progress toward livable communities. The implementation of research findings through the update of various planning and design guidelines and manuals was also discussed.

IMPACT OF COMMUNITY DESIGN ON TRAVELER BEHAVIOR

Susan L. Handy

As a member of the conference planning committee, it is a pleasure to participate in this session.

My comments focus on transportation and land use, a topic at the heart of livable communities. There are two key parts to this topic—the impact of transportation investments on land use and the impact of land use on travel behavior. I will address the second part, the impact of land use on travel behavior. I will discuss the state of research on this topic and highlight areas for further discussion.

To begin, there is no consensus on terms and definitions. Terms such as "the built environment" and "community design" are often used interchangeably. I think of the built environment as consisting of three elements: land use, the transportation system, and design.

Land use refers to the location pattern of activities in an area. The transportation system links those activities to each other. Design, or aesthetic qualities, overlays land use and transportation. In addition, we often talk about the physical environment of an area. I consider this term to include the built environment—land use, transportation, and design—plus the natural landscape and the presence of people. Research studies differ as to which of these elements they examine for their impact on travel behavior. Studies also vary in how they measure these elements. As a result, summarizing current research results is challenging.

In contrast, there is general agreement on the hypothesis that certain community features, including good proximity achieved by mixed land uses and density, together with good connectivity created by the street network and other components of the transportation system, combined with good design, especially for nonmotorized modes, lead to less driving, higher transit use, and more bicycling and walking. These outcomes are not always linked, however. For example, bicycling and walking may increase without a commensurate decrease in

driving. The second half of the hypothesis is that all of these changes in behavior result in beneficial outcomes, such as reductions in congestion and environmental impacts and improvements in equity and health.

The research in this area thus focuses on the causal chain associated with impacts of the built environment on travel behavior and the resulting environmental and health benefits. In a parallel causal chain, the built environment can help create more transportation options, which result in improved equity and quality of life, regardless of their impact on travel behavior. This second causal chain is also central to the goal of livability, but it has not been the focus of research.

The impact of the built environment on travel behavior has been examined in a large number of research studies. Several papers have reviewed those studies. For example, Brian Saelens and I examined the literature on the influence of the built environment on walking for transportation. We reviewed many studies and found fairly strong associations between density, land use mix, distance to destinations, and the amount of walking for transportation. These three built environment elements are all related to proximity, and greater proximity to destinations means more walking. The literature is more ambiguous on the influence of street connectivity, pedestrian infrastructure, traffic, personal safety, parks and open space, and aesthetics.

Research on the influence of the built environment on bicycle commuting also supports the importance of proximity, as my student Yan Xing found. Bicycle lanes and paths, bicycle facilities, distance to the workplace, population density, and urban location all showed strong associations with bicycle commuting.

A number of studies have examined the influence of the built environment on transit use. Density, street connectivity, regional accessibility, and proximity to transit all show strong associations with transit use. Early work focused on the link between density and transit use. More recent studies have examined other features of the built environment that may be associated with density and have a more direct effect on travel behavior.

But we need to know not only that these elements of the built environment have an effect on travel behavior but also how big that effect is. Knowing the size of the effect is especially important in California right now as communities search for strategies to reduce their greenhouse gas emissions. A recent article by Ewing and Cervero reviewed previous studies and calculated weighted average elasticities from the reviewed studies for different elements of the built environment and vehicle miles traveled (VMT). The weighted averages are small but notable. For example, household population density has a weighted average elasticity of –0.04, which means that a 1 percent increase in density is associated with a 0.04 percent decrease in VMT. The decrease, while small, is not insignificant. However, there was a significant range in elasticities from the studies Ewing and Cervero reviewed, suggesting considerable uncertainty about the impact of various elements.

Travel demand forecasting models have also been used to quantify the effects of the built environment on VMT. Modeling studies have been conducted in metropolitan areas throughout the world to test the impacts of different land use assumptions on VMT. The effects of different land use scenarios are in the range of 1 to 7 percent.

But these studies lead researchers to this question: Do we really know that changes in the built environment will lead to changes in travel behavior? We need to be careful in answering

this question. Most studies to date are cross sectional: they compare travel in one place with travel in another type of place. These studies examine the association between differences in land use and differences in travel behavior. The studies do not establish whether there is, in fact, a causal relationship between changes in land use and changes in travel behavior.

More research is needed to establish the existence of causal relationships, especially in view of the potential for self-selection bias. Self-selection may mean that the causality is the reverse of what is hypothesized. That is, an individual's preference for certain types of travel may influence the type of neighborhood where the individual chooses to live. Preferences, not the built environment, may be driving the behavior.

The studies that have examined this issue indicate that some self-selection bias does exist. For example, a study by Xinyu Cao, Pat Mokhtarian, and me asked people about the importance of having shopping areas within walking distance of their home. The results indicated that people who reported that having shopping areas within walking distance of their home was very important in their decision on where to live also reported higher walking rates. This study and others show that self-selection occurs but that the built environment does have an impact on travel behavior after this effect is controlled for.

Even so, I would argue that there is still not definitive proof of a causal relationship between land use and travel behavior—that is, changes in land use will lead to changes in travel behavior. We need research that examines this question directly. We need the type of evaluation studies mentioned by other speakers earlier today.

The Transportation Research Board's (TRB's) *Special Report 298: Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and CO_2 Emissions* recommended "careful before-and-after studies of policy interventions to promote more compact, mixed-used development to help determine what works and what does not." This type of study is called a natural experiment, an intervention study, or a policy evaluation study.

One reason for the lack of this type of study is that such studies are not easy to conduct. An experimental design, with treatment and control groups, is required. But defining and articulating the "treatment" are often difficult, especially if multiple strategies or a group of strategies are deployed. It is also important to identify the measures of outcomes of interest, which might include VMT, bicycling, walking, equity, and health. Measuring these outcomes accurately and efficiently is not easy. Before-and-after measurements are needed. Defining the appropriate after period to allow time for behavior changes is also important.

Two years ago, John Pucher, Jennifer Dill, and I searched for before-and-after studies of bicycle facilities and found very few. The California Safe Routes to School study completed by researchers at the University of California, Irvine, provides a good model. The study involved 10 schools. Data collection included traffic counts and driver behavior before and after the improvements. The parents of third and fifth graders were also surveyed before and after the improvements. The study found increases in walking and bicycling at five out of 10 schools. No increases were documented at the other five schools, however.

Another approach is what I call a "movers" study. A study of this type was recently conducted at the University of Western Australia in Perth. Changes in behavior were monitored in households that moved from a conventional suburban neighborhood to a "new urbanist"

type of neighborhood. Surveys were completed before the move and at 1 and 2 years after the move. Environmental audits were conducted to measure the built environment characteristics. The results have not been fully processed, but the preliminary analysis indicates little change in behavior.

At the University of California, Davis, we have initiated a series of before-and-after studies examining impacts of changes in the built environment on travel behavior. One study examines shopping patterns before and after the opening of a new Target store. A second study examines mode split to downtown and bicycle–pedestrian safety before and after a road diet project. A third study examines travel patterns before and after people move into the West Village project on the University of California, Davis, campus.

We hope these studies and others will begin to build a stronger body of evidence. We consider the evidence cycle to include policy adoption, policy evaluation, and identification of best practices, which then leads back to policy adoption. We are working to encourage this evidence cycle. Developing working relationships among researchers and practitioners is critical in ensuring that evaluations are conducted in a rigorous manner.

Questions have been raised about demand for communities that offer more options for bicycling and walking and closer access to shopping and other destinations. There is evidence of interest in these types of places and that this interest may be growing. Ensuring that these areas are affordable for all income groups may be a challenge. Affordability is a subject for additional research, as is public support for the policies necessary to create these types of communities.

In summary, we know that community design can increase bicycling, walking, and transit use and can reduce driving in some situations if done in the right way. The research indicates that substantial changes in the built environment are needed to achieve changes in travel behavior. In addition, we have not discussed possible disincentives to driving, including pricing. I would argue that for driving disincentives to succeed in reducing driving while enhancing livability, changes in the built environment and an expansion of transportation options are essential.

In conclusion, research to date indicates that community design can increase the use of transit, walking, and bicycling and can reduce driving. It also indicates that substantial changes in the built environment may be needed to achieve meaningful changes in travel behavior.

But more evaluation studies are needed to provide direct evidence that a change in the built environment leads to a change in travel behavior. Research focusing on the role of transportation choices in residential location choice is also needed.

MEASURING LIVABILITY: HOW DO WE MEASURE PROGRESS AND SUCCESS?

Harvey J. Miller

I appreciate the opportunity to participate in this conference. I acknowledge Frank Witlox of the Department of Geography at Ghent University in Belgium, who assisted with the development of this presentation. Frank has done a great deal of research on decision making for large, complex transportation projects, and he has examined the social dimensions of transportation.

We all know that transportation and community livability are closely linked. Transportation is a key shaper of communities, and communities vary with respect to livability. Appropriate measures of transportation-related livability are needed. These measures need to be quantifiable for use in policy and project evaluations. They need to be legitimate and transparent. They also need to be robust and flexible for use in various situations and geographic settings.

A substantial body of literature on measuring the quality of life and sustainability has emerged over the past 5 to 10 years. This presentation focuses on constructing such measures, not on defining livability or sustainability. The two objectives of the presentation are to review recent research on how to construct livability and sustainability performance measures and to suggest enhancements for transportation project evaluations.

One example of measuring livability comes from environmental economics. Munda completed a literature review on constructing sustainability measures in 2005. He identified a number of common properties of indicators. First, there is a need to define the high-level dimensions; for example, livability has social, economic, and environmental dimensions. Second, there is a need to define the objectives within each dimension. Examples of objectives include maximizing productivity, minimizing inequities, and minimizing environmental impacts. Third, there is a need to develop indicators reflecting performance and progress relative to objectives. Possible indicators include minimizing transportation costs, maximizing affordability, and minimizing the impacts of air pollution. Fourth, variables for measuring each indicator are needed. Examples of variables are logistics costs relative to revenue, housing costs relative to income, particulate matter of 10 micrometers or less, and carbon dioxide emissions. Finally, it may be desirable to aggregate all of these indicators to create an overall measure.

There are two major types of indicators for measuring livability. Simple or nonaggregated indicators are the first type. Simple indicators include single indicators or an array of separate indicators. For example, the United Nations publishes a set of approximately 30 indicators on energy. One limitation of this approach is that the results may be hard to comprehend when the indicator set is large.

Another type of simple indicator is the integrated indicators. This approach uses multiple indicators measured in a common unit. The ecological footprint is one example of this approach: this is the amount of land required to provide material inputs and absorb outputs of an economic activity. A limitation of this approach is that it can be hard to express diverse indicators in the same unit.

The second major type of indicator is the composite indicator (CI), which synthesizes an overall indicator from the individual indicators. It provides a summary of overall livability across all the dimensions and indicators. This approach facilitates rankings, which have become popular. This approach can be misleading if the indicator is poorly constructed.

There are two general CI methods for measuring livability: the direct method and the indirect method. In the direct method, the CI is obtained from a theoretical framework. A popular method is data envelopment analysis, which uses linear optimization techniques to calculate the importance of each indicator and provide an overall measure on the basis of an ideal combination of indicators. An advantage of this method is its objectivity. One disadvantage is that it requires strong assumptions and often comes across as technocratic.

The indirect method constructs the CI by weighting and combining indicators on the basis of a multicriteria analysis (MCA). The disadvantage of this method is that it can be subjective. The advantage is that it allows input into the process by a wide range of stakeholders, which is important in most transportation policies and projects.

There are four major steps in constructing CIs: identifying objectives, indicators, and weights; normalizing variables; aggregating weighted variables; and conducting sensitivity and uncertainty analyses. These steps can be executed in a nonlinear manner with a feedback loop. Decision support systems are software environments facilitating these tasks.

The first step is identification of objectives, indicators, and weights. An informal or semistructured process is often used to develop objectives and indicators. Interviews and brainstorming sessions may be used, along with examination of policy statements and secondary information sources. Role-playing exercises are also used in some situations.

Properties of good indicators can be identified. Indicators should be comprehensible and clearly indicate performance. They should be measurable so they can be mapped to a number. Indicators should be complete and cover all relevant aspects of livability. They must be operational; the collection of data must be practical. Indicators should be decomposable; indicators should be independent of each other. They should be nonredundant, with no double counting. Finally, indicators should be minimal, with the set as small as possible to be understandable.

Deriving weights for the CIs focuses on scale-free measures reflecting the relative importance of each indicator. Several methods are available for deriving weights. The analytical hierarchy process is well known. It conducts pairwise comparisons of indicators on the basis of survey or interview responses. Weights and a consistency index can be derived from this comparison. Other methods include fuzzy structure modeling to handle ambiguous relationships among dimensions, indicators, and objectives and the preference ranking organization method for enrichment evaluations and the élimination et choix traduisant la réalité method, which are used in Europe.

After weights have been established, there is a need to convert variables to scale-free measures. Examples of normalization methods include *z*-score transformations, linear normalization, and distance from the best and worst performer. The latter method, which is popular, measures the performance of each unit (e.g., a city) relative to the best and worst performers. A question is whether to measure the best and worst in the current group (e.g., all cities in the world) or relative to an ideal performance. If we decide the former, should we try to obtain the ideal, not merely the current best? If we decide the latter, we must take

care that the ideal be obtainable in the real world. The weighted indicators need to be combined into an overall CI. The most common method for aggregating indicators is called the simple weighted aggregation method. It is a common method, but it assumes compensatory indicators and preference independence. The compensatory indicator assumption means that weights may be traded off between indicators. The trade-off may not be possible with livability indicators. The preference independence assumption means that there are no conflicts or synergies among indicators, which may not always be the case. Other methods include weighted product, weighted displaced ideal, and outranking methods.

The fourth step in constructing CIs is conducting uncertainty and sensitivity analyses. There are a number of potential sources of uncertainty, including the selection of indicators, data selection and cleaning, and normalization. Other possible sources of uncertainty are the weighting method used, the weight value, and the aggregation method. There are numerous methods for conducting uncertainty and sensitivity analyses. The simplest method is the perturbation of inputs to determine any change in the indicators. Error propagation methods, weighting methods, and information loss measures may also be used.

Most of the literature focuses on aggregate livability measures rather than transportation-specific measures. These methods may not be directly applicable to transportation for a number of reasons. One characteristic of transportation projects making application of these measures more difficult is the wide spectrum of diverse stakeholders, who often do not agree. Furthermore, the benefits, costs, preferences, and appropriate solutions are context-specific and can vary by geography at a fine level of detail. Given these characteristics, the question becomes how we can capture these properties in transportation-appropriate livability measures.

A number of approaches can be considered for developing and using livability indicators for transportation. Spatial decision support systems (SDSS) represent one possible approach. This approach combines geographic information system (GIS) and decision support tools. Digital maps are linked with MCA techniques to explore spatial dimensions of livability during construction, evaluation, and application of indicators. Collaborative SDSS represents another approach. Collaborative SDSS may include digitally enhanced meetings at the same location and time, collaborative work environments at the same location and different times, teleconferences at different locations but at the same time, and meetings at different locations and different times through use of the Internet and Web 2.0 tools.

The recent development of multiagent multicriteria analysis (MAMCA) techniques may enhance the development and use of livability indicators for transportation. This approach maintains stakeholder viewpoints throughout the process. Stakeholders get the overall weights and their own indicator weights. Multiple solutions can be presented at each step, including the overall solution, as well as individual stakeholder solutions. MAMCA provides a better understanding of the stakeholders' objectives. It provides motivation for making more reasonable assessments. It also provides insights into the complex trade-offs associated with measuring livability.

MAMCA begins with a stakeholder analysis, which allows individuals to develop their own weights for the various indicators and provides an overall weight. These weights are used throughout the process. The weights for various stakeholders can be displayed graphically to help facilitate discussion at various steps in the process.

I think we can develop context-aware livability indicators that integrate SDSS and MAMCA. This approach would provide GIS-centered livability construction and evaluation capabilities. It would allow maintaining viewpoints based on status and location. We could have global weights for professional stakeholders based on expertise, authority, and responsibility. At the same time, we could have citizen weights based on geographic relationships with a transportation project. This would allow citizens to help determine what is important with respect to livability in their local setting. I want to state a few caveats and preemptive responses. I am not saying that livability is purely a social construct. I do think that there are objective methods for measuring livability. It is important to realize that what is important for livability is context-specific. We should avoid "one-size-fits-all" solutions to livability measurement. Rather, we need livability indicators that are flexible and adaptable, at least to some degree.

I am also not advocating "mob rule" for livability measurement. Greater weights could be given to experts and governmental agencies, especially regulatory authorities, while allowing for local, spatially based input adjustments for stakeholder-derived global livability definitions.

In conclusion, it is possible to develop a livability measurement process that is internally consistent with respect to assumptions and methods and externally valid with respect to capturing a wide range of inputs in a structured and transparent manner. A context-aware livability measurement process can include both a top–down approach, which considers expert, agency, and professionals involved in livability, and a bottom–up approach to allow for citizen adjustment based on local settings. It can also exploit digital and geospatial technologies, including Web 2.0 for use in the process.

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UPDATING TRAFFIC ENGINEERING AND PLANNING MANUALS TO REFLECT LIVABILITY PRINCIPLES: REWRITING THE PLAYBOOK

Reid Ewing

Several widely used traffic engineering reference manuals have recently been updated to reflect current best practices on livable communities. I was asked to provide an overview of these updates, how they were initiated and accomplished, and what research is needed for standard practice manuals that still require major updates.

I was involved in the update of the Institute of Transportation Engineers (ITE) *Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities*. The American Association of State Highway and Transportation Officials (AASHTO) *Guide for Achieving Flexibility in Highway Design* is another good procedures manual. I suggest that both of these manuals are on the edge of the decision-making process, however.

The three key documents guiding the design and operation of the roadway system are the AASHTO *Policy on Geometric Design of Highways and Streets*, called the Green Book; the TRB *Highway Capacity Manual* (HCM); and the ITE *Trip Generation Report*. The Green Book and the HCM appear to be based on the premise that faster driving is better. I think that faster is not necessarily better. Recent research that I have conducted with Eric Dumbaugh at Texas A&M University examines traffic safety and the built environment.

Traffic speeds are related to crash frequency and crash severity. An increase in traffic speeds comes at a cost, which is usually related to safety. Faster speeds also encourage people to drive farther. Robert Cervero examined the literature on induced travel demand in 2002 and found that the elasticities of VMT with respect to lane miles, capacity, and travel time were substantial. I also examined highway inducement development. Not surprisingly, building roads results in new development.

The AASHTO Green Book focuses on wider, straighter, longer, and faster roads. It states that "every effort should be made to use as high a design speed as practical to attain a desired degree of safety." While the Green Book sets minimums and provides flexibility, its application usually results in 12-foot travel lanes and large turning radii. The cross sections presented in the Green Book, which are typically copied by state departments of transportation, may relate to safety, but they have no relationship to smart growth or livability.

A different approach focuses on context sensitivity. For example, Maryland uses a flexible design, which could be referred to as "smart" use of the Green Book. This approach presents a low minimum criterion and then lets the highway designer use the standard needed for a specific project. I think that this approach results in a better product that reflects livability. The Vermont Department of Transportation has taken a different approach of phasing in a lower minimum standard for travel lanes over a period of years.

One reason we may want to consider 9-foot lanes is that research by Kay Fitzpatrick at the Texas Transportation Institute and others has shown that traffic speeds increase as lane width increases. The use of 9-foot lanes may be especially appropriate in traffic-calmed areas. More research is needed on the use of narrower lanes in urban areas.

I think that we will end up by using the "complete streets" approach, which provides a comprehensive view of the roadway system for all users. North Carolina's Traditional Neighborhood Development Streets provide cross sections for different types of streets. One cross section is for main streets without medians, which provide low-speed access to neighborhood, commercial, and high-density residential areas. Missouri has also recently adopted a complete streets approach, which includes cross sections for different types of streets.

The HCM represents the second major guide for highway design. Approximately $4.5 million in research was funded through the National Highway Cooperative Research Program (NCHRP) as part of the 2010 update of the HCM. I suggest that many of these studies will provide more precise estimates of the wrong statistics. That is, I think that they are examining the wrong topics in great detail.

As you probably know, roadway level of service (LOS), which is based on average travel speed, is a key element in the HCM. Average travel speed is the sole determinant of LOS on signalized arterials. Delay is used for signalized intersections. Density is used for freeways, which also relate to speed. This approach does not leave any room for traffic calming, complete streets, or other related approaches. We need new paradigms that focus on mobility, livability, accessibility, and sustainability. We have been talking about the need to reform the LOS process since the mid-1990s, when I developed a traffic calming manual with Steve Brown.

The state of Florida has developed multimodal LOS measures. This approach uses separate LOS measures for automobiles, bicycles, pedestrians, and buses. The process allows for trade-offs between modes. It also includes recommended minimum LOS standards for multimodal transportation districts.

As other speakers have noted, people are concerned with the time needed to reach a destination, not the speed of travel. Research conducted by JHK and Associates after the Intermodal Surface Transportation Efficiency Act indicated that people were happier with a 10-minute commute at 20 mph than with a 20-minute commute at 40 mph.

We also need multidimensional measures of system performance. For example, Portland, Oregon, uses performance measures for safety, congestion, climate change, active travel, VMT, affordability, and access. The climate change measure is a reduction in carbon dioxide emissions. Ultimately we will need to focus on VMT per capita to meet climate goals.

The third major document is ITE's *Trip Generation Report*. The new version has 12 new land use classifications, for a total of 162 land uses. Several land uses were expanded significantly with the addition of new data. While it is good to have more land use classifications and more data, I argue again that the wrong things are being measured. The data were primarily collected at suburban localities with little or no transit service, nearby pedestrian amenities, or travel demand management programs. The manual still focuses on trip generation, not traffic generation. At specific sites, the user may want to modify the trip generation rates to reflect the presence of public transportation service, ridesharing or other demand measures, enhanced pedestrian and bicycle trip-making opportunities, or other special characteristics of the site or surrounding area.

There is a move to update ITE's *Trip Generation Handbook*, including Chapter 7, which addressed mixed-use developments. NCHRP Project 8-51, Enhancing Internal Trip Capture Estimation for Mixed-Use Developments, is supporting this update. Four sites are being added to the three that currently form the basis for internal capture calculations in the *Trip Generation Handbook*. An estimation procedure that includes a proximity adjustment to account for project size and layout is being added.

We also recently completed a project, Mixed-Use Development and Vehicle Trips: Improving the Standard Estimation Methodology, for the U.S. Environmental Protection Agency. This study created a new methodology for more accurate prediction of the traffic impacts of mixed-use developments. It uses household travel records for 36,000 trips to, from, and within 239 mixed-use developments in six regions. We have developed rates for internal capture, external walking, external transit use, and external automobile trip length.

Transportation Agency Perspectives on Research to Support Implementing Livable Systems

Kate Mattice, *Federal Transit Administration*
Patricia Hendren, *Washington Metropolitan Area Transit Authority*
Donald Halligan, *Maryland Department of Transportation*
Shana Baker, *Federal Highway Administration*
Martin Tuttle, *California Department of Transportation, presiding*

This session provided an overview of activities under way at federal, state, and local agencies supporting transportation and livable communities. Speakers from the Federal Transit Administration (FTA), the Washington Metropolitan Area Transit Authority (WMATA), the Maryland Department of Transportation (DOT), and the Federal Highway Administration (FHWA) highlighted current research, programs, and projects.

FTA's LIVABILITY RESEARCH INITIATIVES

Kate Mattice

It is a pleasure to participate in this session and to highlight FTA's livability research initiatives. I will provide an overview of the Partnership for Sustainable Communities, which is a joint effort of U.S. DOT, the Department of Housing and Urban Development (HUD), and the U.S. Environmental Protection Agency (EPA). I will discuss FTA's role in the partnership and current research. I will close by describing future activities.

As Beth Osborne discussed yesterday, the Partnership for Sustainable Communities has six framing principles. They focus on providing transportation choices, providing housing choices, promoting economic competitiveness, supporting existing communities, aligning federal policies, and valuing communities. The principles are appropriate for all sizes and types of communities. We are concerned with rural areas, tribal areas, suburban areas, and urban areas.

All of these agencies—HUD, U.S. DOT, and EPA—play important roles in the partnership and have numerous activities under way. The partnership is leveraging the expertise, capabilities, and programs within the three agencies.

For example, HUD has a long history of using community development block grants to fund projects. HUD recently announced the availability of $100 million for regional planning grants. A HUD local challenge grant program will also be announced soon. Furthermore, HUD has expertise and programs in affordable housing.

EPA covers a broad range of subjects and programs. We have been working closely

with EPA's Smart Growth Office, which provides technical assistance and localized help to communities. EPA also has technical assistance programs for brownfields restoration. We are leveraging this program to examine transportation issues. In addition, EPA has more than $3 billion in a revolving water infrastructure fund program that is available to states.

U.S. DOT has numerous programs that support livable communities. The Transportation Investment Generating Economic Recovery (TIGER) grant program, the FTA programs, and the FHWA flexible funding programs are just a few examples. We are also leveraging existing partnerships, such as the United We Ride program, which focuses on human services transportation. The FHWA livability efforts, state and metropolitan activities, and railroad infrastructure programs are examples of related efforts.

We also have a budding relationship with the U.S. Department of Agriculture (USDA) to address rural needs and activities. USDA has significant resources targeted to rural America. Although we are not officially part of the partnership, we have been working closely with USDA, and we have formed a rural working group to address livability in rural America.

FTA's role in the Partnership for Sustainable Communities focuses on four areas: infrastructure investment, capacity building, policy and guidance, and research. FTA provides approximately $11 billion in grants to urban and rural transit systems on an annual basis. The funding includes formula-based programs and discretionary programs. The new Transit Investment for Greenhouse Gas and Energy Reduction program focuses on grants for such projects.

FTA has capacity-building activities under way. Many of these programs, including peer-to-peer exchanges, are undertaken with FHWA. FTA also provides technical assistance, supports demonstrations, and develops case studies on livable communities initiatives throughout the country.

The laws governing FTA provide flexibility in some areas and limitations in other areas. The joint development policy provides flexibility in the use of federal funds to purchase real estate for transit projects and in support of joint development projects. FTA does not have a transit-oriented development (TOD) program, but it can fund infrastructure investments and help leverage those investments through the joint development policy. We are also examining approaches to change and enhance the guidance on bicycle and pedestrian access to transit. A clarification of FTA policy was announced earlier this year with regard to the use of local funds in bicycle and pedestrian access to transit projects. We are providing more information on flexible funding from FHWA, including the Congestion Mitigation and Air Quality Improvement Program and the Surface Transportation Program, that can be used for transit projects. In addition, FTA is encouraging environmental management systems within transit agencies.

FTA is supporting research related to livable communities. About 5 years ago, we initiated work with staff from HUD to address affordable housing near transit. Over the past 5 years, HUD and FTA have funded research projects examining issues associated with providing affordable housing near transit. We have also been working with staff from the Center for Transit-Oriented Development (CTOD) on various research projects. We have been examining the impacts of climate change on transit, including adaptation. We are interested in access to transit, including access by individuals with disabilities and implementation of the complete streets philosophy.

Affordable housing near transit, or mixed-income TOD, is a joint effort with the Policy Office at HUD. The effort began in 2005, and in 2007 an interagency agreement was executed. The FTA planning requirements for local areas and the HUD planning requirements for local areas do not match. We have been reviewing the requirements and have identified conflicts so that we can better align the requirements of both agencies. We have also been examining financing strategies for affordable housing near mixed-income TODs. Barriers to and incentives for developing mixed-income projects are being identified. CTOD completed a *Mixed Income TOD Guide* for FTA. This tool, which can be accessed from the FTA website, provides information on the steps to follow in planning and developing mixed-income TODs.

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users provided funding for CTOD to conduct a number of studies for FTA. Examples of recent projects and reports include linking transit access to economic development, Rails to Real Estate, and Capturing the Value of Transit. Other projects include the TOD 101 and 200 series, Station Area Planning, and Transit and Employment. The National TOD Database was just posted on the FTA website. It is based on geographic information systems (GIS) and includes all of the fixed-guideway transit stations in the country. Demographics, land use, and other information are included in the GIS for each station.

Climate change mitigation and adaptation are emerging areas of research for FTA, and we have benefited from research conducted through the Transit Cooperative Research Program (TCRP) and the Transportation Research Board. *Transportation's Role in Reducing U.S. Greenhouse Gas Emissions* was prepared last year. It is available on the FTA website. We prepare an annual report on Public Transportation's Role in Responding to Climate Change, which is also available on the website. It provides information on the emissions impacts of transit and provides comparisons with automobiles. It includes data from the National Transit Database on emissions from various types of transit vehicles and from locations around the country. Another recently completed FTA project is the *Transit Greenhouse Gas Management Compendium*. A recent TCRP report is *Methodology for Comparing the Environmental Benefits of Transit Projects*.

FTA is also interested in access to and options for transit. A number of TCRP projects focus on this area. Recent TCRP projects and reports include *Ridesharing as a Complement to Transit, Relationships Between Streetcars and the Built Environment,* and *Guidelines for Providing Access to Public Transportation Stations*. In addition, the Transit Innovations Deserving Exploratory Analysis project Flexible Carpooling to Transit Stations focuses on this topic.

There is interest in research addressing access to transit by specific populations groups. Attracting senior drivers to public transportation is one important area. AARP (formerly the American Association of Retired Persons) has examined what livable communities mean to the aging population. Hurricane evacuation planning for special needs populations is an important topic. We learned during Hurricane Rita that more planning is needed for transporting individuals with special needs.

The Mobility Services for All Americans One-Stop Traveler Management Coordination Center Demonstration focuses on assisting low-income, elderly, and special needs populations in finding transportation options. The National Cooperative Highway Research Program

report *Preparing Coordinated Transportation Plans: A Guidebook for State Department of Transportation* should be of benefit to DOTs and other agencies.

I will conclude by highlighting some of the research areas we hope to focus on over the next year. Livability performance measures continue to be of interest. We have completed performance measures for the state of good repair and safety goals. There is special interest in examining rural livability and rural livability performance measures. Another research area of interest is the first mile and last mile access to transit, including the use of bicycling and walking. Research on complete streets for transit access may also be initiated. We will be undertaking research on climate change adaptation this year, including work with the American Public Transportation Association (APTA) Standards Committee. Finally, we hope to initiate research related to TOD and value capture, including the ability to capture benefits from transit investments. The following websites provide additional resources: http://www.fta.dot.gov/livability, http://www.fta.dot.gov/research, http://www.hud.gov/sustainability, and http://www.epa.gov/sustainability.

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

Patricia Hendren

It is a pleasure to participate in this session and provide a transit agency perspective on livability research needs. I will start by providing an overview of WMATA, which is called Metro. I will highlight how Metro supports the six livability principles and how livability is incorporated into Metro's strategic framework, performance measures, and actions. I will conclude by discussing research that would benefit Metro and other transit agencies.

Metro provides transit services in an area of 1,500 square miles with 3.5 million residents. Metro's service area includes the District of Columbia, two suburban counties in Maryland, and three counties and three cities in Northern Virginia. Its average weekday ridership is 1.2 million passengers. Metro's rail system serves approximately 750,000 passengers per day and is the second-largest rail system in the country. Metro has the sixth-largest bus network in the United States, with more than 300 bus routes. Metro is the eighth-largest paratransit operator in the country.

Metro has a strong connection to the six livability principles outlined by other speakers. As I just described, Metro provides transportation choices throughout the region; that is our job. Metro also promotes equitable and affordable housing around rail stations and in areas with bus service. As Beth Osborne noted yesterday, residents in transit-rich communities spend approximately 9 percent of their disposable income on transportation, compared with 25 percent for residents in automobile-dependent communities. Thus, they can spend more on housing and other goods and services.

Metro enhances the economic competitiveness of the region. Metro connects people to their jobs. A 2008 travel study found that 17 percent of the region's commuting trips are on Metro versus 5 percent nationally. Metro is important to the operation of the federal government. Federal employees account for almost half of Metro's peak-period ridership. Metro also creates jobs. A recently rereleased report from APTA indicates that $1 billion in transit

capital investments translates to 24,000 jobs. Metro supports existing communities through TOD and transit services. For example, the area around Ballston Station in Arlington, Virginia, was primarily used cars lots when the station opened in 1979. Today, the vibrant area includes restaurants, shops, housing, and offices.

Metro works with other agencies to coordinate policies and leverage investments. For example, implementing traffic signal priority for buses in a corridor requires coordination with local communities, the District of Columbia, and state DOTs. Finally, Metro values communities and neighborhoods. FHWA's *Livability Guidebook* notes that "publicly funded transit programs are increasingly viewed as critical community anchors and catalysts for more concentrated economic growth and development." So, transit does equal livability.

Livability is addressed throughout Metro's strategic framework. A number of Metro's goals and objectives relate to livability. For example, creating a safer organization, improving reliability of service, maximizing rider satisfaction, improving access, promoting the region's economy and livable communities, and reducing environmental impacts all relate to livability. Livability is also reflected in Metro's performance measures. We use a range of performance reports to meet the needs of different audiences. We use a monthly *Vital Signs Report* and a web scorecard to communicate with the public and the WMATA board. These reports include information on livability measures related to safety and the delivery of quality service. Metro's general manager reviews more detailed performance information with his direct reports in a monthly one-on-one meeting. On the department level, the Office of Performance is working across the agency to develop execution plans that link Metro's daily functions to the strategic goals. It is key to align priorities to the agency's strategic goals. In terms of promoting, we need to demonstrate the importance of Metro in creating a livable region. We also need to unify Metro staff behind the goals and objectives, including those relating to livability.

Finally, Metro's actions reflect the livability principles. Metro provides more than 1 million trips on an average weekday. Metro promotes TOD. We are working on a new mixed-use development around the New Carrollton, Maryland, rail station. Metro received a TIGER grant to promote bus priority corridors because of our partnership with regional stakeholders. Metro recently implemented a peak-of-the-peak fare to encourage riders to change their travel times slightly to address capacity challenges. A new sustainability coordinator position has been added at Metro to promote livability.

With regard to research, we need stronger evidence of the link between transit and livability. Additional research on transit livability performance measures would be beneficial. These measures need to resonate with the public, use existing databases, move over time, and provide a range of options. It is important to keep the audiences for performance measures in mind and to provide consistency in performance measure definitions but not impose standards or targets. While research has been conducted on value capture, much of it is too academic for the public to understand or transit staff to use. Research highlighting transit as a public good would also be beneficial. Second, research on better methods to show the livability benefits of transit would be beneficial. Visualization tools utilizing existing software packages and free technology would be useful in presenting this information. Most transit agencies have limited staff time and financial resources for presenting data.

Research on collaborations and partnerships to advance livability initiatives is needed. This research could be accomplished through case studies that highlight innovative approaches. Other areas of needed research include tips on strategies to change travel behavior, strategies for different markets, balancing public input on the context of livability, and prioritizing strategies. Metro is willing to try new projects through grant programs and pilots, including partnerships with other agencies, organizations, and businesses.

Effectively sharing research and best practices is essential. One suggestion is to create a U.S. transit benchmarking organization. There are international examples of these types of organizations, including Community of Metros and Nova, which are operated by universities. Additional case studies, before-and-after evaluations, and summaries of successful collaborations across stakeholder groups would be beneficial. Peer exchanges are an excellent means of pushing innovation forward.

In closing, let me emphasize a few items to consider in conducting research focusing on public transportation and transit agencies. First, transit agencies have limited resources for analyzing data. While we collect a great deal of data, we do not have the staff resources for extensive analyses. We also have limited time to make our case with policy boards. Transit agencies face fierce competition for funds, and we have diverse customers. I encourage you not to recommend changes to the federal formula funding, since this formula is critical to the operation of transit services. Finally, we should remember the lessons learned from sustainability and smart growth as we work on livability initiatives.

MARYLAND DEPARTMENT OF TRANSPORTATION

Donald Halligan

I am pleased to have the opportunity to participate in this session and to provide a state DOT perspective on livability. My comments focus on Maryland DOT's role in supporting livability and related initiatives in the state.

Maryland is a small state in both size and population. The state covers 6 million acres and has a population of approximately 5.6 million. Maryland is the fifth most densely populated state in the country. Maryland is a growing state, however. The population is forecast to increase by 1 million people, with 400,000 jobs added, over the next 20 years.

Addressing the anticipated increases in population, employment, and housing is a concern in the state. The smart growth concept was first introduced in the state in 1997. The State Smart Growth Map, developed by the Maryland Department of Planning, is used to identify priority funding areas for transportation projects. The map also illustrates the anticipated growth areas by 2030. Providing affordable housing is a special concern, particularly in areas where growth is projected to occur. Affordable housing clearly has transportation implications. Many workers endure long commutes to be able to purchase affordable housing. Exploring how transportation can be part of the solution to affordable housing is important.

A new law, the Sustainable Communities Act of 2010, creates a common definition of sustainable communities across agencies in Maryland and compels agency coordination. It directs Maryland DOT to consider sustainable communities as it annually revises its capital program. It further requires the department to consult with the Smart Growth Subcabinet twice a year to coordinate mutual investments across the state. In addition, other state agen-

cies are providing incentives to locate developments in older neighborhoods and adjacent to our transit stations. For Maryland DOT, the act prolongs and enhances an existing rehabilitation tax credit through 2014, simplifies and targets the revitalization program by creating sustainable communities, establishes a new transportation focus on older communities, and enhances the role of the Smart Growth Subcabinet in the revitalization of communities.

The structure of Maryland DOT is multimodal. The department includes the Maryland Aviation Administration, the Maryland Port Administration, the Maryland Transit Administration (MTA), the Motor Vehicle Administration, and the State Highway Administration (SHA). The Maryland DOT Secretary is the Chair of the Maryland Transportation Authority Board, which operates the toll facilities in the state. Maryland appoints two WMATA board members, and the department funds one-third of the WMATA Compact.

Livability is a key focus of Maryland DOT and all the modal administrations. Maryland DOT has developed a portfolio of programs and activities that define and guide our participation in smart growth, sustainability, and livability efforts. We continue to examine ways to be effective in enabling stronger, more sustainable, and more livable communities.

SHA focuses on improving communities throughout the state. Examples of activities supporting livability include the use of context-sensitive design, bicycle and pedestrian projects, and community conservation efforts. The Intercounty Connector, a new 18-mile toll facility, included replacing 88 acres of existing parkland with 800 acres of new parkland.

Livability initiatives under way at the Port of Baltimore include community development and education programs, the greening of school sites, oyster seeding, wetland creation, and the greening of port operations. Research is needed to quantify the benefits and impacts of these types of programs.

MTA has numerous livability-related initiatives under way. Transit is a key component for serving the mobility needs in the state, especially with an aging population. MTA has made significant investments in rail systems and additional extensions are under way. Significant investments have also been made in TOD.

The State Center TOD represents a major initiative in downtown Baltimore. The project, which was initiated in 2004, focuses on the redevelopment of the state office complex. The 28-acre site currently includes office buildings housing 14 state agencies and parking lots. The complex is served by the Baltimore Metro and by light rail transit (LRT). Although the stations are one block apart, the site is one of the few places in the country served by both rail systems. The site is underused and has no activities outside the 8-hour workday.

The vision concept for the State Center TOD was developed in 2005. It includes 1 million square feet of office space, 500,000 square feet of retail space, 60,000 square feet of institutional space, 3,000 dwelling units, and 3 acres of parks and open space. The State Center will be developed in five phases. The vision concept was developed through a collaborative process involving multiple state agencies, the city, and neighborhood groups. The LRT and Metro stations will be better connected. The State Center project has encouraged redevelopment in the area. One complex, which includes offices, retail space, and apartments, has been completed.

The West Baltimore Transit-Centered Community Development is another important project. This ongoing effort focuses on using the proposed MARC station and other transit services to facilitate community improvements. The area currently is not of sufficient interest to the private sector to attract private investment.

Fourteen TOD areas have been designated around LRT, Metro, WMATA, and MARC stations. The state will provide incentives to support development in these areas and will work with local communities and neighborhood groups. Our experience indicates that livability is based on successful partnerships. Transportation must be a part of the solution, but it cannot be the solution. Success requires that public agencies, communities, local groups, and the private sector all work together.

In closing, I suggest the following questions for you to consider during your discussions. What is transportation's role, and should the focus be on new systems, existing systems, or both? When is intervention needed, and what type? What can we influence? What can we control? How can we align interests to motivate desirable actions and behaviors? How do you best engage communities that are weak? How do you deliver on the hope and expectations you generate without major investment in community infrastructure in weak areas?

Maryland has a number of good examples of livable communities and neighborhoods. Transportation has been a key element of many of these areas. We have communities in need of improvement, however. We face ongoing challenges in making all communities in the state livable. Thank you.

TRANSPORTATION FOR LIVABLE COMMUNITIES: CHARTING A RESEARCH AGENDA

Shana Baker

I appreciate the opportunity to participate in this session and this conference. At FHWA, we are committed to livability. Good planning is key to ensuring livable communities.

My comments focus on FHWA's livability research agenda. I will cover three general topics. First, I will highlight the *Livability in Transportation Guidebook*. Second, I will describe the livability strategic initiative, which includes a livability white paper, regional workshops, a toolbox of materials, and a model regional livability plan. I will conclude by discussing elements of the FY 2011 livability strategic initiative.

The *Livability in Transportation Guidebook* was developed by FHWA in coordination with FTA. It is designed as a practitioner's resource and guide for use by state DOTs, metropolitan planning organizations (MPOs), and others to advance livable community developments. The guidebook illustrates how livability principles have been successfully incorporated into transportation planning, programming, and project design. It explores how transportation planning and programs can improve community quality of life, enhance environmental performance, and increase transportation and housing choice.

The guidebook is based on a series of 14 case studies and strategies that cover both urban and rural communities. The case studies address revitalizing small towns, better connecting downtowns with neighborhoods, investing in compact mixed-use development, and maximizing the efficiency of existing transportation infrastructure. The case studies highlight the successful implementation of the livability principles. Examples of the projects included in the

guidebook are Maryland DOT's TOD; the FasTracks project in Denver, Colorado; a downtown redevelopment project in Fargo, North Dakota; and a streetscape project in Cathedral City, California. The guidebook contains summaries of all the projects and the actual project documents. The guidebook will be posted on the FHWA livability website this month.

The livability white paper is one element of the livability strategic initiative. We are just initiating development of this white paper, which will describe and differentiate between livability and sustainability. We believe that it is important to note the differences between these two terms, since at FHWA sustainability relates to environmental issues. The white paper will also describe and differentiate between livability in rural and urban areas. The white paper will discuss the role of highways in livability. It will present analytical tools, performance measures, and data collection for assessing livability.

The livability workshops are a second component of the livability strategic initiative. On completion of the white paper, five workshops will be held throughout the country. The workshops will incorporate a discussion of the white paper and will highlight livability efforts in the area. The workshops will provide participants with the opportunity to identify activities that the federal government can pursue to assist state and local governments in improving coordination and finding tools that are needed to further livability, identify technical assistance that is needed to overcome barriers to implementing projects that promote livability, and identify training materials that are needed for implementing projects that promote livability. The workshops will include representatives from state DOTs, MPOs, transit agencies, local governments, housing agencies, and organizations interested in livability.

The toolbox of training materials is the third component of the livability strategic initiative. The toolbox will assist in educating personnel at federal transportation, housing, and environmental agencies; state DOTs; MPOs; transit providers; and the general public about aspects of livability. Training materials will be developed for use by executives, elected officials, staff, and the public. In addition, responses to frequently asked questions, fact sheets, and brochures will be developed highlighting key elements of the livability strategic initiative and examples of livability projects.

The development of a model regional comprehensive livability plan is the fourth element of the livability strategic initiative. The plan will contain elements incorporating the six principles of the Sustainable Communities Partnership. The plan will also discuss how it can be linked to the strategic highway safety plan and the long-range transportation plan. PlanCheyenne (Wyoming), which was developed through the joint efforts of the MPO, the state, and local agencies, is one example of a comprehensive livability plan.

The major project for the livability strategic initiative in FY 2011 is the development of a livability performance measures handbook. It is envisioned that this how-to handbook for practitioners will guide users through the process of establishing and measuring quantitative and qualitative livability performance measures without imposing significant new data collection requirements.

Perspectives from University Transportation Centers

Susan L. Handy, *University of California, Davis*
Lisa Aultman-Hall, *University of Vermont Transportation Research Center*
Joseph L. Schofer, *Northwestern University*

This session provided comments from three university transportation center (UTC) representatives on the roles UTCs can play in advancing research, education, and technology transfer related to transportation and livable communities.

UNIVERSITY OF CALIFORNIA, DAVIS

Susan L. Handy

I welcome the opportunity to make a few final comments concerning the role of the UTCs in follow-up activities to this conference. The UTC program has been important to me and my career. I was a PhD student at the University of California, Berkeley, when the UTC program was initiated. As a junior faculty member at the University of Texas at Austin, I was involved with the Southwest UTC. I am currently the director of the Sustainable Transportation Center at the University of California, Davis.

The UTC program has probably accounted for half of the research projects I have conducted during my career. I estimate that more than half of my published papers have resulted from UTC projects and that these papers have been read more often than the others. If it is assumed that there is some benefit to the field when someone reads one of my papers, I am just one example of the tremendous impact the UTC program has had.

The combined mission of the UTCs—its focus on research, education, and outreach—is key to the success of the program. For the topic of livability, this combination is especially important.

The flexibility of the research agendas at the UTCs is important for addressing livability. The flexibility of research agendas varies across the UTCs, depending on the source of the local match. For example, the California Department of Transportation provides the local match for the five UTCs in the state, with few restrictions on research topics. This approach provides unique opportunities for projects motivated and originated by researchers, enabling both basic and applied research. This flexibility is important for livability-related research, which does not always serve an immediate deployable role for the state department of transportation.

Other UTCs obtain support for the local match on a project-by-project basis, which often brings new agency partners into the process. For example, Jennifer Dill at the Oregon Transportation Research and Education Consortium has been successful in partnering with

metropolitan planning organizations and local governments on projects. This approach creates additional opportunities for innovative partnerships, especially in implementing research results, conducting before-and-after evaluations of transportation projects, and providing training for transportation professionals. For example, the poster presented by Ann Forsyth provides guidance to local agencies in conducting cost-effective surveys of bicyclists. UTCs can also contribute by developing planning tools and performance measures for livability.

Education is a second important role for UTCs. UTC funding has been used to develop new transportation programs and courses at many universities. Many of these efforts are interdisciplinary. For example, Marc Schlossberg and Nico Larco have done a great job in developing and coordinating curriculum at the University of Oregon with the Sustainable Cities Initiative. Continuing education is an important role of some UTCs.

The third role of the UTCs is outreach. Presenting research in a way that is usable to practitioners is an ongoing challenge. There are numerous examples of good outreach and technology transfer activities at UTCs, especially with local partners. We continue to strive to transfer research results into everyday practice.

Let me end by commenting on our discussion on defining livability. One place to start is with the position that the status quo is not good enough, as everyone surely agrees. While transportation planning has always focused on improving the status quo, the goal of livability gives priority to improving the status quo by providing more transportation options and improving the quality of our communities in particular. This perspective has traditionally been underrepresented in transportation practice and in transportation research. As our next steps, we must begin to fill in those gaps.

UNIVERSITY OF VERMONT

Lisa Aultman-Hall

Although I have a shorter history than Susan with the UTCs, I echo her comments about the role they play in research, education, and outreach. I appreciate the opportunity to serve as chair of the conference planning team and to provide a few closing comments.

I suggest that there are three important roles UTCs can play in developing and advancing research for transportation and livable communities. The roles are change agent, advanced modeler, and inventor. First, UTCs can act as change agents to help break down many of the silos we have talked about during the conference and promote the interdisciplinary and interagency approach needed to promote livable communities.

Second, UTCs can play a key role as advanced modelers. Many participants discussed the wealth of data available from numerous sources. The UTCs are a logical place to compile and make sense of these data. UTC researchers and students are on the cutting edge of many data and modeling applications.

Third, UTCs can play a key role as inventors. UTCs provide the creative environment to invent solutions to transportation issues. The inventions may relate to technologies, policies, and processes. The UTCs can act as incubators for emerging technologies and ideas that benefit livable communities.

NORTHWESTERN UNIVERSITY

Joseph L. Schofer

In scoping out livability, it is important to remember that the subject is broader than transportation. Transportation can facilitate livable communities, but livability must include land use, housing, public infrastructure, and services. What assets are and should be available will be determined by many factors, including customer preferences, the context, and the availability of resources. UTCs can play important roles in understanding and contributing to these elements and, in the process, in breaking down the barriers among disciplines, agencies, and organizations that can contribute to the pursuit of livability.

We spent a good deal of time discussing the scope of the livability concept. I caution that if we think of livability as encompassing everything, then it really becomes nothing. The discussion at this conference raises the following question: Is livability an individual or a social concept—is it my livability or our livability? The answer is that it is both: we can each sort out our own ideals of livability, but combining those ideals into a community or a societal vision of livability is more challenging. Whether we are considering an individual or a social concept affects our approach to measurement and research. We need to consider how we can achieve livable communities that meet a broad variety of needs—who is in charge, and who has the leverage and the mandate to adapt communities? Defining roles for engineers and planners, as well as universities, in supporting research and education on livable communities is an important task.

In approaching livability research, it is important for each UTC to identify directions for its own research and education that match its strengths, its local partners, and the needs of its constituency. One size does not fit all in the UTC program: each center has unique opportunities, needs, and strengths. Each can establish and foster collaborations with other UTCs and local partners to achieve its goals.

In the pursuit of livability research, maintaining objectivity is important. We should not confuse what is currently done or what we personally like with what is necessarily good or bad. The customer ultimately defines livability, and thus we need to focus on how different people behave, what they want, and the best methods for delivering what they want. As research centers, the UTCs can play a key role in building the knowledge base and communicating this knowledge to others—the relationships between community design, infrastructure, and transportation services and travel behavior, modal utilization, environmental quality, public health, and satisfaction. The UTCs also play a critical role in determining and communicating "the power of why." We need to go beyond describing relationships to understand the underlying causality that will provide a basis for improving designs and predicting behavioral responses. We cannot stop at collecting and presenting data; we must also develop and integrate theory to explain those data.

A key opportunity for the UTCs is conducting evaluations of livability projects, policies, and programs. Evaluations focus on actual outcomes and people's responses, and of course they include that important search for causality—why did things happen the way they did? UTCs can bring objectivity to these evaluations, and we can build that essential knowledge base from multiple case studies. In the process we can address the complexities involved in

evaluations, including measurement, self-selection, confounding effects, and the multiplicity of impacts resulting from an intervention. In this work there may be important opportunities for groups of UTCs to collaborate on multisite livability experiments.

One topic suitable for some research groups will be creating livable designs for physical spaces, roadways, and other features. The designs could be evaluated in the laboratory and in before-and-after pilot studies. Other research topics include appropriate outcome measurements, the conduct of evaluations and the analysis of benefits and costs, exploration of consumer choices and preferences, and development and review of predictive models.

Of course, we must remember that education is at the heart of the UTCs' mission—we should be training the next generation of change agents who can deliver livable communities. This need brings us to an important question: What should we be teaching our students? We had serious discussions of the need for and barriers to interdisciplinary research. I am fortunate to be at a university that encourages interdisciplinary research and education, where the barriers to boundary crossing have mostly been removed. We certainly should not be reinforcing the distinction between engineers and other scholar-professionals.

Livability demands interdisciplinary approaches that engage engineers, planners, architects, social scientists, and other experts. We need to attract such an interdisciplinary mix of students and help them develop a broad set of ideas and skills. We need fundamental analysis and design tools more than ever, but we also need to be careful of rigidity. We must expose our students to both left-brain (analytic) and right-brain (synthetic) thinking skills. Cross-disciplinary studies are needed to break down barriers early. We also need to teach students to ask why continually: Why did this outcome occur, what is the underlying causality, and what guidance does it offer us for the future?

PARTICIPANT DISCUSSION

Identifying Topics for Further Research

Livability and Transportation for All Communities

The conference provided numerous opportunities for participants to share their experiences and ideas on transportation and livable communities. During the opening session, participants were invited to provide feedback on the definition of transportation and livable communities developed by the planning committee to help guide organization of the conference. Participants also discussed where further research is needed to advance transportation and livable communities, performance metrics, and other topics in the breakout sessions. Comments from those sessions are summarized in this section.

COMMENTS ON THE CONFERENCE DEFINITION OF TRANSPORTATION AND LIVABLE COMMUNITIES

The following definition of transportation and livable communities was developed by the planning team to assist in organizing the conference. Participants were asked for their feedback.

> Transportation systems that create livability and work with land use to give everyone multiple travel choices for meeting their daily needs affordably, safely, conveniently, and efficiently.

Comments of individual participants on the conference definition are summarized below.

- Safety is a large part of livability. If people do not feel safe walking or bicycling, they will not use those modes. There are two aspects to safety: perceived safety and physical or actual safety. More attention, including research, needs to focus on perceived safety, which is often overlooked.
- Sometimes, a measure of community attractiveness is the level of home prices—reflecting the demand for living in those communities. This measure is sometimes used as a proxy for livability. Unfortunately, not everyone can afford to live in these communities.
- The place-making function is important in determining livability. It may be as important as or more important than mode choice.
- The economic value of livability is often overlooked. The transportation system influences the quality of communities. Transportation is how we experience cities. Incorporating the concept of value capture into the definition of livable communities would help address this element.

• Emphasizing mode choice is good. The emphasis in the definition could be flipped, however. Transportation systems in themselves do not create livable communities or livability. Transportation is a necessary but not a sufficient condition for achieving livability. There is a need to shift the balance with mode choice so that the lower-impact modes are given priority.

• Efficiency may be interpreted as moving more vehicles through an area.

• Livability and sustainability may be thought of as being related, with livability being a human-centered version of sustainability. Adding sustainability to the definition would emphasize that livable communities do not degrade the environment.

• Working definitions of livability are often transportation-centric and urban-centric. A suggestion is to focus the definition on only the transportation elements of livable communities. Another suggestion is to change the wording to "give everyone the travel choices they need and desire to meet their daily requirements."

• The definition appears to avoid answering the question of what a livable community is, and it ignores the important question of what success is and what its indicators are. Affordability, safety, convenience, and efficiency are traditional transportation goals. Other goals, such as sustainability, appear appropriate. The need to do all or at least many of these things in a balanced approach should be highlighted. A suggestion is to incorporate balance, performance measures, local flexibility, and quality of life into the definition.

• A suggestion is to add a recognition that sometimes transportation systems and travel choices are not about the consumer moving, but the supplier moving. There is a complementary pattern to travel—goods can be delivered to rural areas, and information can be obtained electronically.

• The definition does not appear to challenge the current transportation system or current thinking. It could be applied to support automobile travel. Automobile travel is affordable, safe, convenient, and efficient. A definition that is more explicit in saying that the current system needs to be changed to give preference to modes that have less impact could be considered.

• The definition may be too narrow. Sustainability is more than just the long-term focus of the community; it is also how a community interacts with other communities. Many communities are considered livable, but they are not accessible to everyone. Livable communities do not exist in a vacuum. The definition should be broad enough to promote livability within a community and propagate livability among surrounding communities.

• The definition does not recognize consumers and their expectations, which will determine the effectiveness of land use and urban design, and their travel choices. Incorporation of the consumer in the definition could be considered.

• There appears to be a tension between a definition that is value-neutral and one that reflects certain values, such as equity and accessibility for everyone. There is danger in letting communities develop their own definitions of livability. Exclusive neighborhoods that are not accessible to all groups may consider themselves livable.

• The report *Global Warming: Six Americas*, which is a market segmentation analysis identifying six points of view on climate change and the demographics associated with those points of view, may be useful in defining livability.

• A suggestion is to consider how livability relates to U.S. competitiveness and the international economy, especially in light of the recent report of the National Academies, *Rising Above the Gathering Storm*.

• The use of "multiple travel choices" may be assumed to mean "multiple modes." Individuals may make other choices, including route choices and time-of-day choices. The use of "convenient and efficient" may be redundant. The use of "health" might be a good substitute. Health addresses emissions and impacts on the environment, as well as physical health, which also focuses on mode choice.

• To address concerns related to the extensive use of personal vehicles to the detriment of the community, consider appending "while not disrupting the ability of others." Providing lifestyle choices for people, including where they live and how they live, may be part of an expanded livability definition.

• Consider adding public health in the definition. Public health includes an individual's personal health and the ability to avoid exposure to pollutants. Land use is important in considering approaches to reduce greenhouse gas emissions. Transportation alone cannot address the needed reductions. Transportation, land use, and housing all need to be considered, along with the linkages among these elements.

• Consider being more explicit on land use by adding "accessibility to destinations." Affordability could be further examined by describing affordability to whom and in what time frame. Considering affordability by the cost of daily travel provides a perspective different from that of considering the annual costs of owning and operating an automobile. Another dimension of affordability focuses on the public sector in terms of infrastructure costs and subsidies for various services. A suggestion is to add sustainability and the absence of air, noise, and water pollution.

• Definitions that are simple and easy to understand avoid ambiguity and resonate with policy makers and the public. Providing a link to national priorities is also useful. These priorities might include reducing greenhouse gases; focusing on energy-efficient modes; and promoting modal integration, national competitiveness, and corridor integration.

• The definition puts transportation first, which is the problem with the way we address livability. Transportation is not an end in itself. Transportation supports other goals. There is a danger in saying that transportation is the solution when it is just a means to an end. Examining how transportation supports sustainable community design would be appropriate.

• A focus on accessibility to jobs and economic opportunities appears to be missing. Unfortunately, many people cannot afford to live in livable communities, which is often where the jobs are. Modes like carpooling and vanpooling, along with transit, are important for work commuters. An emphasis on connectivity—where the jobs are and where people live—would be appropriate for inclusion in the definition.

SUMMARY OF BREAKOUT GROUP DISCUSSIONS

Conference participants were assigned to a breakout group for discussions on Tuesday morning. Each of the six breakout groups was made up of 15 to 20 individuals from agencies, universities, consultants, and other organizations. Each breakout group had two leaders: a facilitator and an "honest broker." The honest broker helped maintain a focus on the discussion topics and research needs. The leaders of the breakout groups were as follows:

Breakout Group 1. Johanna Zmud, Rand Corporation, and Diana Bauer, U.S. Department of Energy;

Breakout Group 2. Roderick Diaz, Los Angeles County Metropolitan Transportation Authority, and Reginald Souleyrette, Iowa State University;

Breakout Group 3. Robert Dunphy, consultant, and Jason Bittner, University of Wisconsin;

Breakout Group 4. Steven Polzin, University of South Florida, and William Carr, District of Columbia Department of Transportation;

Breakout Group 5. Shawn Turner, Texas Transportation Institute, and Cynthia Burbank, PB Americas, Inc.; and

Breakout Group 6. Teresa Adams, Midwest Regional Transportation Center, and Susan L. Handy, University of California, Davis.

The following three general topics were covered in each of the breakout groups:

- Summarize issues and ideas from the conference definition, panels, and poster session;
- Identify critical topics for further research; and
- Identify candidate performance measures.

DEFINING TRANSPORTATION FOR LIVABLE COMMUNITIES

Many of the points associated with the definition raised during the general session were discussed more extensively in the breakout sessions. Common themes across the groups related to safety; travel choices; the differences between sustainability and livability; and a definition encompassing urban, suburban, exurban, and rural areas. The definition used by the U.S. Department of Transportation—livability is transportation options, housing options, and destinations close to home—was noted by many participants as a good approach focusing on the key elements of livability. On the basis of these comments, the following conference definition was proposed.

> Transportation for livable communities means fully considering land use and transportation together to offer everyone travel choices to meet their daily needs affordably, conveniently, and safely.

TOPICS FOR FURTHER RESEARCH

Participants identified a wide range of topics for further research during the breakout group discussions. The rapporteur summarized the general research needs discussed by participants and developed brief research project statements on common topics. A summary of the research topics identified in the breakout group discussions is presented in this section, along with the research project statements. These statements can be used by the various university transportation centers (UTCs) to develop research projects. The statements can also be expanded and submitted to the cooperative research programs managed by the Transportation Research Board, federal agencies, state departments of transportation, metropolitan planning organizations, private organizations, and other groups.

Institutions and Livability Communities

Participants discussed the agencies and organizations involved in developing and sustaining livable communities, issues associated with partnerships among these groups, and approaches for enhancing coordination and cooperation among agencies. The role of the private sector, including developers, was discussed. Potential programs and funding sources were identified, and limitations of various programs were discussed. The following research problem statements address some of these issues.

- Prepare a synthesis on local partnerships for livable communities. At the national level, the U.S. Department of Transportation, the Department of Housing and Urban Development, and the Environmental Protection Agency—which are responsible for transportation, housing, and environmental protection, respectively—have formed a partnership to advance livable communities. The U.S. Department of Agriculture has recently participated in these efforts to provide assistance in rural areas. The synthesis would examine partnerships among transportation, housing, environmental, and other agencies at the local level responsible for developing and supporting livable communities. The synthesis would present best practice case studies of partnerships in urban, suburban, exurban, and rural communities. The case studies would describe the project components and highlight the institutional arrangements, funding sources, implementation strategies, and experience to date. The involvement of project champions, grassroots support, and involvement of the public would be discussed. The role of the private sector would be described. Any issues encountered with the agencies working together would be documented, along with the methods used in overcoming these concerns.
- Conduct a research project examining barriers and opportunities associated with more extensive interagency partnerships and public–private partnerships to advance livable communities. Topics to be examined include limitations on various funding programs, legal requirements of the various agencies, responsibilities of federal and local agencies, and the role of project champions or change agents. The project would explore existing public–private partnerships in more detail, including public agencies working with residential and commercial land use developers. Issues associated with insurance, livery laws, reductions in federal and state funding, local housing and building design codes, and other concerns would be examined.
- Conduct a research study by using a social science approach to examine state and national institutions, structures, and cultures that support policy changes toward livability. Explore methods of addressing identified barriers and issues.

Travel Behavior and Livable Communities

Participants in the breakout groups discussed issues associated with the impact of the built environment and land use development patterns on travel behavior. The need for more extensive before-and-after studies examining causal relationships was emphasized by many

participants. Market dynamics, the role of pricing, life-cycle changes, and longitudinal changes were considered important. Before-and-after studies, the use of activity analyses, assessment of the impacts of social networks, and evaluation of the use of incentives to promote travel behavior changes were discussed. The following presents research problem statements focusing on some of these topics.

- Develop and conduct a program of before-and-after studies examining the impacts of various livability projects on travel behavior. The program would develop a comprehensive, multidimensional approach for conducting before-and-after assessments to determine the impact of livable community projects and other changes in the built environment on travel behavior and the transportation system. Common procedures, data collection and analysis techniques, and evaluation measures would be developed. Ongoing studies of projects in urban, suburban, exurban, and rural areas would be conducted. The results of the studies would be maintained in one location and would be a rich data source for all groups interested in a better understanding of the travel behavior impacts and causal relationships of different types of projects in different settings and areas.
- Conduct market research studies to explore the factors influencing individual decisions related to housing type, home location, and perceptions of livable communities. These studies, which might include focus groups, interviews, and other market research techniques, would provide a better understanding of the factors influencing decisions on where to live and housing choices. The studies would be conducted to promote a mix of social, economic, and geographic coverage. They would explore perceptions concerning the transportation system and the effect of the availability or lack of availability of various modes on individuals' decision-making processes. The importance of transportation, housing, and place-making elements would be explored for various age groups.
- Conduct a study examining how market dynamics affect travel behavior. This project would work with developers and other private-sector groups to develop a better understanding of the role market dynamics play in influencing housing and residential location choices and travel behavior.

Roadway, Transit, Bicycle, and Walking Infrastructure Design and Operations for Livable Communities

Breakout group participants discussed issues related to the design and operation of elements of the transportation system, including roadways, transit, and bicycle and pedestrian facilities. Comments focused on the need to explore new design treatments to enhance livable communities, to work with the appropriate organizations to make needed changes in design and operation manuals, and to monitor and evaluate the experience with various designs and operating strategies. Many participants identified a need to examine transit operating strategies for urban, suburban, exurban, and rural areas. The need for examining safety impacts—including those on personal, physical, and perceived safety—was noted in many of the breakout groups. The following research problem statements are presented to address some of these topics.

• Conduct research studies examining new designs for roadways, bicycling facilities, and sidewalks and walking paths. The studies would develop and analyze modifications of existing designs and new design treatments. Exploration of designs beyond the complete streets concept would be included. Designs for spot improvement would be examined.

• Conduct research studies evaluating the impacts of various designs and operating strategies. The studies would monitor and evaluate the impacts of design treatments for roadways and bicycle and pedestrian facilities. The project would develop a common evaluation methodology, data collection and analysis techniques, performance measures, and reporting methods. Multiple studies would be conducted to evaluate different types of design treatments. The results would be maintained in a central location and would provide a rich source of data on the impacts of various design treatments.

• Conduct a research study examining the actual and the perceived safety impacts of the transportation elements associated with livable communities. The study would explore the risk of crashes and actual crashes, personal safety (safety from crime), physical safety (the ability to use facilities safely, such as the avoidance of falls by elderly individuals), and perceived safety and security (perceptions of the safety and security of a facility). The study would examine crash, personal injury, and crime data. Focus groups and other market research activities would be conducted to improve identification of perceptions related to various facilities. The study would examine case studies in urban, suburban, exurban, and rural areas.

• Conduct a research project examining innovative transit services to meet the needs of diverse populations in livable communities in urban, suburban, exurban, and rural areas. The study would document examples of innovative approaches in use in various types of livable communities and serving various population groups, including elderly individuals, youth, lower-income groups, non-English-speaking groups, and special-needs populations. The case studies would highlight the planning process, including public involvement activities, funding sources, and experience to date. Case studies might include flexible routes, alternate day services, bus pools, feeder routes, and social networks. Carsharing and bicycle-sharing programs would be examined. The case studies would be documented in a synthesis to provide information to practitioners and researchers. A second part of the project would consider other innovative approaches that could address the needs of population groups and geographic areas. These approaches would be developed in concept stages for consideration as demonstrations and pilot projects.

Land Use, Development, and Livable Communities

Participants discussed a number of issues related to land use, development, and livable communities. Many of these topics related to items described under other topics, including travel behavior changes associated with different types of land use, market demand for livable neighborhoods, and trends in development patterns. Additional topics focused on better integration of transportation and land use planning, incentives for livable neighborhoods and community developments, and involvement of developers and private-sector representatives in promoting livable community concepts. The following research problem statements address some of these topics.

• Complete a synthesis of best practice case studies of coordinated land use and transportation planning and project development related to livable communities. The synthesis would present examples of the planning and development of livable neighborhoods and communities incorporating various combinations of housing, destinations, and transportation to promote livability. The methods and techniques used to plan, fund, and develop the various elements would be highlighted.

• Conduct a research study on methods for enhancing the coordination of transportation and land use planning. The study would build on the synthesis and explore methods to enhance transportation and land use planning in promoting and sustaining livable communities. Examples of innovative approaches to improving coordination of transportation and land use planning in urban, suburban, exurban, and rural areas would be examined. Information on land banking, infill development, land recycling or redevelopment, and incentives for promoting livability elements in developments would be examined.

Data on Transportation for Livable Communities

Participants in all the breakout groups identified data as an issue and discussed topics for further research related to data availability, collection, quality, integration, and consistency. They also discussed funding for data collection and analysis. The link between data and performance measures, benefit–cost analyses (BCAs), and other analyses was discussed. Accurate and timely data were considered critical in analyzing the impacts of measures to promote livable communities. The following research problem statements address some of these topics.

• Complete a synthesis on best practice data collection and analysis methods. The synthesis would present a snapshot of the best methods for collecting and analyzing data to assess the impacts of livable communities. Data on transportation, housing, land use, safety, health, the environment, and other elements would be examined. Data available at the national, state, and local levels, as well as private-sector data, would be included in the assessment. Gaps in needed data would be identified. The synthesis would fill an immediate need in providing examples of data collection and analysis and would provide the background for a more extensive study, which is described next.

• Conduct a research study examining data needs for assessing the impacts of livable communities. The research project would identify transportation, housing, land use, health, safety, environmental, and other data needed to assess all of the impacts of livable communities. The sources for obtaining the data would be defined, and the availability of needed data would be discussed. Data needs and availability for urban, suburban, exurban, and rural areas would be examined. Gaps in current data would be identified, and methods for filling them would be presented. The use of private-sector data and spatial data would be addressed, along with data integration and analysis methods. The use of technology for collecting data on travel behavior would be explored. The project would develop a suggested approach for ensuring consistent data across jurisdictions and time periods. The project would develop an approach for integrating relevant data collection and analysis at the national, state, metropolitan, and local levels. Methods for displaying and analyzing the data would be presented.

BCA and Other Analysis Methods

Participants discussed the need for assessing the potential and the actual benefits of livable communities and presenting this information to policy makers, stakeholders, and the public. The need for analysis techniques, including BCA, in the conduct of these assessments was discussed. The importance of identifying the appropriate techniques and ensuring their correct use was noted. The following research problem statement addresses this topic.

Conduct a research project examining the use of BCA and other analysis methods for livable communities. The project would identify typical benefits of livable communities and present methods for monetizing the benefits. Use of this information in a BCA would be described. Other possible analysis methods would be identified and reviewed for use in assessing the costs and benefits of elements of livable communities. Best practice case studies would be researched and presented. Elements to be examined include unintended consequences, environmental and health impacts, return on investment, lifetime costs, impacts on adjacent communities, and other variables. The project would include a how-to guide for conducting a BCA and would discuss other analysis methods for livable community projects.

Freight, Goods Movement, and Livable Communities

Participants discussed the role that freight and goods movement plays in supporting livable communities. They noted that freight movement both contributes to and detracts from livability. The importance of designing and operating transportation systems to deliver goods in a cost-effective and sustainable manner to ensure livability was noted. Participants noted that industries that provide jobs and support the local economy and thus advance one aspect of livability also require freight movement. They discussed the movement of agricultural produce and food items, which is often overlooked but is important for livable communities. The following research problem statements address some of these topics.

- Conduct a research study examining the interaction among livability, the consumption of goods, and freight movement. The project would analyze the role of freight movement in supporting livable communities as well as the negative impacts of freight on livable communities. Methods to mitigate the negative impacts would be explored.
- Develop best practice case study examples of freight movement supporting livable communities. The case studies would include examples of substituting the delivery of goods for personal travel, transporting freight from manufacturing facilities in livable communities, and facilitating the movement of freight through livable communities.

Technology and Livable Communities

Breakout group participants discussed the impacts of technology on livable communities. Topics discussed included optimizing the use of technology for mobility and accessibility services, as a substitute for travel, and for data collection and analysis. Using technology to optimize data collection has been discussed previously. The following research problem statement addresses the use of technology as a substitute for travel.

Conduct a research project examining the role of technology in supporting livable communities. The study would document the use of technology as a substitute for travel and as a method to enhance mobility and services in urban, suburban, exurban, and rural communities. The second part of the project would include a "visioning" exercise to identify technologies that might be available in the future for use in supporting livable communities.

Education and Professional Development

Participants in the breakout sessions discussed topics for further research related to education and professional development, as well as changes in and enhancements of university programs and training activities. The following research and activities were identified to provide enhanced educational and professional development opportunities and ultimately provide a pool of professionals with training and expertise in transportation and livable communities.

- Complete a synthesis on interdisciplinary university courses and professional training programs related to livability and sustainability. The synthesis would document training courses and professional development opportunities offered by universities in planning, engineering, public policy, architecture, and related disciplines. The synthesis would identify gaps or deficiencies in current offerings, barriers to and weaknesses in collaborative efforts, and examples of good interdisciplinary programs.
- Conduct a research project that builds on the synthesis and identifies core competencies for "transportation and livability professionals." The research would examine the new skills needed by practitioners and identify types of classes and training sessions necessary for meeting these needs. Core competencies would be identified, along with new or modified university courses and training sessions. The results would be disseminated to UTCs and professional organizations for their use in modifying existing classes and developing new courses.

Outreach, Technology Transfer, and Public Awareness

Participants discussed the need for outreach to a wide range of stakeholders, including professional organizations, policy makers, developers, state departments of transportation, transit agencies, metropolitan planning organizations, cities, land use and housing agencies, and the public. The following outlines two possible outreach, technology transfer, and public awareness activities.

- Develop brochures and other materials on transportation and livable communities appropriate for outreach efforts to policy makers, developers, public agencies at all levels, and the public. The materials would highlight the key elements of transportation and livable communities; the benefits of livable communities; and examples of approaches in urban, suburban, exurban, and rural areas.

• Continue efforts to coordinate the activities of federal agencies, the Transportation Research Board, UTCs, professional organizations, and other groups related to updating current transportation, transit, land use, and other manuals and guidebooks to reflect the needs and experiences of livable communities. These efforts might include joint work groups, project-specific work groups, and other arrangements to share expertise and knowledge to update appropriate manuals and guidebooks.

PERFORMANCE MEASURES FOR TRANSPORTATION AND LIVABLE COMMUNITIES

Participants in the breakout groups discussed the use of performance measures with transportation and livable communities. Use of the Federal Livable Community Partnership's six principles for livability was discussed as one approach in helping frame performance measures. Participants discussed the need to measure not only the outcomes of livability, such as happiness and good living, but also the transportation outputs, such as less travel. The need for both qualitative and quantitative performance measures was noted. The use of multiple measures and multicriteria techniques was discussed. It was further suggested that objective and subjective measures are complementary, because both stories and data can be used in motivating change. In addition, it was suggested that measuring livability within ranges, rather than targeting specific measures, makes sense.

The idea of moving beyond current transportation system performance measures and including methods and techniques from other disciplines was suggested by some participants. One approach might be the use of a Leadership in Energy and Environmental Design for Neighborhood Development–type measure. Complex systems measures may be useful since they can include multiple agents over time within a region. The appropriateness of market research techniques was noted, but there are challenges associated with stated versus revealed preference. It was suggested that equity issues and the needs of disabled individuals should be addressed. The appropriate geographic boundaries were discussed. The need for scalable performance measures was noted, along with the potential to establish benchmarks to monitor changes over time.

The following performance measures (not in priority order) were suggested by individual conference participants for use in assessing transportation and livable communities (as explained in the Preface, the purpose of the conference was to identify research needs, not to set priorities or endorse any particular research):

- Number of viable travel options and mobility services provided,
- Traffic volumes,
- Congestion levels,
- Pedestrian volumes,
- Bicycle volumes,
- Vehicle miles traveled,
- Travel time burden,
- Travel time index,

- Number of crashes and crash rates,
- Perceived safety,
- Crime rates,
- Sidewalk and bicycle network,
- Mode choice and split,
- Existing gravimetric-style measures of accessibility,
- Land use mix,
- BCA,
- Connectivity versus potential connectivity,
- Cost of living versus wage levels,
- Combined transportation and housing costs,
- Public health measures such as obesity rates,
- Subjective evaluation from surveys and focus groups of residents,
- Greenhouse gas emissions and energy consumption, and
- Air pollution levels.

APPENDIX A

Poster Summaries

Fifty posters were presented at the conference in an interactive poster session. The poster authors were available during the session to discuss elements of the projects and to answer questions. The summaries prepared by the author are presented below. The summaries are not provided in the order they were listed in the conference program.

Poster Summary 1

PROMISES AND PITFALLS OF SENATE BILL 375 AS A MODEL FOR REGIONAL PLANNING COORDINATION

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This presentation provides findings from data analysis and interviews with stakeholders involved in implementing California's Senate Bill (SB) 375 (2008), legislation mandating transportation and land use planning to reduce greenhouse gas (GHG) emissions from the transport sector. SB 375 helps implement earlier state legislation, Assembly Bill (AB) 32 (2008), which calls for reductions in GHG emissions by 2020 in line with levels recommended by the international scientific community. SB 375 requires the state's urban regions to plan for more efficient development to help achieve the state's climate policy goals.

Dubbed "the nation's first law to control greenhouse gas emissions by curbing sprawl," SB 375 has gained national attention. Through the federal interagency Partnership for Sustainable Communities and upcoming reauthorization of the federal transportation law, the SB 375 approach may be extended nationally. Under SB 375, metropolitan planning organizations (MPOs) must develop "sustainable communities strategies" (SCSs)—development scenarios deemed capable of achieving mandated GHG emissions reduction targets for vehicles and light trucks. With MPO governing boards made up primarily of local government representatives, SB 375 strengthens the framework for coordinating state, regional, and local plans and priorities. An SCS must be consistent with the mandated state emissions reduction target under SB 375, with the MPO's long-range regional transportation plan, and with California housing law requiring local governments to plan and zone for housing in amounts and types accommodating projected population growth.

The California Air Resources Board (CARB), which is charged with implementing AB 32, has defined a three-pronged strategy for transportation, which accounts for 37 percent of total GHG emissions in the state: improving fuel efficiency, improving vehicle efficiency, and reducing vehicle travel. The first two strategies are projected to account for 91 percent of targeted emissions reductions from transportation by 2020. CARB considers the third strategy—reducing vehicle miles traveled (VMT), the goal of SB 375—to be critical in the long run, because increases in VMT could eventually erode emissions benefits from technological improvements. Absent interventions, statewide VMT will double from 1990 to 2030.

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SB 375 builds on both regional and local precedents. The MPOs for the four largest metropolitan areas in the state, as well as several smaller ones, have developed "blueprint plans" examining strategies for infill, compact growth, and transit-oriented development (TOD). As of 2009, about 38 percent of the cities in the "blueprint regions" had brought their local plans into conformity with the blueprint plan. In addition, more than three-quarters of cities had adopted or were in the process of adopting climate policies and plans. These activities lay the groundwork for the development of SCSs.

Many city planners indicated that adopting local climate policies helps them to coordinate and prioritize existing smart growth policies and programs. Another motivation for local government action is that the state's stringent environmental review laws now require project-by-project review of climate impacts. However, if a local government develops a climate action plan that meets state standards for GHG reduction and mitigation, it can rely on the plan and avoid project-by-project analysis. The time and cost savings could be large.

Nevertheless, obstacles to achieving the goals of SB 375 remain formidable. Despite the important role that some policy makers expect SB 375 to play in addressing climate policy goals, its means are relatively modest. SB 375 provides no state funding and few mandates for SCS development or implementation. The law does not require local governments to alter land use decisions to comply with the SCS, and some local governments appear disinclined to cooperate. The law does offer streamlined environmental review for certain infill development projects, but the inducement depends on local interest in infill development in the first place.

In addition, recent state budget cuts for transit and redevelopment, which were made in response to the economic downturn, threaten the viability of ambitious infill and TOD strategies. In the interviews, local planners complained that the costs of providing additional or upgraded urban infrastructure and services, such as sewers, transit, and parks, are high, but such investments are needed to support infill projects and ensure their acceptability to current residents. Furthermore, many regional agencies, such as transit agencies and water and sewer districts, have not been actively engaged in efforts to redirect resources to infill sites, and their leaders sometimes appear disinclined to make such reprogramming a priority. With few direct incentives available for infill development, the interviewees expressed concern that regional negotiations over SCSs may become zero-sum conflicts, as some communities are called on to accommodate higher shares of regional population growth without the funds to support such growth, while other communities not targeted for TOD may be disinclined to reallocate resources to assist their densifying neighbors.

Reflecting SB 375's modest provisions, CARB recently adopted first-round emissions targets for MPOs that accommodate an increase in total GHG emissions under the law. The targets call for each large region to reduce per capita GHG emissions, but total emissions reductions are undercut by projected growth in VMT. CARB estimates that annual carbon dioxide emissions from passenger vehicles and light trucks—the emissions covered by SB 375—will increase by 10 percent from 2005 to 2020 and by 18 percent from 2005 to 2035, solely on the basis of the SB 375 targeted reductions. CARB expects that its other policy measures will be sufficient to achieve called-for reductions from the transportation sector to meet AB 32 goals in 2020. However, the evolving policy casts some doubt over the role that land use and transport measures will play in the overall program.

Poster Summary 2

PENNY WISE, POUND FUELISH

New Measures of Housing and Transportation Affordability

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People have a variety of reasons for deciding where to live: public safety, quality of schools and other public services, the time it takes to get to work, the mix of nearby amenities such as stores and restaurants, and, last but certainly not least, the character and cost of the community. The typical home seeker weighs all of these factors to strike the right balance for his or her family in choosing a community.

In an effort to bring the American dream of homeownership to more people, society has enabled and encouraged growth in places where low land costs deliver relatively inexpensive housing but where sprawling, single-use development adds significantly to the cost of carrying out the daily tasks of getting to work or school, running errands, and enjoying an evening out. Unlike house payments, transportation costs are difficult to track because they are paid in disaggregated ways: monthly car payments, semiannual insurance premiums, weekly fill-up at the pump, and periodic maintenance. As a result, Americans only grasp the magnitude of these expenses after committing to a community.

The Housing and Transportation (H+T) Affordability Index offers transportation cost data for 161,600 neighborhoods across 337 regions of the United States and provides proof that compact development can significantly reduce household travel costs.

The H+T index challenges conventional wisdom about affordability and demonstrates that the combined cost of housing and transportation places the vast majority of communities in this country beyond the reach of median-income households. Two out of three communities (69 percent) are considered affordable under the traditional definition of housing costs at 30 percent of income. That shrinks, however, to just two out of five (39 percent) when both housing and transportation costs are considered and a 45 percent affordability benchmark is applied.

The index also shows that a community's location, character, and design are better predictors of overall affordability than are household size and income. Compact, walkable, mixed-use communities with convenient access to public transit and employment centers may initially appear expensive because of higher housing costs. But after application of the H+T index, these places can often make for more affordable living than less dense exurban communities because households can own fewer cars—the single biggest expense in a household transportation budget—and still maintain a high quality of life.

Among the important findings are the following:

• Families who pursue a "drive until you qualify" approach to homeownership in an effort to reduce expenses often pay more in higher transportation costs than they save on housing.

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• Residents of "drive until you qualify" zones are most sensitive to jumps in gasoline prices because of the distances they must drive.

• The longer distances associated with sprawl translate into more congestion on highways, less leisure time with families as workers spend more time in their cars getting to and from jobs, and higher greenhouse gas emissions.

• Density is strongly correlated with automobile ownership and vehicle miles traveled.

• Household transportation cost savings from residing in a compact neighborhood rather than a dispersed community can range from $1,580 per year in Little Rock, Arkansas, and $1,830 in Minneapolis, Minnesota, to $3,110 in Chicago, Illinois, $3,610 in Phoenix, Arizona, and as high as $3,850 in Boston, Massachusetts.

• Aggregate regional transportation savings through 2030 range from $239.8 million in a small region like Charlotte, North Carolina, to as much as $1.1 billion in San Francisco, California, and $2.1 billion in Phoenix if 50 percent of projected population growth could live in more location-efficient places.

These facts suggest that regions need to change the way they plan for and accommodate growth to preserve affordability at the household level and sustainability at the regional level. The index demonstrates the need for performance measures rooted in the realities that confront households trying to make ends meet and that regions confront in balancing growth with the cost and quality of life, the amount of greenfields lost to development, traffic congestion, infrastructure costs, improved economic competitiveness, and reduced carbon emissions. Finally, it provides a quantitative tool for new federal policy redefining affordability in America that better reflects economic reality and provides an objective basis for regions to make the necessary changes.

Poster Summary 3

FREIGHT AND LIVABLE COMMUNITIES

Does Economic Sustainability Still Matter for Transportation Decision Making?

Jason Bittner[3] and Joshua Levine
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Livability, as it applies to transportation investment, is not well defined. In many respects, Supreme Court Justice Potter Stewart's famous declaration that "I know it when I see it" is applicable. An emerging community of academicians, advocates, and planners tends to think about livability in terms of "complete streets"—streets that provide adequate pedestrian and bicycle access; limit the need for automobiles; and enhance the community's walkability for shopping, recreation, and entertainment. These approaches "give everyone multiple travel choices for meeting their daily needs affordably, safely, conveniently, and efficiently." Inherent in the complete streets concept—and often overlooked—is that these businesses and entertainment destinations need to be serviced by delivery vehicles. Products and services require a freight system capable of delivering goods in a timely manner.

The National Center for Freight and Infrastructure Research and Education (CFIRE) at the University of Wisconsin–Madison operates with a research theme of sustainable freight

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transportation infrastructure and systems. This work has resulted in both hard-side and soft-side transportation research, with much of the effort directly related to the policy impacts of transportation investments. To define sustainability, CFIRE adopted a "triple bottom line" approach, which includes social, economic, and environmental sustainability measures. Among the critical concepts included in these policy-oriented works are the concepts of megaregional development and urban access.

Approach

The authors explored whether increased urbanization and the development of megaregions will be sustainable with respect to freight transportation. To accomplish this objective, the authors characterized current freight patterns in urban areas and associated those movements with economic and environmental costs. The authors will eventually prepare outreach and educational materials in the context of current efforts targeting livability performance measures.

In fall 2010, the University of Wisconsin–Madison, with assistance from CFIRE, sponsored the development of a transportation management and policy colloquium exploring livability as a concept in transportation decision making. To ensure that society continues to prosper, the concept of livability must include freight access, urban delivery, and intermodal connectivity. These considerations will help reflect modern society's needs, demands, and expectations.

In this poster, the authors outline the principal issues related to incorporating freight-related transportation priorities into the livability framework.

Observations

The environmental and equity impacts of transportation have been thoroughly researched. In many respects, the lessons from the Interstate era demonstrated the shortcomings of decision-making processes devoid of human interactions. Great strides have been made in accommodating bicycle and pedestrian modes and limiting the environmental impact of personal automobile travel. However, many observations and cautionary tales need to be included in these discussions.

The following are among the primary considerations identified for freight in an era of livability:

- Access management and delivery availability;
- Emissions (during delivery, in congestion, and at ports and terminals);
- Alternative energy systems;
- Physical infrastructure accommodations (including freight-only infrastructure);
- Decision-making criteria to weight freight and passenger projects;
- Lane width, geometry, and bridge clearances;
- Industrial and commercial development land uses;
- Terminal and freight facility location; and
- Interconnectivity.

Preferred practices for incorporating freight and examples of inadequate accommodations for freight are provided through discussion of several of the listed topics. The poster demonstrates the value of including freight-related aspects in the broad scheme of livability and the importance of freight to the economic well-being of society as a whole. The authors hope to encourage additional discussion concerning how to incorporate economic growth, and its freight requirements, with livability.

Poster Summary 4

FOUR DECADES OF PLANNING FOR LIVABLE COMMUNITIES
Insights from Freiburg, Germany

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For four decades, the city of Freiburg (population 220,000) has been at the forefront of promoting sustainable transport in Germany. Up to the late 1960s, Freiburg encouraged greenfield development, widened streets, abandoned trolley lines, and built car parking lots. Motorization increased rapidly, transit ridership plummeted, and the city was sprawling. Air pollution, traffic fatalities, congestion related to the car, and other environmental concerns shifted public opinion away from automobile-centered growth. Between 1982 and 2007, the number of trips by bicycle tripled, transit ridership doubled, and the share of trips by car fell from 38 to 32 percent. Since 1990, the level of motorization has stagnated and per capita carbon dioxide emissions from transport have fallen. Freiburg achieved a more sustainable transport system by (*a*) successfully integrating land use and transport planning, (*b*) coordinating and integrating public transport regionally, (*c*) promoting bicycle use, (*d*) restricting automobile use, and (*e*) encouraging citizen participation throughout the process.

Governments at the federal, state, and local levels in Germany determine the sustainability of the transport system. Federal gasoline taxes, sales taxes, and regulations make automobile use and ownership expensive and encourage demand for less polluting and smaller cars. In addition, the federal government provides matching funds for local public transport, walking, and cycling projects. Federal, state, regional, and local governments interact in a federally mandated bottom–up and top–down land use planning process. Lower levels of government participate in drafting plans at the next higher level but are bound by the higher-level plans once they are adopted. At each level, land use plans are coordinated with housing, transport, and environmental plans and with neighboring jurisdictions. Local governments draw up the actual land use plan. The role of the federal government is limited to ensuring consistency of planning techniques, enforcing planning and environmental laws, and formulating broad spatial planning goals. Federal and state governments provide the framework, but cities—like Freiburg—have been developing and implementing innovative policies.

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Integrating Transport and Land Use Planning

Even though Freiburg started implementing sustainable transport and land use policies in the early 1970s, the comprehensive transport plan of 1979 was the first to call explicitly for the integration of the two planning sectors. The land use plan of 1981 prescribed that new development was to be concentrated along public transport corridors. In 2006, 65 percent of Freiburg's residents and 70 percent of all jobs were located within 300 meters of a light rail stop. Freiburg's most recent land use and transport plans were developed simultaneously, and both are based on the goals of reducing car use and keeping trip distances short.

Expanding and Coordinating Public Transport Services

In the late 1960s, Freiburg's city council decided to stop abandoning trolley lines. Fifteen years later, in 1983, the first new light rail line was added to the remaining 14 km of tracks. Freiburg opened four new lines with a total extent of 36.4 km in 2008, and the supply of light rail service has tripled. In 1984, Freiburg's public transport system offered Germany's first monthly ticket—transferable to other users. In 1991, the geographic coverage of the ticket was expanded to include the city and two adjacent counties. Services, fares, subsidies, and timetables for bus and rail operators are coordinated regionally. The monthly ticket offers unlimited public transport travel within the entire region for about $60. More than 90 percent of passengers have monthly or annual tickets. Freiburg's transit system has become one of the most financially efficient in Germany and requires operating subsidies of only 10 percent.

Making Cycling a Viable Transport Alternative for All Trips

The bicycle is a feasible option for all trips and all destinations in Freiburg. Between 1972 and 2007, Freiburg expanded its network of separate bicycle paths and lanes from 29 to 160 km. The network is complemented with 120 km of bicycle routes through forests, 400 km of traffic-calmed roads (30 km/h or less), and 2 km of bicycle streets. Slow automobile speeds in traffic-calmed areas encourage more cycling and make it safer. The city requires bicycle parking for all new buildings with two or more apartments, as well as for schools, universities, and businesses. Between 1987 and 2009, the number of bicycle parking spaces increased significantly. Among the additions was a major bicycle parking garage at the main train station with space for 1,000 bicycles.

Restricting Automobile Use

Many of the policies that promote public transport, bicycling, and walking involve restrictions on car use, such as car-free zones and traffic-calmed neighborhoods. In addition, Freiburg's parking policy is designed to make car use less convenient and more expensive. Parking garages are relegated to the periphery of the city center. In residential neighborhoods, parking is reserved for residents and requires a special permit. On-street parking in commercial areas of the city becomes more expensive nearer the center.

Citizen Involvement

Citizen participation has been a key aspect of transport and land use planning in Freiburg. For example, Freiburg's latest land use plan has been developed with sustained input from 900 citizens, 19 neighboring municipalities, and 12 special-purpose governments in the region. Citizen involvement and public discourse kept the environment and the sustainability of the transport system in the news in Freiburg for decades. Public opinion in Freiburg has become more and more supportive of sustainable policies.

Lessons for the United States

The innovative transport and land use policies introduced in Freiburg offer useful lessons on how to increase transport sustainability. First, controversial policies were implemented in stages—often starting in neighborhoods where people were most supportive. Second, transport policies were multimodal and included both incentives for alternatives to the car and disincentives to automobile use. Third, transport and land use planning were fully integrated, culminating in the simultaneously drafted transport and land use plans of 2008. Fourth, citizen involvement was an integral part of policy development and implementation, with citizens often driving the sustainability agenda. Fifth, the support and collaboration of higher levels of government were crucial in making local policies work. Sixth, sustainable transport policies were long term, and policies were maintained for lasting impact.

More details are available in the following: Buehler, R., and J. Pucher. Sustainable Transport in Freiburg: Lessons from Germany's Environmental Capital. *International Journal of Sustainable Transportation*, Vol. 5, 2011, pp. 43–70.

Poster Summary 5

TOD 3.0

Aligning Partners in Real Estate Development and Transit Implementation

Ian Carlton[5] and William Fleissig
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With support from Reconnecting America, Livable Cities, and the Ford Foundation, Ian Carlton and William Fleissig identified an emerging direction for transit implementation, station area planning, and infrastructure finance to achieve more successful livability-oriented transit corridors. On the basis of case studies and practitioner interviews, Carlton and Fleissig have determined that an emerging transit-oriented development (TOD) era, "TOD 3.0," is focused on coordinating transit planning and real estate development potential because (*a*) fixed-guideway transit infrastructure is becoming the corridor armature that defines sustainable and livable communities and (*b*) real estate development is a principal funding source for local livability-related infrastructure. By combining seldom-coupled standard practices into a cohesive strategy, TOD 3.0 enables more people over larger geographic areas to access the benefits of more livable places and equitable communities.

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The authors posit that transit-served corridors of walkable, high-quality, mixed-use communities reflecting TOD principles are the future models of livable communities. However, built TOD to date has a mixed track record, with most examples achieving neither their anticipated community benefits nor real estate return expectations. The research has identified a consistent disconnect between the real estate development community and the transit planning world that has contributed to the mixed track record of existing TOD. A previous era, labeled TOD 1.0, exhibited isolated transit infrastructure implementation and real estate development processes that resulted in one-off real estate projects built only when markets and regulations fortuitously allowed development. Subsequent to 1991's Intermodal Surface Transportation Efficiency Act, which called for the inclusion of land use criteria in the new starts funding process, TOD 2.0 exhibited greater regulatory coordination focused on TOD outcomes, although TOD projects still occurred on a one-off basis when markets fortuitously allowed them. A paradigm shift that aligns transit implementation with real estate development potential to maximize livability-related improvements, which are often funded via real estate development, is required to achieve consistently livable TOD in the future.

The authors believe that the next evolutionary step of TOD, TOD 3.0, will be a coordinated transit implementation and real estate development process requiring multidisciplinary transit corridor–based land use and financial planning from the outset. Because new real estate development funds a large portion of livability benefits, transit planners must become aware of the economic development and real estate development potential of their station location options.

A survey of current practice suggests that several transit projects have achieved a heightened level of real estate awareness in the early planning stages, which has led to the siting of transit facilities in good or great real estate markets. Market alignment has allowed high-quality, livable communities to emerge around transit. Incorporation of real estate development potential in the transit planning process was often spurred by the need to finance a significant portion of the transit capital costs from real estate development–related revenues (e.g., tax increment financing, assessment districts, joint development). This process, commonly referred to as value capture, can become a critical tool in aligning transit planning with real estate development.

Real estate developers are often expected to fund local infrastructure needs, public art programs, affordable housing, or other livability benefits. Carrying this out along an entire transit line calls for greater planning coordination and the implementation of transit corridor financing districts that can capture value and distribute livability benefits along corridors. Because not all stations will have significant real estate development opportunities, funds generated in "high-value" station areas can cross-subsidize livability benefits (i.e., preservation of affordable housing, streetscape improvements, public service enhancements) in other station areas along the transit corridor. Also, because development projects are typically burdened with significant up-front livability-related infrastructure costs and the first projects in a station area are disproportionately burdened, TOD is often unattractive to real estate investors. Thus, TOD 3.0 leverages local finance districts as a means of transforming large up-front costs into smaller, distributed, ongoing costs. Successfully orienting "developer exactions" toward transit station area livability goals is a minor adaptation of current assess-

ment district and tax increment district practices. Such modifications of existing practice can be facilitated or required by policy makers, transit agencies, public–private partnerships, and—as the critical finance source for transit projects—the federal government.

Current practices can be tweaked, combined, and broadly adopted to achieve the transit–real estate partnership that the authors believe defines the future of livable communities. They assert that best practices adoption, facilitated by new flexibility built into existing transit policies, can generate a livability-focused paradigm shift.

Poster Summary 6

REVERSING URBAN SPRAWL

A Reclaimability Approach to Reviving Downtown Brownfields

Maria Chrysochoou,[6] Geeta Dahal, Kweku Brown, Norman Garrick, Catalina Granda-Carvajal, Kathleen Segerson, and Amvrossios Bagtzoglou
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A key step in promoting smart growth in urban environments is the reclamation of dilapidated, underused, or abandoned contaminated urban sites, also known as brownfields. Brownfield redevelopment promotes smart growth because it involves land reuse in urban areas and leads to economic and community vitality. Brownfields commonly occur within an urban context where basic infrastructure, workplaces, and other amenities are already in place. Brownfield redevelopment therefore can be planned in a way that leads to creation of walkable neighborhoods, favors public transportation, and revives local markets.

Prioritization of brownfields for redevelopment has become important because according to U.S. Environmental Protection Agency estimates, there are approximately 450,000 brownfields in the United States. With the substantial number of brownfields and limited amount of funding, decision makers face the following question: Which projects can be completed with the available funding sources, and which need to be wait-listed? The lack of decision support tools for prioritization of brownfields for redevelopment is an impediment in obtaining maximum benefits from the available funding resources. This research explores a prioritization scheme for brownfield redevelopment that uses geographic information systems (GISs) implemented to visualize socioeconomic factors, smart growth, and environmental attributes of brownfield sites and their surrounding areas. Because socioeconomic, environmental, and smart growth–related factors tend to be considered in evaluating the benefits derived from brownfield redevelopment, these parameters were chosen as the basis of the indexing scheme. Its application to New Haven, Connecticut, as a case study demonstrates a general scheme that can be used by urban planners and public agencies in pinpointing smart growth and environmentally sensitive locations that can be set as priority areas for funding. The indexing approach attempts to consider all three factors (socioeconomic, smart growth, and environmental) in such a way that they are independent of the end use and do not require any site-specific environmental investigation aggregation.

Environmental factors for the prioritization scheme were based on a rough assessment of the environmental sensitivity and potential environmental risk of a brownfield site. Six

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environmental variables—the site's past use, zoning (proximity to residential areas), proximity to water bodies, proximity to sensitive receptors (parks, habitats, and biodiversity areas), floodplain categorization, and underlying soil type—were chosen to assess environmental risks. An environmental index map based on the proximity of the brownfields to the sensitive receptors was generated. On the basis of the levels of risk, brownfields were categorized into three color codes—red, yellow, and brown. Red indicates high-risk brownfields with industrial past uses and that are at a distance of less than 0.25 mile [based on the Leadership in Energy and Environmental Design for Neighborhood Development (LEED-ND) rating system] from water bodies and natural diversity areas. Yellow indicates moderate risk and represents brownfields with industrial past uses that are at a distance of more than 0.25 mile from water bodies and natural diversity areas. Brown represents sites with commercial and unknown uses that would require further assessments of environmental risks. In addition, on the basis of available zoning information, a mixed-used potential map was generated representing brownfields with industrial past uses that are at a distance of less than 0.25 mile from the intersection of industrial, commercial, and residential zones.

Smart growth location mapping is based on transportation and land use variables determined by the LEED-ND rating system. The variable selection process yielded six variables: intersection density, presence of utilities, jobs–housing balance, bus transit, rail transit, and the potential for transit. All variables were classified as high, medium, or low, indicating a variable's value range with the strongest, moderate, or no positive influence, respectively, on an area's capacity for supporting smart growth development. Indicators of smart growth were scored from 0 to 2. Zero corresponds to a low indicator for smart growth, 1 to medium, and 2 to maximum potential. Finally, smart growth locations were grouped into two categories. Smart Growth Area 1, with a score ranging from 0.8 to 1.4, indicates a lower smart growth potential than Smart Growth Area 2, with a score ranging from 1.4 to 2.

The incorporation of socioeconomic factors into a general prioritization scheme presented the biggest challenge in terms of selection of variables and data acquisition. Depending on town and state policies, the use of various types of demographics to target distressed municipalities for redevelopment may be desirable; therefore, the types of variables should be determined at the discretion of the decision makers.

The results of smart growth location mapping for New Haven suggested that 74.1 percent (14.1 square miles) of the town contains the necessary infrastructure and other location-specific features that would best accommodate smart growth development. Most of the high- and moderate-risk brownfields along with brownfields exhibiting mixed-use potential in New Haven are already located in smart growth locations. This implies that these brownfields could be accessible to markets, suppliers, and employees. In addition, brownfields representing higher risks are indicative of the environmental sensitivity pertaining to their locations and possibly the urgency to address them. These brownfields are areas of concern and exhibit potential redevelopment priority for New Haven.

The goal of this project was to allow, through the visual tool and mapping index, the state government and other public agencies to prioritize brownfields for redevelopment and make decisions that would focus limited funds and other resources on the more promising remediation projects in terms of environmental and smart growth criteria. This constitutes a

significant departure from previous decision support tools that aim at assessing the suitability of a particular end use for a brownfield site or at estimating the smart growth potential of a specific project. Application of the GIS tool to New Haven with the available data showed that a brownfield with high environmental sensitivity and smart growth potential could be a potential target area, while isolated brownfields with mixed-use potential could be transformed if redeveloped. At present the major limitation in the application of this GIS tool is the availability of data. Additional data would help in quantifying the risks associated with the sites and help in the creation of more refined areas of concern.

Poster Summary 7

REAL-TIME RIDESHARING FOR LIVABLE COMMUNITIES

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Much of the public discourse about livable communities focuses on transit-oriented development and planning for walkable neighborhoods. While both are important, the concept of livability should also embrace sustainable transportation options that provide connectivity between jobs and where people live. Transportation options such as carpooling and vanpooling provide affordable mobility and access to jobs for the 89 percent of people who do not live within walking distance of transit stops with regular service frequency. This presentation will introduce the technology created to enable on-demand, real-time ridesharing as a flexible, safe, and convenient form of commuter transportation that reduces the number of cars on the roads, saves people money, and extends public transit.

Traditional top-down transportation networks are failing, as illustrated by the increasing-percentage of people who drive alone (76 percent today, 64 percent in 1980) and the small percentage of people (4.7 percent) who use public transportation to commute to work. Average car occupancy is now 1.5 people per car, and traffic congestion costs the United States $87.2 billion per year in wasted fuel and productivity and 4.2 billion hours wasted sitting in traffic—not to mention the devastating environmental impacts from carbon dioxide emissions. Building our way out of congestion is an expensive and time-intensive proposition and will only lead to additional sprawl and increased emissions. A more cost-effective solution is to improve utilization of capacity in the form of empty seats in private cars.

However, traditional carpooling fails to recognize the increasingly variable working hours of today's commuters. Many workers' schedules are simply incompatible with the fixed commuting schedules required for an established carpool. Fortunately, the advent of location-intelligent consumer technology has enabled a new bottom-up approach that uses-market forces to reduce the vast amounts of wasted seat capacity on the nation's busy roads. By providing a marketplace for drivers to be matched with riders in real time, Avego's iPhone-enabled Shared Transport technology essentially enables people to run their car as a bus, saving money by picking up riders along their route. Avego combines on-demand ride matching with a price incentive in the form of an electronic micropayment to drivers at the end of each journey.

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This approach builds on the bottom-up phenomenon of "slugging" or "casual carpooling" in cities such as Washington, D.C., and San Francisco, California, where cars pull over at dedicated points to pick up riders to be eligible for travel on high-occupancy vehicle lanes. It is a win–win situation for both drivers and riders, tens of thousands of whom use this form of transit without reports of major problems. Until now, this on-demand ride matching has been limited to just a few routes in a few cities. Avego's technology makes this possible for commuters on every road. Commuters add the routes and stops to the network, so the network organically expands throughout a community to areas underserved by public transit.

Avego Shared Transport includes a number of additional benefits. Among them are automated payment transaction management, real-time passenger information, and comprehensive safety features—everything required of a modern, reliable, and sustainable transportation network. Anyone can book a ride online or by using any mobile phone and receive notification as the driver approaches the pickup point. Commuters can define their own preferences in filtering potential ride matches (e.g., by gender, community, social network, nonsmoking). A self-policing, self-correcting user rating system is provided so people can make informed decisions when they are matched with someone. A one-time personal identification number allows drivers to verify a rider's identity on pickup.

The presentation will demonstrate how this Shared Transport technology offers an efficient and cost-effective way of easing traffic congestion, relieving parking problems, and expanding commuting options. Evidence will be presented from Avego's pilot program at University College Cork (UCC), where the technology is being implemented to provide UCC's 19,000 staff and students with a flexible, reliable, and affordable alternative to single-occupancy vehicle commuting to and from the campus. The presentation will also demonstrate how Shared Transport can be integrated with existing public transportation infrastructure, with evidence from the OPTI-TRANS project in Madrid, Spain. There, Avego is working as part of a consortium to develop multimodal traveler information and guiding systems that provide commuters with real-time information about available capacity in public transportation and private cars.

Poster Summary 8

STRATEGY OF ALTERNATIVE FUELS FOR URBAN TRANSIT: PHASE 1

Life-Cycle Assessment of Alternative-Fuel Buses

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The decisions made at the purchasing phase of infrastructure management have long-lasting implications for the sustainability and level of service provided by a transit operator to a community. National ambient air quality standards and U.S. Environmental Protection Agency emissions standards have long required municipalities to reduce local pollutants (e.g., particulate matter), significantly improving the quality of air for many urban residents.

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However, reducing tailpipe emissions does not necessarily correspond to a reduction in greenhouse gas (GHG) emissions or in total pollutants over the life cycle of the vehicle. To plan for transit operation properly, infrastructure and rolling stock costs must be valued in light of their total environmental and economic footprint over the planning horizon. Research addressed the issue of strategic bus fleeting by combining decision-making models with models of life-cycle assessment (LCA) to explore the relationships and trade-offs between the economic and environmental costs of infrastructure decisions over the planning horizon. The first phase of the research is to conduct an LCA of alternative-fuel transit buses. The analysis promotes a life-cycle view of strategic decisions and helps support an understanding of the multidimensional return on investment of various infrastructure and rolling stock options. It will give decision and policy makers the information necessary to maximize the sustainability of transportation infrastructure.

Literature Review

Many researchers have studied the factors and environmental effects of various alternative-fuel technologies in vehicles. Most attention has been focused on the personal automobile, while public transit and other modes have received less attention (Chester and Horvath 2009). In a significant undertaking, MacLean and Lave (2003) provide an evaluation of automobile fuel and propulsion system technologies, including a substantive review of previous LCAs conducted on these technologies.

Within the literature on buses, much of the research has focused on compressed natural gas (CNG) buses. A review of studies of alternative-fuel vehicles by Hesterberg et al. (2009) found that the sources of emissions differences were often attributable to fuel production techniques. A California Energy Commission (2007) report found that the source of the hydrogen fuel had a significant impact on the emissions associated with the bus. A study of fuel cell buses in Perth, Australia, found that when the fuel pathway is included in an LCA, current hydrogen fuel cell (HFC) buses demand more energy than and have values of global warming potential similar to those of diesel buses (Ally and Pryor 2007). However, future HFC vehicles could significantly reduce energy demands and GHG emissions (Colella et al. 2005). These results indicate that the valuation of GHG emissions savings and reduced dependency on fossil fuels will be critical factors in determining the economic viability of hydrogen as a vehicle fuel.

Methodology

In this phase of this two-part research, the life-cycle economic costs and GHGs associated with an urban transit bus, including vehicle manufacture, vehicle operation, the fuel pathway, energy generation, and other supply chain inputs, are examined. Four transit bus technologies are examined: diesel, hybrid-electric diesel, CNG, and HFC.

The data for this project come from a series of demonstration studies on alternative-fuel buses conducted by the National Renewable Energy Laboratory (NREL), a subsidiary of the U.S. Department of Energy. In studies such as that of Chandler and Eudy (2009), NREL pur-

chased and operated commercially available alternative-fuel buses on existing transit routes in urban areas and evaluated the performance of the buses.

A study baseline of 2008, a life span of 15 years, and an average mileage of 26,000 miles per year per bus were used to conduct an LCA of each of the four types of transit bus. Emissions from the manufacturing phase were calculated by using economic input–output LCA (Carnegie Mellon University Green Design Institute 2008) (http://www.eiolca.net). Data on emissions from the operating phase and fuel pathway were gathered from NREL, the California Energy Commission, and other sources.

Results

- All of the alternative-fuel transit buses (hybrid, CNG, HFC) offer a savings of GHG emissions compared with a diesel bus. The marginal costs of these savings varied from $180 to $10,000 per metric ton, depending on factors such as the cost of fossil fuel and the lifetime mileage of the bus.
- GHG savings from the HFC were highly dependent on whether the hydrogen was produced by using fossil fuel or renewable energy sources. In the former case, HFC buses had higher levels of lifetime GHG emissions than did diesel buses.
- Fuel-dispensing and storage infrastructure for CNG and HFC buses require significant capital investment by transit operators, which would make a gradual shift away from diesel buses economically impractical. With a fleet of 50 buses, the per bus infrastructure investment can raise the cost of each bus by 33 percent.
- Alternative-fuel vehicles often have level-of-service characteristics (e.g., capacity, speed, maintenance time) different from those of diesel buses. When they are measured on a per passenger basis, alternative-fuel vehicles may produce more GHG emissions than do their diesel counterparts in some markets.

Conclusions

Switching to alternative-fuel buses, especially HFC buses where the fuel is produced by using renewable resources, can result in significant savings in lifetime GHG emissions. At a projected future price, HFC buses have the lowest marginal cost in terms of dollars per GHG unit saved. However, this is highly dependent on the ability to produce hydrogen cheaply from non–fossil fuel sources. At current prices, CNG and hybrid buses are much more accessible for struggling transit operators, and such buses still contribute some GHG savings.

Technological development in fuel cell technology will continue to increase the options available to transit operators, and further emphasis on GHG reduction will increase the motivation for transit operators to decrease their carbon footprint. To reach the goal of sustainable transportation infrastructure, the complex relationships between social, environmental, and economic factors in strategic transit fleeting decisions need continued examination.

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Poster Summary 9

UNDERSTANDING THE IMPACT OF DIFFERENT (AND NEW) HOUSING CHOICES ON OLDER ADULTS' MOBILITY IN THE COMMUNITY

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A transportation system that enhances residents' mobility is an essential component of a livable community. Different residents may use different modes, but the ideal transportation system can meet the needs of a variety of users—for example, those of various ages and incomes and those who may face barriers to mobility. As the population ages and physical or medical issues that make driving more difficult or impossible for some increase, the role of transportation in sustaining livable communities is becoming more central.

In 2010 the U.S. census estimated that 13.0 percent of the population is age 65 or older; the projection is that by 2030 nearly one-fifth of the population will be age 65 or older. Aging, along with the rapid growth of the older adult population, presents new challenges to society; the population of older adults living today is unprecedented. While the challenges an aging population presents are varied, a substantial body of research has been devoted to examining the impact of aging on mobility (e.g., Dobbs 2008; Rosenbloom 2001) and to the hurdles, including geographic isolation, that many older adults face should they not be able to drive (e.g., Bailey 2004). Other work has documented the negative health impacts of reduced driving and mobility among older adults (e.g., Marottoli et al. 2000). As a result, transportation and mobility are identified as key features of some indicators of quality of life (e.g., Spinney et al. 2009).

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Much of the previous research on transportation options for older adults has taken the form of surveys or case studies of transportation programs. Less work has proceeded from the perspective of how the housing choices of older adults, in concert with any restrictions on their mobility, may affect their mobility and ability to live independently in the community. The authors argue that considering different models for older adults' housing choices, rather than looking community by community, is a better approach to thinking about transportation solutions and to enhancing the livability of communities for older adults. This paper examines how emerging models of housing communities for older adults and the residents of these communities lead to different combinations of accessibility, availability of activities, and density—key components of transportation livability within a community.

The standard housing choices for older adults have been to age in place in the community (a choice endorsed by 79 percent of older adults today as well); to move to a retirement community and to live independently; to move in with family members and to live in their community; or, when necessary, to move to a nursing home or other care facility. These options still exist for older adults, but they have been joined by new models, notably active adult/lifestyle or 55+ communities, continuing care retirement communities (CCRCs) that provide support for older adults ranging from none to little to around-the-clock nursing care, and aging in the community with the support of a formal neighborhood association (a "village").

This work examines each of the housing models for older adults and the transportation options that promote or erode a community's livability. A variety of sources of data were used. Transportation availability for active adult/lifestyle communities and CCRCs within the metropolitan Boston, Massachusetts, area was examined; CCRCs were interviewed to determine what kinds of transportation services they provide residents; and village members, like those from Beacon Hill Village in Boston and Supporting Active Independent Lives in Madison, Wisconsin, were interviewed to understand the transportation offerings and challenges they face. The work reviews other services available at the community level, including paratransit services, private offerings such as ITNAmerica, and other public–private partnerships.

This paper will result in a residentially or housing community–centered approach to thinking about transit solutions to enhance mobility and livable communities for older adults. By focusing on the models of housing choices older adults make, communities may discover other means of providing transportation services to improve the quality of life for their older residents and the livability of the community for all.

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Poster Summary 10

IMPLEMENTATION OF ACTIVE LIVING POLICIES BY LAND USE AND TRANSPORTATION AGENCIES

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The extent to which a community has a system of accessible, well-designed, and well-maintained sidewalks and bicycle routes; safe means to cross busy roads; paths; convenient and dependable public transit; and walking or bicycling distance between homes, workplaces, schools, and other common destinations defines the extent to which there are alternatives to the sole reliance on a car for everyday mobility. The built environment is the result of dynamics of land development involving builders, investors, consumers, and local government policies, such as zoning and land use planning. In addition, transportation infrastructure, and therefore transportation agencies, play a major part in this system.

The overall aim of this research was to examine why public agencies adopt actions that support walking and bicycling (active living). Understanding why can then be used to promote reformation of planning and policy processes. The following were among the specific research questions:

1. What actions (e.g., policies, plans, standards, programs, funding) can land use and transportation agencies take to support active living?
2. Which agencies have taken these actions?
3. Why have these agencies supported active living? What factors influence adoption?
4. To what extent are health and active living a motivation for these actions?
5. Why are more agencies not adopting such actions?

Methodology

For the land use side of the question, the adoption and implementation of mixed-use and related zoning provisions among U.S. cities and counties were examined. Planning directors from 53 "best practice" and 145 randomly selected midsized communities were surveyed. For the transportation side of the question, all 50 state departments of transportation (DOTs) were inventoried. The focus was on statewide transportation plans, along with pedestrian and bicycle plans or guidance documents. The regional transportation plans for 100 randomly selected metropolitan planning organizations (MPOs) were also inventoried.

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Findings

The surveys of planning directors found a relatively high rate of adoption of innovative land use, parking, and urban design policies that support walking and bicycling. Top concerns motivating adoption included avoiding bad development and promoting economic development, followed by livability, creating dynamic centers, and community revitalization. A number of factors were positively related to increasing levels of innovation such as livability, conservation of natural resources, and traffic congestion. It appears that policy innovations framed with respect to these factors will gain more momentum; a follow-up study could test this hypothesis.

The study demonstrated the importance of the jurisdiction's master plan in influencing the adoption of innovative policies. State land use legislation was considered to be far less important. Higher levels of innovation were associated with regional and state transportation plans. Lack of planning staff time and opposition from residents are the top reasons (65 percent) for not adopting policy innovations. This is followed by opposition from the business community (57 percent) and lack of leadership from elected officials (52 percent). The basis of opposition to innovative policies is what would be expected and includes a variety of concerns with regard to density, perceived incompatibility in land uses, challenges to single-family residential norms, traffic congestion, and parking demands, all of which were noted by two-thirds or more of the respondents.

Analysis of adopted DOT planning documents shows that more than two-thirds of state DOTs support, or at least mention, the following elements of planning for active living: retrofitting streets with pedestrian and bicycle accommodations, pedestrian- and transit-friendly site designs, crosswalks, bicycle lanes, multiuse trails and paths, and traffic calming. In contrast, fewer than one-third of DOTs explicitly support increasing density and mixed-use development, road diets and narrow or "skinny" streets, and rail transit for everyday travel. DOT innovation appears to be highly related to regional differences and the existence of a state land use agency. It is correlated (positively) with the degree of urbanization and (negatively) with the amount of roads in the state.

Similarly, MPO plans showed the highest levels of support (through funding or encouragement with financial incentives) for infrastructure such as sidewalks, trails, bicycle lanes and paths, bicycle parking, Americans with Disabilities Act requirements, and access management strategies. A majority of MPO plans did not include provisions for road diets or complete streets or for the use of innovative designs, street trees, or pricing of parking. MPOs with larger populations, densities, and geographic coverage showed significantly greater support for active living in their plans. MPOs with residents having higher incomes; proportionately more advanced degrees; and commuters who walk, bicycle, or use transit also showed greater innovation.

Poster Summary 11

URBAN DESIGN STRATEGIES FOR INTEGRATING SAFETY AND LIVABILITY

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A great deal of scholarly attention has been given to the effects of geometric design on crash incidence, particularly in rural environments. However, comparatively little research has been done to understand how the design and configuration of communities may influence the incidence of traffic-related crashes, injuries, and deaths, and none has examined how community design can be applied to integrate safety and livability concerns. This is particularly surprising since many of the design features that characterize contemporary community design, such as the functional classification of roadways, the disconnection of local street networks, and the separation of residential and retail uses, all emerged as strategies to enhance traffic safety.

This presentation gives the results of a recent study sponsored by the Southwest University Transportation Center examining the relationship between community design and traffic safety. It briefly recounts the traffic safety assumptions that led to contemporary design practice and then examines these assumptions by using a geographic information system–based database of crash incidence and urban form developed for the city of San Antonio, Texas. Through the use of negative binomial regression models, it finds that community design is strongly associated with variations in crash incidence. Arterial thoroughfares, strip commercial uses, and big box stores were associated with significant increases in total, injurious, and fatal crashes. Higher-density communities with pedestrian-scaled retail uses reported significantly fewer crashes and injuries.

These findings suggest that safety and livability are compatible design objectives. Indeed, many of the design features currently promoted to enhance livability, such as pedestrian-scaled retail uses and a departure from functionally designed street networks, may be useful as ways to reduce crash incidence. It further suggests that many urban traffic safety problems may be addressed—at little or no cost to the public—through the safety-conscious administration of local land use codes. The presentation concludes by outlining three strategies for doing so. Specifically, it calls for land development codes that manage the tension between speed and access on urban streets, that reorient access-related commercial and retail uses to lower-speed thoroughfares, and that adopt a network-level perspective on land use and speed management. In so doing, communities that are simultaneously safe and livable can be designed.

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Poster Summary 12

MULTIMODAL CORRIDORS

Making Transit and Nonmotorized Modes Work in Highway Corridors

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Successful and balanced multimodal systems are important components of livable communities. Transit Cooperative Research Program (TCRP) Project H-36, Reinventing the Interstate: A "New Paradigm" for Multimodal Transportation Facilities, studied and identified the transportation facility and land use combinations that lead to successful multimodal freeway corridors—corridors that serve and are served by balanced transit, freeway, and nonmotorized systems. A combination of case study and statistical analysis was used to compare the performance and designs of various multimodal freeway corridors.

Previously, little was known about the facility design characteristics and land use conditions that favor multimodal systems built within freeway corridors. Many U.S. cities have built multimodal freeway corridors—freeways and high-capacity transit lines running parallel in the same travel corridors. Until now, the benefits of these projects were largely seen in terms of cost: transit infrastructure built by using spare freeway rights-of-way can be a cost-effective alternative to assembling a right-of-way from scratch.

But multimodal configurations built on previous models of multimodal freeway corridor development—the so-called "old paradigm"—have yielded mixed results. Transit tends to generate the highest ridership in dense, pedestrian-oriented, mixed-use environments, while freeways encourage low-density, automobile-oriented development that discourages pedestrian and transit activities. Many multimodal systems built in freeway corridors were designed with transit stations that optimize automobile access and circulation, often leaving transit, pedestrian, and bicycle access to stations—important components of a livable environment—as an afterthought.

On the basis of the findings of this research, a typology was developed that describes successful multimodal systems and their surrounding corridors. The typology was applied to survey freeway corridors around the United States to identify locations where "new paradigm" facilities are feasible. This typology represents the foundation for a proposed new paradigm for planning, designing, building, and operating multimodal freeway corridors.

New paradigm transit facilities are built with the following goals:

- Enhancing corridor capacity and performance without adding freeway capacity by building and operating transit lines in existing freeway corridors,
- Building transit systems that attract high ridership levels and encourage corridor livability, and
- Transforming a corridor's land uses and activities to a more transit-oriented pattern.

These goals are achieved through encouraging "market segmentation" between transit and freeway. Market segmentation is achieved with the following principles and techniques:

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- Market-segmented transit and freeway designs (multimodal coordination): Station and interchange spacings along each facility are designed to give each mode an advantage either in long-haul or short-haul corridor trips. By dividing the travel market within the corridor, each mode has the opportunity to thrive and potentially increase the total carrying capacity of the corridor.
- Market-segmented urban form: The development of separated, distinct land use and urban design environments for each mode. Transit station areas should have high-density, mixed-use, pedestrian-oriented land uses and urban design characteristics. Freeway interchange locations should have lower-density, separated uses with street designs conducive to smooth traffic operations and freeway access.
- Market-specific station access: Corridors that focus on providing freeway-competitive transit speeds should prioritize automobile and bus access to their stations. Corridors that focus on maximizing transit line access to corridor land uses should encourage bicycle, pedestrian, and bus access to stations; discourage automobile access; and place stations as far from freeway interchange ramps as possible to reduce conflicts between automobiles and nonautomobile uses.
- Market segmentation through constrained freeway capacity: Putting a low ceiling on the carrying capacity of the freeway can give the transit line an operational advantage, particularly for long-haul corridor trips.
- Coordinated and distinct intermodal operations: The new paradigm incorporates two approaches to maximize interoperability between transit line, freeway, and other modes.
    1. Intermodal connections limited to key locations: The new paradigm encourages intermodal transfer stations to be built at end-of-the-line (terminal) locations and key midline locations where existing bus lines, freeway facilities, and bicycle and pedestrian routes converge, effectively dividing the corridor into separated travel submarkets.
    2. Intermodal intelligent transportation systems: Intermodal transfers between free way and transit can be facilitated and encouraged by using real-time traveler information systems that provide information on corridor traffic conditions (congestion and incidents), transit schedule and schedule adherence, comparative corridor travel times (freeway versus transit), and station and destination parking availability and costs.

This presentation focuses on an overview of the TCRP H-36 research project and the new paradigm, case study multimodal freeway corridors, and the policy implications of the new paradigm.

Poster Summary 13

RATING URBAN STREETS FOR PEDESTRIAN FACILITIES ON THE BASIS OF USERS' PERCEPTION

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The Complete Streets Act of 2009 requires that all road users, including motorists, transit users, pedestrians, and bicyclists, be accommodated and allowed to use the roadways. To fulfill that requirement, the roadway factors influencing the quality of service provided to each user must be identified. This paper presents the results of a research study conducted to predict level of service (LOS) ratings for urban streets for the pedestrian facilities on the basis of users' perception of the quality of service. The data used in this study were collected for the National Cooperative Highway Research Program (NCHRP) 3-70 research study. The data for the pedestrian mode were gathered by using video simulation techniques from Tampa, Florida, and San Francisco, California. Ten video clips were shown to 145 participants of both sexes and of various ages at four locations: Oakland, California; Chicago, Illinois; New Haven, Connecticut; and College Station, Texas. The participants were asked to rate the clips for the pedestrian facilities on a scale of 1 to 6, with 6 being equal to LOS A and 1 being equal to LOS F.

The pedestrian LOS rating model presented in NCHRP 3-70 is a function of a range of roadway geometry and operational variables. The objective of this research was to provide the transportation and traffic engineering community with a simple but effective tool to rate urban streets for pedestrian facilities on the basis of users' perception of the quality of service. The methodology for developing the tool was as follows:

- By using the graphical analysis technique, visualize variation in the data set of the dependent variable (i.e., LOS ratings) with respect to each independent variable (i.e., roadway geometry and operational data). On the basis of the results of this analysis, categorize the roadway variables so that the maximum variation in the LOS rating with respect to these variables is obtained. For example, on the basis of the results of a box plot, sidewalk width data were compressed into two categories: less than or equal to 5 feet and greater than 5 feet.
- Conduct correlation analysis to select the roadway geometry and operational variables that significantly influence the LOS ratings.
- Classify urban streets on the basis of the LOS ratings as a function of the selected roadway variables.

The results of the correlation analysis indicated that sidewalk width, number of traffic lanes, presence or absence of barriers between the pedestrians and the roadway traffic, and the same directional traffic volume were the significant variables influencing the comfort level of the pedestrian. The correlation analysis showed that on urban streets with sidewalks wider than 5 feet and barriers between the pedestrian and vehicular traffic, pedestrians have a higher level of comfort. In contrast, higher numbers of traffic lanes and heavier traffic

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volumes impede the safe movement of the pedestrians. The data showed a significant decrease in the pedestrian ratings for quality of service for number of through lanes greater than two and traffic volume greater than 1,500 vehicles per hour.

For urban street classification, the study used the regression tree modeling technique. A regression tree model is a flowchartlike structure. Each branch represents an outcome, and each leaf represents a decision. The advantages of using a regression tree rather than other regression techniques are that a regression tree captures nonlinear effects, allows complex interaction between variables, and is easier to interpret. The significant explanatory variables influencing LOS—sidewalk width, number of traffic lanes, and traffic volume—were used to build a regression tree model for urban street ratings. Since the results of the correlation analysis between the independent variables indicated sidewalk width and barrier to be highly correlated, the variable barrier was excluded from the model to avoid multicollinearity effects between the variables.

The regression tree model selected sidewalk width to be the root node, indicating sidewalk width to be the variable explaining the most variation in the LOS rating data set. The data set with sidewalk width less than 5 feet was further partitioned on the basis of the number of traffic lanes and traffic volume. The tree model rated urban streets with sidewalk width less than or equal to 5 feet and with one traffic lane as B. For urban streets with sidewalk width less than or equal to 5 feet and traffic volume less than or equal to 1,500 vehicles per hour, streets with two lanes were classified as C and streets with three lanes were classified as D. For urban streets with sidewalk width less than or equal to 5 feet and traffic volume greater than 1,500 vehicles per hour, streets with two lanes were classified as D and streets with three lanes were classified as E. Urban streets with sidewalk width sidewalk greater than 5 feet were classified as B or C.

Poster Summary 14

MULTIOBJECTIVE OPTIMIZATION MODEL FOR URBAN STREET DESIGN

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For decades, transportation legislation has demonstrated the desire to plan, design, and operate multimodal surface transportation systems. The encouragement of multimodal operations stems from several concerns including environmental impacts, natural resource scarcity, rising fuel costs and dependency on foreign oil, and the declining health of Americans due to their reliance on personal automobile travel. However, the methods used by engineers and planners in designing such facilities are lacking in their ability to reflect travelers' perceptions of service by mode, which is needed for the successful design of multimodal transportation systems. In addition, design guidance does not include methods by which engineers and planners can weigh the range of alternative designs to optimize the design of streets to accommodate all modal travelers comfortably.

The purpose of this study was to develop a multiobjective optimization model to support the design of complete streets and to identify optimal urban street designs that achieve a predefined level of service (LOS) rating for travelers on an urban arterial, including automobile,

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pedestrian, and bicycle modal users, while meeting geometric design standards. To achieve this goal, existing cumulative logit LOS models were used for the automobile, pedestrian, and bicycle modes that incorporate travelers' perceptions of LOS and provide a distribution of perceived LOS to assist decision makers.

The objective function and the constraints for the multiobjective optimization model were developed by using the existing cumulative logit models for the automobile, pedestrian, and bicycle modes. The variables used in the model were found to be significantly correlated to travelers' perception of LOS, including the following: space mean speed and median presence for the automobile mode; number of traffic lanes and sidewalk width for the pedestrian mode; and number of traffic lanes, bicycle–shoulder width, and posted speed limit for the bicycle mode.

The objective of the optimization model was to design an urban street so as to minimize LOS D or worse (E or F) provided to automobile, pedestrian, and bicycle modes on urban streets for a set of constraints. Conversely, the objective was to optimize the urban street design so as to maximize LOS to D or better provided to automobile, pedestrian, and bicycle modes. Thus, the set of optimized geometric variables obtained for an urban street design will accommodate all modes simultaneously with the user perception taken into account.

The sets of constraints in the model were based on the levels of satisfaction of the users of automobile, pedestrian, and bicycle modes, which can conflict with each other. For example, automobile drivers perceive a higher level of satisfaction when the average travel speed is higher than or equivalent to the posted speed limit and the roadway has multiple lanes. In contrast, pedestrians and bicyclists perceive a higher level of satisfaction when their facilities adjoin streets with low traffic speed and fewer traffic lanes.

The main constraint of the optimization model was as follows:

- Optimized right-of-way (ROW) = given ROW.
- Optimized ROW = median width + (no. of traffic lanes × traffic lane width + sidewalk width + grass strip + bicycle lane width) × 2.

The ROW constraint was developed to reflect the state of the practice and standards established by governing bodies such as the American Association of State Highway and Transportation Officials. In addition, a set of new decision variables and a set of nondecision variables were added to aid the design of a complete street and livable community.

The sensitivity analysis using the multiobjective optimization model was conducted for the following scenarios:

- For a given ROW width, obtain the optimal number of traffic lanes with optimized lane width, median width, sidewalk width, and bicycle lane width.
- For a given ROW width and a given number of lanes, obtain optimal lane width, median width, sidewalk width, and bicycle lane width.

For example, for a 100-foot ROW width and three traffic lanes in each direction, the model provided the following for each side of the road: optimal lane width for the traffic lanes, 12 feet; sidewalk width, 9 feet; and bicycle lane width, 5 feet. The model did not provide a median in this case.

Poster Summary 15

PEDESTRIAN AND BICYCLING SURVEY APPROACH

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Many communities are interested in promoting walking and cycling. However, few communities know how much of such nonmotorized travel actually occurs in their communities. Existing data sources have limitations, such as the following:

- National-level surveys typically measure only one kind of travel, such as commuting, or do not provide data for small areas.
- Regional travel surveys occur infrequently and may record few walking and cycling trips.
- Local-level surveys vary greatly from place to place in terms of quality.

This poster reports on the development and reliability testing of the Pedestrian and Bicycling Survey (PABS), a new survey to assess local walking and cycling behavior suitable for use by local governments. PABS was designed to be economical and simple for a local jurisdiction to administer by using a random (cluster) sampling approach, with surveys either mailed or mailed with an Internet option for response.

PABS allows communities to answer questions such as the following:

- How much walking and cycling are occurring in my community?
- What is the purpose of walking and cycling trips?
- Who is completing the bulk of the walking and cycling trips?
- How often are people walking and cycling?

Methods: Reliability Testing and Sampling Pilot

The four-page mail-out–mail-back questionnaire was tested to determine whether the questions produced similar answers when people took the same survey multiple times (this check for reliability across administrations is called "test–retest reliability"). Did people answer the same questions in a similar way when those questions dealt with stable or habitual behavior?

An early version was tested with 100 people; the final version was tested with 87.

With the exception of some surveys focused on physical activity from a health perspective, this is the first survey that the authors know of to report reliability data for a survey focused on walking and cycling. PABS therefore provides an important baseline for improving travel behavior.

In addition, the random sampling strategy (a two-stage cluster sample) was tested in San Jose, California, by using readily available mailing lists.

To make it easy for local governments to implement the survey, the team developed an implementation manual, which is available at http://www.designforhealth.net/health/PABS.html.

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Findings: The Survey and Sampling Worked, But Good Recruitment Is Essential

The San Jose field test showed the following:

- Most survey questions achieved adequate to excellent reliability.
- The PABS questionnaire was able to measure walking and cycling modes well. It detected more active travel than did the American Community Survey, which is often used as a metric of walking and cycling.
- The survey can be effectively administered and analyzed without considerable resources.
  - While the amount and type of personnel required will vary by location, the San Jose pilot was administered and analyzed by a local coordinator, a local research assistant, a collection of volunteers to address and mail, a research assistant to enter the data, and a research assistant to analyze the data. (The research assistants each worked, on average, 100 or so hours on their respective tasks.)
  - The two-stage cluster sampling approach was cost-effective in a large city. In a smaller city, a simple random sample might be as appropriate and would avoid the problem of missing areas.
- A good strategy for increasing recruitment is essential. Achieving high response rates for any type of survey with the general public is always a challenge. As is outlined in the accompanying manual, a number of simple strategies can help increase response rates. One approach is to raise awareness of the survey.

Poster Summary 16

ITNAmerica

Network Connectivity Through Social Enterprise and Information Technology

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ITNAmerica

ITNAmerica is the first national, nonprofit transportation system for America's aging population. Founded in 1995 in Portland, Maine, as the model Independent Transportation Network (ITN), ITNAmerica became a national organization in 2004. Research and development of the economically sustainable ITN model was funded by the Transit Innovations Deserving Exploratory Analysis program, the Federal Transit Administration, AARP, and numerous private philanthropies. In 2005, the Atlantic Philanthropies funded the national rollout with a $3.5 million grant. ITNAmerica now has 16 affiliates in 12 states, with a total of more than 1,500 dues-paying members.

Methodology

Most older Americans depend on the automobile for transportation. This dependence poses serious safety and mobility problems for older drivers of diminished capacity, who rely on

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private automobiles for access to the necessities of life. The problem is compounded by where older people choose to live. More than two-thirds of seniors live in rural or suburban communities that lack the density for traditional mass transit. Older people who stop driving become dependent on favors from family and friends for as long as a decade. Women who stop driving outlive their decision by 10 years; men by 6. Those who continue to drive face limited mobility and the highest fatal crash rate per mile driven of any group except teenagers.

ITNAmerica's solution to this growing national problem was to create a consumer-oriented, economically sustainable model in a defined geographic area; replicate the model in other defined communities; and connect communities (affiliates) into one efficient national system with a shared brand and business rules and a unified database and sophisticated information system, ITNRides, that is now a Microsoft Success Story (http://www.microsoft.com/business/success/?StoryID=290). ITN maximizes individual choice and recreates the comfort and convenience of private vehicle ownership by using automobiles to provide service 24/7, for any purpose. People who use the service become dues-paying members of the organization and open Personal Transportation Accounts to pay for rides. ITN keeps fares reasonable by charging roughly half the true cost of rides and covering the balance through a diversified base of voluntary local community support. Through innovative payment plans automated in ITNRides, ITN integrates previously inaccessible private resources to help fund rides, storing resources in Personal Transportation Accounts and sending members monthly account statements. No money changes hands in the vehicles; transfers and charges are processed automatically in the database. ITN's CarTrade program helps seniors trade their vehicles to pay for their rides; the Transportation Social Security program gives volunteers transportation credits in the system when they drive others; and the Road Scholarship program encourages volunteers to donate these credits for low-income riders who cannot afford their share of the fare. Sustainability is supported by efficient dispatching of volunteer and paid drivers through use of the geographic information system in ITNRides.

Findings

Research findings from a Centers for Disease Control and Prevention study demonstrate that ITN is used to transport older nondrivers and younger visually impaired adults for a wide variety of purposes. Among 1,557 ITN members who used the service between January 2004 and December 2008 (mean age 79.6 years; age range 22 to 104; 58,736 rides originating at home), 83 percent took at least one ride for health care purposes, accounting for 46 percent of total rides. Members also used ITN for a full range of ride purposes, including consumer activities, social and recreational travel, trips for worship, intermodal connections, education, employment, and professional services. One-third of rides during the 5-year study period were provided to members with visual impairment.

An Atlantic Philanthropies–funded evaluation conducted from May 2007 through June 2010 measured the impact of ITN on the quality of life for three groups: ITN customers, family members of ITN customers, and ITN volunteer drivers. The study included customers and family members from five ITN affiliate communities: Charleston, South Carolina; Lexington, Kentucky; Los Angeles, California; Orlando, Florida; and Portland, Maine. The sample

of volunteers provided rides in those communities as well as in three others: Middletown, Connecticut; East Windsor, Connecticut; and San Diego, California. Results of the evaluation study provide empirical evidence of the positive impact of ITN on quality of life for these groups.

For ITN customers, transportation difficulty decreased from 64 percent before ITN membership to 49 percent 6 months later and 43 percent 1 year later. ITN customers who reduced or stopped driving reported an increase in confidence in arranging personal transportation. Furthermore, nondrivers increased to the level of drivers in confidence in arranging personal transportation (mean scores were 50.1 versus 60.3 before ITN membership, 68.0 versus 67.9 after 6 months of membership, and 70.2 versus 69.4 after 1 year).

Family members of ITN customers worry much less about their relatives' transportation adequacy and safety after their relative joins ITN. Before ITN membership, 65 percent of family members worried whether their relative had adequate transportation; 6 months after their relative joined ITN, the proportion dropped to 19 percent. The percentage of family members who worried about their relatives' safety when they traveled from home decreased from 70 to 39 percent. They experience less emotional stress (mean scores decreased from 2.8 to 2.3) and are less likely to miss work. The percentage of family members who said they had to miss work because they had to arrange or provide transportation decreased from 64 to 27 percent.

ITN volunteer drivers derive personal and social benefits from this role. More than two-thirds said that volunteering for ITN has affected their quality of life, and 36 percent said that volunteering for ITN has enriched their social lives. Significant minorities are storing ride credits in an ITN account for their own future transportation needs (39 percent) and are donating their credits to the Road Scholarship Fund for low-income riders (38 percent).

ITNAmerica's entrepreneurial approach has affected public policy in several states, including Maine, Florida, New York, Connecticut, and Kentucky. A 50-state analysis of policies that remove barriers or create incentives for the use of private resources for community mobility is under way by ITNAmerica. Other research and development projects include ITNEverywhere: A Revolutionary Approach to Community Mobility, a suite of software programs that extend ITN's core business innovations—Personal Transportation Accounts and a flexible approach to private resources—to the general population, and a business plan for ITNCanada.

Poster Summary 17

EFFECTIVENESS OF TRAFFIC CALMING FOR SPEED MANAGEMENT IN SMALL RURAL COMMUNITIES TO ENHANCE SAFETY AND QUALITY OF LIFE

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Main streets in small communities function much like main streets in any community with pedestrian activity and bicycles. Much of the pedestrian traffic is often children crossing to community activities such as schools, recreation centers, or playgrounds. However, the main

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street through many small, rural communities in the United States is often a high-speed state or county highway outside the community. Highways and county roads are characterized by high speeds outside the city limits and transition to a reduced-speed section through the rural community. Consequently, drivers passing through the community may enter at high speeds and then maintain those speeds throughout.

The combination of community activities and high-speed through traffic poses a safety problem. At higher speeds drivers are able to process less in their field of view and have less time to react, and more severe injuries or fatalities occur when a pedestrian or bicyclist is struck at higher speeds. The likelihood of a pedestrian dying in a rural collision is more than twice that of a pedestrian struck in an urban area. High speeds also diminish the quality of life in small communities.

A project conducted by the Center for Transportation Research and Education at Iowa State University evaluated seven traffic-calming treatments on the major road through five small rural Iowa communities. The research evaluated the use of two gateway treatments in Union and Roland, Iowa. Five single-measure treatments (speed table, on-pavement "Slow" markings, a driver speed feedback sign, tubular markers, and on-pavement entrance treatments) were evaluated in Gilbert, Slater, and Dexter, Iowa. Speed data were collected before each treatment was placed and at 1-, 3-, 6-, 9-, and 12-month intervals after the treatment was placed.

A gateway treatment in Roland consisted of a set of converging chevrons placed as vehicles entered the community from the east and west. On-pavement speed signing and lane narrowing through shoulder widenings were also used. Results of the speed analysis indicate that the gateway entrance treatments, which consisted of converging chevrons and a "25 MPH" on-street pavement marking, were reasonably effective. Speeds decreased for all speed metrics for all of the after periods, and decreases remained constant over the data collection period. However, the lane narrowing and on-pavement speed markings within the community did not appear to affect speeds in any meaningful manner.

Union was also a gateway treatment community. The treatments for Union included optical speed bars, median and shoulder widening, and driver feedback signs. Entrance treatments consisting of the transverse bars were used at the west, south, and north community entrances. The transverse markings appear to be moderately effective in decreasing vehicle speeds directly downstream of the markings for all three gateways, although none of the differences was large. The lane narrowing using center island widenings did not appear to be effective. The speed feedback signs were very effective.

A single speed table was placed in Gilbert on the main through road. The speed table was successful in decreasing speeds for all speed metrics both immediately upstream and downstream of the speed table for all of the after periods. The table slowed speeds in both directions. The effectiveness of the speed table remained relatively constant over time.

Dexter received an entrance treatment similar to several used in Europe. It consisted of red pavement markings and on-pavement speed signing. The treatments were effective in reducing speeds at all three of the locations where they were tested. The effectiveness varied over time with the exception of one location during the 9-month after period when the markings had faded.

Slater had three areas of concern, so three low-cost treatments were applied. A speed feedback sign was used for a northern section of roadway. Because of late procurement, sign malfunctions, and road construction, the sign was only evaluated for one after period. A western roadway section received on-pavement "Slow" markings. The treatments were not judged to be effective. The final treatment was creation of a center island using tubular channelizers. Two islands were created one block apart. Speeds were significantly reduced with the channelizer islands.

In many cases, even the most effective treatments only reduced mean and 85th percentile speeds by a modest amount. The true effectiveness was their ability to reduce significantly the number of high-end speeders (vehicles traveling over the speed limit by 5, 10, 15, or 20 mph).

The poster describes the treatments and their effectiveness.

Poster Summary 18

PROGRAMS THAT MATCH SENIORS WITH VOLUNTEER DRIVERS

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The senior population is growing as a proportion of the U.S. population. Seniors need adequate transportation, not only to maintain their health and vitality but also to stay active in the community and participate fully in life. The development of livable communities includes providing safe, comfortable, efficient transit service giving access to destinations of interest from one's home with a high frequency of service throughout the day and evening. When communities succeed in providing such transit systems, more and more seniors will be able to continue to meet their transportation needs. A livable community goal should be that as transit service continues to improve in safety, comfort, and convenience, the point at which a senior citizen can no longer ride transit service because of frailty is postponed. This is the point at which volunteer driving programs for seniors provide the needed transportation.

The problem that this research project addresses is the documented general lack of transportation options presently suitable for seniors who are no longer able to drive, and particularly those who are too frail to use public transportation. Volunteer driving programs for seniors attempt to meet this need, but they encounter numerous operational challenges.

Seniors are living longer, and many prefer to age in place. Current seniors and the baby boomer population have generally not planned for their future transportation needs. This study found that volunteer driving programs strive to meet the needs of a particular market of seniors. These seniors generally are on a fixed income, which limits their transportation options. Seniors represent a broad range of physical abilities, and many develop disabilities. While travel generally decreases overall in later years, seniors have travel needs that still may include longer trips across jurisdictions. Many seniors have difficulty navigating the various available transportation options and their associated eligibility, application, and advance reservation requirements to arrange a ride.

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To meet the demand for transportation, many driving programs for seniors have been formed over the past several years, and there are now several hundred such programs nationwide. This poster presentation represents research that complements existing implementation guides by examining the challenges that remain and proposing actions for overcoming these challenges and strengthening programs.

Methodology

The project approach included the development of an expert advisory panel; the identification and description of business models and service configurations through review of the literature and agency annual reports, as well as interviews; a legal analysis of liability; and documentation of operational issues.

Findings

The issues with which volunteer driving programs struggle include a demand for service that is far greater than program capacity. These challenges involve configuring sustainable volunteer driving services within the limitations of scarce resources. While the issues facing volunteer driving programs are varied, the problems that stand out are insufficient numbers of volunteers and the difficulty of programs in obtaining adequate and affordable insurance coverage. Protecting the safety of riders and drivers and properly insuring a program are both fundamental to the success of a volunteer driving program.

Providing quality transportation through volunteer driving programs will require the collaboration of transit agencies, commuter assistance programs, area agencies on aging, the volunteer driving programs, and community leaders. Support at the state and federal levels will further advance volunteer driving programs for seniors. The available evidence suggests that most volunteer driving programs for seniors have excellent safety records. In any case, insurers are influenced by perception of risk, specifically that volunteer drivers may lack training and that riders are an especially vulnerable group. Indeed, seniors are much more likely to sustain serious injuries in an automobile accident than are younger people.

This study examined volunteer driving programs nationwide and identified several main service delivery models and the circumstances under which one model may work better than another. The study provides recommendations to volunteer driving programs for enhancing risk management, recruiting volunteers, and supporting their organizations. The study includes case study write-ups and a legal analysis of risk associated with volunteer driving programs. The study findings propose an agenda for action through institutional and community partnerships to bolster volunteer driving programs and the important transportation services they provide.

Topics for further research include quantification and characterization of the unmet need for transportation by seniors. Previous survey research has shown that after driving cessation, overall travel, including trips taken for medical appointments, decreases. However, less is known about the differences among seniors. It would be useful to know what factors enable

some seniors to maintain higher levels of activity and travel after they stop driving. The use of activity-based travel demand modeling recognizes that demographics, including age, play a large role in determining travel patterns. A better understanding of the travel behavior of seniors before and after they stop driving, including the range in differences among seniors and the factors that determine those differences, would inform the planning of transportation services and facilities. To develop activity-based models, a richer base of region-specific travel survey data could be collected from senior study participants through the use of Global Positioning System–enabled cell phone technology. Another area that would benefit from policy research is the potential conflict between volunteer driving programs and taxicab companies. There is a need to explore and draw an equitable line between the two so that volunteer driving programs, especially those receiving government grant funds, do not infringe on private enterprise, and so that government policies and regulations do not prohibit the operation of volunteer driving programs.

Poster Summary 19

USING OPEN DATA TO DEVELOP MULTIMODAL TRIP PLANNERS FOR LIVABLE COMMUNITIES

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Investments over 60 years to support automobile travel have created a dense network on which it is possible to drive almost anywhere in the United States. Investments in infrastructure for public transportation, bicycling, and walking have been much more limited, resulting in networks for these modes that often are sparse and less well connected. A person considering making a trip by driving can assume the ability to reach the destination by car. A person considering making a trip by bus, bicycle, or foot cannot assume that the mode will connect the intended origin and destination with each other or that it will do so with a reasonably direct route. If the trip is new, it is necessary to check. As accustomed as people have become to using online trip planners to get directions for driving, such tools are even more important for people who use alternative modes.

Transitioning from communities that are based on a single transportation mode to those that provide multiple travel options requires an investment not just in new transportation infrastructure but also in data collection and information systems that can assist residents in being aware of and choosing from new options as they become available. There are significant barriers to providing this information for alternative modes:

- Much transportation infrastructure information is currently embedded in proprietary formats and systems and cannot easily be shared, viewed, updated, or commingled without permission from the agency and vendor and without expert data analysis.
- Many jurisdictions lack geographic data on their networks of sidewalks and bicycle lanes except along major streets (state or county roads for which other agencies collect and maintain data).

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• Many maps of alternative infrastructure are confusing to read and use, especially when there are gaps in the network of facilities; this appears to reflect a diverse set of interests among users.

• There is not yet a uniform data standard for sidewalk, bicycle lanes, transit, or non-network infrastructure (benches, shelters, bicycle parking, crosswalks) that supports use of transit and other modes.

• Even if standards existed for data on these facilities, current methods of collecting, coding, and maintaining data are labor-intensive and expensive.

• Something needs to link all of this together to allow joint consideration of a range of features that affect the feasibility and desirability of using alternative transportation modes and to generate seamless multimodal trip plans (e.g., cycling to a bus stop, parking the bicycle, riding the bus, and walking from the bus to the final destination). Most software that does this is expensive or restricted to use in a single area.

Approach

The approach taken to overcoming these barriers was to work with open sources of data and software:

• OpenStreetMap (OSM) is a "Wikipedia" for geographic information, to which any individual or community can contribute information about local sidewalks, bicycling, transit, and road infrastructure via an easy-to-use mapping website. OSM supports data attributes such as stairs, curb cuts, and sidewalk slope and thus can record data for accessible routes from one location to another for individuals with physical disabilities. It focuses on observable physical attributes, and it is not well designed for recording information on schedules or activity levels.

• The General Transit Feed Specification (GTFS) is an open format for stop, route, and schedule data. More than 125 transit agencies in the United States make their data available through GTFS for public download for use in free services such as Google Transit. It appears to be becoming a de facto standard for data describing transit stops, schedules, and route geometry.

• Public domain data sets vary in spatial and substantive coverage. They end at jurisdictional boundaries and often include only facilities for which the jurisdiction has direct responsibility. Some agencies restrict access or require attribution for any use of the data. Nonetheless, in some cases these files can serve as skeletons to which additional data can be added.

• The OpenTripPlanner project has become more capable, more comprehensive, and available much sooner than had been expected. Its developers have demonstrated its ability to work with all of the data sources mentioned above, plus proprietary address or street data to which a municipality may have purchased rights. The objective is to assess how well the data sources above can support next-generation multimodal trip planners.

Preliminary Findings

The ability to move transit stop data from GTFS into OSM, allow the public to correct the stop locations and add data on supporting infrastructure, and then retrieve the changes for use by the transit agency has been demonstrated. Of 3,819 stops loaded into OSM, students and other members of the public have edited 110, with 19 of them being relocated by more than 100 meters. The source code for the software that synchronizes data between GTFS data sets and OSM has been made publicly available under the Apache 2.0 open source license, and the source code has been published on Google Code's project hosting site.

Measures of level of service for walking and cycling require data on traffic volumes that most jurisdictions measure only for major roads, that the average member of the public cannot easily observe, and that OSM was not meant to record. Further research is needed to derive meaningful level-of-service measures that only need easily observable data.

Bicyclists (and would-be bicyclists) have widely differing comfort levels and expectations for information. Additional research on their information needs and on how to display information to make it most useful to them would be helpful.

Some people navigate by following a line on a map. Others, probably more numerous, navigate by following step-by-step instructions. Where infrastructure closely follows streets, directions can use street names and be clear. Additional research is needed on how to provide clear directions when sidewalks and paths do not follow streets.

Some technical knowledge is needed to place public domain data sets into OSM. Once there, however, they can be augmented and corrected by persons with much less technical proficiency.

Research is needed on how to combine objective data (e.g., the presence or absence of a crosswalk) with subjective data (e.g., whether crossing at a location is safe).

Poster Summary 20

ISSUES IN DATA COLLECTION, METHODOLOGY, AND ANALYSIS OF TRANSPORTATION-BASED ECONOMIC DEVELOPMENT

The District of Columbia and the Great Streets Development

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The poster for the paper Issues in Data Collection, Methodology, and Analysis of Transportation-Based Economic Development: The District of Columbia and the Great Streets Development provides selected elements of the analysis and methodology used in conducting the study associated with the paper. Six maps are given in the center detailing key socioeconomic data collected for each Great Street corridor. Data on population, income, poverty, unemployment, vacancy, and owner-occupied unit rates for each census tract included for each street corridor were highlighted.

Beneath the six central maps, the 42 selected data points (out of 150) that were used to analyze each corridor are listed according to thematic category.

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On the left side of the poster a partial abstract is given and the methodology is detailed. In the right column results are discussed, and in the bottom right-hand corner a snapshot profile of 7th Street Northwest–Georgia Avenue Northwest is given.

The goal of the poster is to tell the story of each of the Great Streets visually. It was impossible to include all the information relevant to the study on a single poster. However, what is presented offers a broad understanding of how data were collected, filtered, analyzed, and then used for drawing policy conclusions. The maps illustrate the data and point the viewer toward initial policy ideas, and the method of analysis, applied in the context of the policy goals for the Great Streets development effort, provides the link between a database of numbers and real-world implications.

This poster is based on a study that used an original methodology. The District of Columbia Department of Transportation collected more than 150 data points to provide insight into the economic, social, and transportation impacts of the Great Streets development project. On the basis of the data points, 42 individual performance measurements were selected to allow comparative evaluation of the project in coming years, and initial analysis of the current conditions was conducted. The results indicated the need for taking into account a variety of nontransportation issues to maximize the probability of success in development projects.

The Great Streets development initiative is a targeted regeneration effort for six designated street corridors in the District of Columbia. Among other items, criteria for inclusion as one of the corridors included a history of policy neglect, low relative development levels, and persistent market stagnation in recent decades. Approximately $176 million will be spent in a combination of transportation and infrastructure projects to stimulate the economic development of the areas, with the money divided among the six corridors.

Poster Summary 21

EFFECT OF ROADWAY AND ROADSIDE DESIGN FEATURES ON OBSERVED VEHICLE SPEEDS

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Speeding is one of the major problems confronting traffic safety engineers. According to the National Highway Traffic Safety Administration, about one-third of all fatal crashes in the United States are speed related. However, few North American studies have used vehicular speed observations in comparing the safety of multiple street and highway locations. A number of studies have focused on the effects of speed change on safety at a given location, but these results are not generally transferable to other sites. Most multilocation safety studies have attempted to account for the effect of speed by using the speed limit at each location. This has led to spurious results because of the sometimes arbitrary and political nature of speed limit selection and the fact that the actual speeds chosen by drivers traveling on many roads are often much higher than the speed limit.

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Why are there so many roads where a high proportion of drivers disregard the speed limit? One explanation is that drivers come to conclusions different from those of the applicable legal authorities about what is the "safe and reasonable" level of speed on these roads. In other words, is the design of the road and its environment projecting the right message to the driver? There are many examples of situations where drivers do not perceive school zones, town centers, and primary roads through residential neighborhoods as slow speed areas. It is in this light that the ability to influence vehicle speeds through the selection of the characteristics of the roadway and of the roadside environment could help in improving safety on roadways. The objective of this project was to close gaps in the knowledge about how various components of the road environment and their interaction affect a driver's chosen speed and how drivers' speeds relate to the observed crash experience.

Methodological Approach

Closing these gaps requires better information about travel speeds on roads with different design geometries and roadside environments along with the crash experience on these roads. Crash counts and actual speeds were compared on roads with similar geometric characteristics and roadside environments, and the observed traffic volumes were controlled for. Combinations of characteristics and environments that are commonly found in Connecticut were investigated, as well as some that may be less common but that offer opportunities for isolating the effects of particular elements. An important secondary objective of the research was to identify characteristics that affect driver speed or crash incidence but not the other elements.

Data were collected from two-lane road sections in rural and suburban areas, and generalized linear modeling techniques were used to analyze the following (geographic area and traffic volume were controlled for): (*a*) variance in observed travel speeds by geometric and roadside features and (*b*) variance in crash count by observed travel speeds and geometric and roadside features.

Summary of Findings

The findings clearly demonstrate that the running speed of traffic on a road can be influenced through careful selection of roadway and roadside design elements. Drivers appear to take cues from elements of the roadway and roadside environment to decide how fast to drive, and these cues are independent of the posted speed limit and other considerations that might be important to the community for reducing speeds. The good news is that drivers' choice of speed can be influenced through design of roadway and roadside elements; the bad news is that many roads cue drivers to travel much faster than the posted speed limit and faster than the community would like.

The factors associated with higher average running speeds are wide shoulders, large building setbacks, and a residential location. The factors associated with lower average running speeds are on-street parking, sidewalks, and a downtown or commercial location. These findings suggest the following recommendations for designing roads with respect to desired vehicle speeds:

1. Wide shoulders should only be used on roads intended for high-speed through traffic, such as interurban roads in open land. Wide shoulders should be avoided in town and village centers or other areas where high-speed traffic would be considered disruptive to the community.
2. Sidewalks and on-street parking should be considered wherever there is potential street activity, such as in the vicinity of public institutions and collections of shops and homes.

By following these guidelines, the road and roadside characteristics can be used to help enforce the desired vehicle running speed.

Poster Summary 22

CAST WALKABILITY AUDITS

A Citizen-Powered Neighborhood Assessment of Walking and Bicycling Safety

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National surveys have shown serious increases in overweight among children and adolescents. Childhood obesity has become an increasing public health concern given its relation to multiple health and psychological problems (e.g., cardiovascular disease, Type 2 diabetes, stress, and low self-esteem). To address these problems, major public health efforts focus on two areas thought to reduce the prevalence of obesity in children: nutrition and physical activity. While schools are often cited as the environment most capable of addressing obesity and related public health concerns, community environments are increasingly seen as a primary influence on childhood obesity—environments that are outside the control of schools.

National programs such as Safe Routes to School seek to ameliorate obstacles that limit connections between schools and neighborhoods, with the secondary benefit of increasing child activity via walking and bicycling to school. For these efforts to succeed, community infrastructure must permit children safe walking and bicycling between home and school. Indeed, street redesign is emerging as a strategy for public health interventions that increase active transportation choices. Building awareness and a local knowledge base is an essential first step in bridging the divide between built environments as they stand today and the behavior of new generations of pedestrian and bicycling citizens willing and capable of new active transport lifestyles.

This presentation describes a large citizen mapping effort conducted to address these issues.

Community-Less Streetscape Assessments

In partnership with the Communities and Schools Together (CAST) Project at Oregon Research Institute—a National Institutes of Health–funded obesity prevention grant in Eugene, Oregon—parents of elementary school children assessed the safety and accessibility of the

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built environments surrounding their schools. The following were the goals of the street audits: (*a*) develop community and family awareness of street barriers for child walking and bicycling, (*b*) highlight opportunities for active child transport to and from schools, (*c*) develop and mobilize knowledgeable community members in the nomenclature of built environments, (*d*) create a community-based data set and public assessment process for eventual use by city planners, and (*e*) develop community readiness for Safe Routes to School encouragement and enforcement grant applications.

The assessment involved an audit of the streets and intersections in the Bethel School District on factors related to safe walking and bicycling conditions for children. The assessment drew from two community-based mapping tools (SEAT and CSAT) that were developed at the University of Oregon and that have been tested in other communities. The street assessment relied on participant use of handheld computers running geographic information systems (GIS) software. The data were then uploaded to servers and mapped to the city grid, a process previously described across a series of national conferences. Multiple series of walking and bicycling assessment events were scheduled among each of the seven district elementary schools from April to October 2009. Members of the CAST Parent Advisory Council (PAC) were trained during the initial pilot assessment in April and were subsequently assigned to pairs or small groups of new parents at each of the elementary school neighborhood audits—a "train-the-trainer" approach that became termed the "PAC-plus model." The seven school attendance areas were mapped into zones that parents selected to walk and score on safety ratings for street segments and intersections. Assessments were conducted over a 3-hour period during weekday or Saturday mornings. Food, child care, and a family stipend for parent participants were provided at all school neighborhood assessment sessions.

Results

The complete street assessment was conducted by more than 28 members of the CAST PAC, as well as 33 other elementary school parents in the district, and was facilitated by project researchers, staff, and partners. In all, the project assessed 40 percent of the 13.5–square mile region of the Bethel School District, or 5.4 square miles. The area audit captured the living environment of 20 percent of the households in Eugene.

Data were synthesized, mapped, and reviewed for accuracy and interpretation by parents and project partners. Results from the study were shared at a public forum involving the school district, PAC members, city and county transportation planners, and other Bethel parents and community members in May 2009.

The complete streets tool provided a socially acceptable, efficient, and understandable resource for evaluating streets and intersections for ease of child walking and bicycling. Street and intersection ratings were combined with city crash data, enabling parents to determine "hot spots" in their neighborhood. Overall, parents became more aware and empowered with regard to their role in the public planning process. Equal emphasis was placed on obtaining a reliable data set for city planning officials and allowing parents to express their impressions of safe streets on the basis of their knowledge of the community and the skill sets of children

in navigating streets and intersections safely.

The community mobilizing process in this participatory GIS study led to a successful Safe Routes to School grant application, and school-based programming is under way in four of the seven elementary schools of the district. The study's results also influenced county transportation recommendations to add sidewalks around a neighborhood elementary school that was constructed when these amenities were not considered necessary. In addition, the study's participatory process and data are being shared in the development of a revised pedestrian and bicycle plan with the city of Eugene.

Findings from the CAST audits reflect the needs, challenges, and opportunities for participatory approaches in evaluating built environment infrastructure and community capacity for walking and bicycling. Data from this study are being incorporated into the CAST Community Health Information Database System and will be analyzed in conjunction with other project measures of social and environmental factors influencing childhood obesity. Building awareness and a local knowledge base is an essential first step in this effort. Both the participatory process and the audit results are being used to encourage a new generation of pedestrian and bicycling citizens to adopt more active lifestyles.

Poster Summary 23

EAGLE RIVER (ALASKA) CENTRAL BUSINESS DISTRICT AND RESIDENTIAL CORE STUDY

A Case Study of Applied Livability Principles

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Eagle River, Alaska, is a rapidly growing community located about 15 miles from downtown Anchorage along the Glenn Highway corridor. Approximately 85 percent of the workers in the Eagle River area commute daily to the military bases or other employment areas in Anchorage. Shopping, business, and governmental services opportunities are beginning to expand in the central business core of Eagle River. The ability of the transportation network to serve future travel demands adequately has been identified as a primary issue in the adopted Central Business District (CBD) Revitalization Plan. The plan recognizes that the foundation of a vibrant Eagle River CBD is a fully integrated land use and transportation system.

It is essential that people and goods move safely and efficiently within and through the business district. Residents of the community should feel "connected" to the area and proud to claim it as their downtown. Unfortunately, the transportation system creates barriers for access and circulation, the perception of an unfriendly pedestrian environment, and frustration with congestion that grows with the community. These challenges are expected to continue as the Chugiak–Eagle River area is projected to grow to a population of approximately 55,000 residents and an employment base of roughly 8,100 within the next 20 years. The purpose of this study was to enable the community to develop cost-effective and implementable

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solutions that address access, circulation, safety, and multimodal amenities to create a vibrant downtown core.

Six guiding principles of the study provided a framework for technical analysis:

1. Develop transportation solutions that support a vibrant downtown by building on the community's adopted vision of the CBD.
2. Plan a complete, interconnected network of roadway, pedestrian and bicycle, and transit facilities to meet needs for circulation, access, safety, and aesthetics.
3. Balance community mobility needs with local access needs along the Old Glenn Highway corridor.
4. Build a consensus for action among local government officials, community councils, business leaders, transportation providers, and residents.
5. Balance short-term disruptions and impacts on businesses with the intended long-term economic stimulus of the downtown core.
6. Develop a set of actionable, cost-effective transportation improvements and solutions with logical sequencing for incorporation into the long-range transportation plan, the regional transportation improvement program, and the local capital improvement program.

The development of a complete, interconnected network of roadway, pedestrian and bicycle, and transit facilities was a primary task of this study. Transportation system performance had to be examined under a variety of scenarios that consider new links; improved parallel routes; modifications of intersections; and enhancements of the pedestrian, bicycle, and transit facilities. Solutions must meet needs for local and regional mobility and reliability while creating a safer and more attractive place for pedestrians and increased opportunities for transit to meet local travel needs. Such improvements will also enhance economic competitiveness with improved access to jobs and a robust business environment to bolster existing markets and develop new opportunities.

The study resulted in the development of four transportation solution strategies:

1. No plan strategy—business as usual without a specific long-range plan.
2. Complete streets strategy—use existing Old Glenn Highway corridor with improved collector streets connectivity.
3. Couplet strategy—create a one-way couplet with Old Glenn Highway and Business Boulevard plus the improved collector streets connectivity.
4. Main street—create a one-way couplet with Business Boulevard and a new northbound roadway to the east of Old Glenn Highway plus the improved collector streets connectivity. This strategy would convert the existing Old Glenn Highway corridor into a traditional "main street" cross section with on-street parking.

Multimodal level-of-service analysis was an innovative technique used in successfully completing the project. This analysis technique estimates a separate mean level of service for each of four modes of travel within the urban street right-of-way: motorist, bus passenger, bicyclist, and pedestrian. Urban streets should be designed to accommodate all users, and this new methodology enabled all participants (general public, stakeholders, and decision makers) to see the changes in level of service from one mode to the other as changes or improvements

are made in the design and operation of the urban street. This innovative methodology provided insight and helped develop strategies and improvement sensitive to all users.

The measures of success for this study were determined through a closely coordinated process with key business and citizen stakeholders and transportation system providers (Municipality of Anchorage, People Mover, and Alaska Department of Transportation and Public Facilities). Stakeholders were guided through the study process to develop feasible options (based on performance, cost, and community impacts) before deciding on the "best" plan of action. The plan developed a phased, implementable set of improvements to move the Eagle River community forward toward a functioning transportation system that will ensure a vibrant future CBD for residents and business owners of the Chugiak–Eagle River area.

Poster Summary 24

LOWER DON LANDS

A Sustainable Waterfront Development near Downtown Toronto, Canada

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Unique in size, scale, and complexity, the Lower Don Lands (LDL) project entails the master planning of a 308-acre waterfront development located southeast of downtown Toronto, Canada. The objective of the project is to promote a sustainable community in which development, transportation infrastructure, and natural resources are integrated and where transit, walking, and bicycling are convenient and safe modes of transportation. Integral to this development is a multimodal transportation network that supports the objectives while helping connect the waterfront with the rest of Toronto. On its implementation, the LDL site will be home to an anticipated 20,000 to 25,000 new residents and 8,000 to 10,000 new employees.

The LDL project is a collaborative approach to development taken by Waterfront Toronto, the City of Toronto, and the Toronto Transit Commission. Waterfront Toronto was established in 2001 to oversee and lead redevelopment and to be the master planner for revitalizing Toronto's waterfront with a commitment to creating a dynamic waterfront that prioritizes public spaces, sustainable development, and economic growth.

Approach

The LDL design team, led by Michael Van Valkenburgh Associates, Inc., took an integrated design approach that included transportation planners, landscape architects, urban designers, and leading sustainability experts. The master plan phase of the project is largely complete and includes a significant transportation planning and engineering component, which was led by Arup. To ensure that the transportation network meets the sitewide goals, Arup conducted two tasks over the duration of the design process: an urban design study to determine the layout and interaction of various multimodal facilities within the site and an analytical study to determine the mobility impacts within the district. The tasks reinforced the importance of a robust transportation network as a component of a livable community.

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Results

The integrated approach taken by the design team resulted in a plan to create a livable waterfront community supported by a multimodal transportation network. Three of the main components of the LDL master plan—transportation options, a live–work–play community, and naturalization of the river—are described below.

Transportation Options

The proposed transportation network supports the goal of creating a sustainable community through the provision of transportation options, access, and connectivity. LDL is representative of the protransit shift in transportation and planning policies at all levels of government, but particularly for the City of Toronto. The project implements the sustainable development policies that the city has advocated by making provision for transit-oriented development and investing heavily in transit, pedestrian, and bicycle infrastructure.

The anchor of the plan is the transit network, which ties in with the light rail transit lines proposed in the surrounding neighborhoods and connects the waterfront with nearby communities. The mobility needs of pedestrians are met with high-quality pedestrian amenities and a high degree of access to transit. The proposed bicycle network includes a mix of on- and off-street facilities that serve the needs of both commuter and recreational cyclists. Strategic placement of on-street parking will contribute to active and vibrant streets, which are necessary for supporting development in the area, while not encouraging visitors and residents to rely on automobiles.

Live–Work–Play Community

The planning process aimed at creating, rather than a residentially dominated bedroom community, a mixed-use, transit-oriented, live–work–play community in which the employee-based development supports area residents and amenities in the public realm provide opportunities for recreation and socialization. The extensive pedestrian, bicycle, and street networks, combined with quality amenities (such as wide sidewalks, promenades, dedicated bicycle lanes, parking) promote an improved public realm. In addition, the compact and multimodal cross sections of the streets allow for enhancement of the public realm within the rights-of-way through streetscaping and landscaping. Numerous Keating Channel crossings dedicated to active transportation users provide access to the water's edge public spaces, reconnecting people to Toronto's natural resources.

Naturalization of the Don River

The goals for the design competition that launched the LDL project were to develop an iconic identity for the Don River that accommodates flood protection and habitat restoration requirements and to integrate development, transportation infrastructure, and the river mouth

into a harmonious whole. The LDL master plan brought together infrastructure, public realm, and scientific approaches to connect the LDL back to the city, lake, and river in a dynamic and balanced relationship. The Don Mouth Naturalization and Flood Protection Project was conducted concurrently with the LDL master plan and includes naturalization of the Don Mouth and Don River.

Conclusions

The project has attracted global interest with its selection by the Clinton Climate Initiative as one of the 16 founding climate positive developments. By promoting compact, walkable communities with extensive access to transit networks, the LDL project is accomplishing the goal that many North American cities have been striving toward—the creation of livable communities that are economically viable and advocate environmental stewardship and active lifestyles.

Poster Summary 25

DRIVING SMART

Car2Go in Austin, Texas, and Beyond

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Carsharing is a specific type of car rental that allows individuals or businesses to rent vehicles by the hour or minute, as opposed to traditional car rentals that are based on day- or weeklong rentals. Most carsharing organizations charge a membership fee, a deposit that is refundable on leaving the organization, hourly fees, and mileage after a certain number of free miles. The carsharing service then handles all costs of ownership, including purchasing, maintaining, insuring, and fueling the vehicle. This type of service draws users who only need a car on an occasional basis and allows them the benefits of private vehicle access without the demands of car ownership. Whether individuals own their own vehicle or not, carsharing provides them with additional choices for their travel needs affordably and efficiently. In the United States, for-profit and nonprofit carsharing organizations are emerging and expanding at high rates. Studies of these organizations have shown that they could have a significant impact on transportation patterns and, once firmly established, on land use patterns.

Daimler Auto Group has entered this market with its Car2Go, a carsharing organization with a fleet composed entirely of Smart Fortwo vehicles, beginning with a pilot program in Austin, Texas. Car2Go provides several innovations not yet seen in carsharing operations. First, Car2Go allows one-way rentals, whereas other carsharing programs require that the vehicle be brought back to the place of rental. The flexibility and spontaneity provided by Car2Go increase its appeal and will result in usage patterns significantly different from those of other carsharing programs. Second, Car2Go charges users by the minute instead of by the hour as other carsharing organizations do, meaning that short trips are economically efficient.

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This analysis began before Car2Go launched and used new survey data as well as previous literature to compare the Austin market with successful carsharing markets around the country to determine the likelihood of success for Car2Go. The results of the analysis confirmed some basic demographic information for Austin: that the general population is younger and more highly educated than national averages. Previous research has concluded that the young and highly educated are precisely the groups who are most attracted to carsharing, suggesting that the city as a whole is a prime market for the service. However, the survey data went further to show that specific subgroups, particularly those who live in downtown Austin and those who work and study at the University of Texas campus, are an even richer market for a carsharing operation.

This analysis also looks at Car2Go's pilot program and public operations, which began on Friday, May 21, 2010. A large amount of research remains to be done on the ideal operational characteristics of Car2Go as it moves forward, but the service has begun collecting interesting data about the usage patterns of the vehicles and their users.

Car2Go has become the fastest-growing carsharing operation in the country, reaching 10,000 members within 5 months. The fleet in the Austin area is 200 vehicles, and nearly a quarter of them are in motion at any given moment. In addition, Car2Go has developed an operation that appeals to more than just college students and faculty; approximately 80 percent of members are not affiliated with the University of Texas. No "typical" user profile has emerged, indicating that the carsharing service is appealing to a broad spectrum of Austin residents. The one-way rental service has also proved to be advantageous, since few vehicles require relocation services. Instead, the significant majority of the vehicles are rerented and driven to another location within 24 hours of the end of a rental. As a direct result of the organization's successes in Austin, Car2Go plans to expand to several other cities within North American in the next year.

Poster Summary 26

HOW TO DEFINE COMMUNITY CONTEXT AND TRANSLATE THE INFORMATION INTO INDICATORS TO EVALUATE DIFFERENT TRANSPORTATION SOLUTIONS

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This presentation is based on three national highway research projects: two completed and one under way. All three projects focus on understanding community quality-of-life considerations as part of transportation decision making, but they differ in terms of their focus. Two are primarily concerned with defining aspects of community quality of life (what to measure? when to measure?) so that indicators can be identified to inform the evaluation process for different solutions or outcomes. The third focuses on providing tools to help practitioners define community context (how to measure?). The goals of the presentation are to inform transportation practitioners of the findings of the two completed research projects and build awareness of the ongoing project so that they can begin to use these resources to help create

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livable communities through transportation investment. The following information describes the three projects discussed by this presentation.

The first project was funded through the Standing Committee on Planning of the American Association of State Highway and Transportation Officials (AASHTO) (http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1280). It includes an examination of community and social impact assessment practices that can be used to inform the selection of community quality-of-life indicators. The focus of this research project [National Cooperative Highway Research Program (NCHRP) 8-36, Task 66: Improved Methods for Assessing Social, Cultural, and Economic Effects of Transportation Projects], was on disaggregating the dimensions of quality of life to improve understanding of how transportation affects social well-being. The research leveraged lessons learned from current community impact assessment practice along with an in-depth literature review and interviews with scholars both outside and within the transportation profession. It combined information from other disciplines related to public health and safety, housing, neighborhood quality, and social capital to present a framework for understanding social well-being that includes measures that can be applied systematically to understand how well a community is functioning.

The framework introduced new measures and new data sources to help practitioners identify areas of concern so that transportation projects do not impose additional stressors. Three major domains including social capital, economic health, and physical health were applied to a case study by using real-world data to evaluate the practicality and value of the framework. The proposed quality-of-life measures provide a quantitative source of information that practitioners can use to supplement more qualitative assessment approaches. Three categories of methodological improvement were recommended for immediate implementation: analyzing traditional data sources in new ways, adopting data used by other disciplines, and utilizing new data sources available from nontraditional sources. The benefits from implementing these additional quantitative assessments included improved community data, improved decision-making processes, effective public involvement, development of flexible design solutions, avoidance of community impacts, identification of partnerships to improve community well-being, effective visualization techniques, and identification of performance measures to develop quality-of-life benchmarks.

The second project presented was funded through the Strategic Highway Research Program Capacity Research Program (http://shrp2visionguide.camsys.com/index.htm). It included a task that examined how community context and related indicators can inform visioning processes. The C08 project (Linking Community Visioning and Transportation Practice) framed some of the critical information necessary for practitioners in preparing for a visioning process, creating a vision, and implementing a vision. The project resulted in the identification of numerous tools and techniques to assist in understanding community context as part of a visioning process through the examination of the following questions:

- What is important?
- Where are we now?
- Where are we going?
- Where do we want to be?
- What have we accomplished?

This project provides an extensive database of more than 800 indicators grouped by categories: economy, natural environment and resources, mobility, public services, public health and safety, sociocultural, built environment, and governance. The database can be used by practitioners to identify indicators reflecting common community quality-of-life considerations.

The last project showcased as part of this presentation is under way through AASHTO's Standing Committee on Environment (http://itre.ncsu.edu/cte/communitycontext/). NCHRP 25-25, Task 69 (Identification of Tools and Techniques to Define Community Context as Part of the Transportation Project Planning and Development Process), seeks to inventory tools that can assist environmental planners and practitioners in comprehensively and systematically defining community context. Researchers are collecting tools and methods from many disciplines, including public health, community development, environmental science, landscape architecture, historic preservation, and urban design, as well as from community members and neighborhood organizations, to help define and describe community context. The inventory of tools and methods will be synthesized to create a user-friendly index of resources organized in such a way that practitioners can identify the best tool to use in their particular circumstances. The index will be organized to include such elements as the scale of the transportation project; the type of environmental study (categorical exclusion, environmental assessment, environmental impact statement); the discipline expertise and stakeholder involvement needed to use the tool; its relationship to the key decision points of the environmental decision process; the substantive issues incorporated (context components) and potential social, economic, cultural, and environmental impacts; and the spatial and temporal requirements of the tool or technique.

All these research projects provide useful information to both practitioners and researchers with regard to defining community context, particularly as it relates to identifying indicators that can be measured to evaluate livability goals and objectives. In combination, they provide practitioners with information on what quality-of-life issues to consider and when and how to consider them in the various phases of transportation decision making.

Poster Summary 27

YES, THEY DO WALK IN SUBURBIA

Suburban Multifamily Housing and Trips to Strips

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Multifamily housing has been the largest-growing housing market in the United States since 1970. One in five units in suburbia consists of multifamily housing (U.S. Census Bureau 1973–2007). This housing type is often located around commercial strip malls and typically acts as a buffer between strip malls and adjoining single-family home neighborhoods (Moudon and Hess 2000; Hess 2005). Contrary to what is typically considered the norm, the proximity between multifamily housing and "daily use" commercial areas creates a strong potential for walking and bicycling to occur in suburbia. However, the site design of the vast majority of these developments continues to adopt the detached and enclaved single-family

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home development pattern, which significantly reduces connectivity and challenges the potential for increased walking and bicycling (Larco 2009).

The study investigates whether connectivity in suburban multifamily developments affects residents' rates of walking and bicycling to their local commercial area (LCA). The study is localized, but in view of the generic nature of multifamily development around the country, the results may be applicable nationally. The hypothesis was that increased connectivity would result in increases in walking and bicycling.

Methods

To test this hypothesis, 14 multifamily housing developments in Eugene, Oregon, were studied. In 2001 Eugene revised its multifamily housing code to include specific language on street network requirements, parking design, and pedestrian infrastructure, which increased the connectivity of later developments. Eight developments built before the code change and six built after the change were chosen. Connectivity ratings were created for each development. They were based on criteria such as the presence and networked degree of pedestrian paths both internal and external to the developments, the pedestrian network node density, route directness, and access point distribution around the site. A composite score that included all of these criteria was derived for each site, and the sites were ranked accordingly. A natural break in that ranking separated the well-connected from the less-connected developments. The two groups of sites were similar in size, number of units, and distance to comparable LCAs that included pedestrian magnets such as banks, grocery stores, post offices, and restaurants.

A direct marketing database was used to gather addresses for all residents. A survey was sent to each household (1,493) in these developments asking about their transportation modes and frequency, attitudes toward travel modes, ease of walking and bicycling, housing choice, and personal information. Surveys were sent to all residents at the same time to eliminate any differences in responses that might be caused by weather. A total of 229 surveys were returned and analyzed. This response rate did raise some questions as to how well the survey responses were representative of residents in general. However, given the strength of many of the results outlined below, this was not believed to be a major concern.

Results

Contrary to popular perception as well as studies concerning mode choice in suburbia, residents reported a substantial amount of active transportation trips (walking and bicycling) across both well-connected and less-connected developments. Results of the survey were analyzed by using descriptive statistics and regression models. Across all sites, more than one-third (38 percent) of trips to the LCA are active transportation trips, with most being walking trips.

In addition, travel mode use and connectivity are significantly associated: residents of well-connected sites are significantly more likely to walk and less likely to drive to the LCA

than are residents of less-connected sites. Almost half (43.0 percent) of trips to the LCA were walking trips for residents of well-connected sites versus less than a quarter (23.7 percent) for residents in sites that were not well connected.

When resident travel choices instead of total trips are considered, the results indicate that significantly more residents chose to walk and bicycle in the well-connected sites. Seventy-three percent of residents in these sites use active transport to the LCA at least once a week, as opposed to only 58 percent of residents in less-connected sites. In other words, the well-connected sites are correlated with more individuals considering and using active transport as a viable form of transport to their LCA. In addition, a significantly larger number of residents in well-connected sites than residents of less-connected sites only walk or bicycle to their LCA (20 versus 9 percent).

Further statistical analysis using regression models indicated that these differences in travel mode were not correlated with resident demographic characteristics or attitudes toward a particular mode but were highly correlated with the connectivity of the built environment in which the person lived.

Implications

Residents of suburban multifamily housing do walk and bicycle to their LCA, and they do so at significantly higher rates if they live in a well-connected development. Increases in active travel have been associated with improved health, reduced rates of obesity, and increases in independence (Frank et al. 2006). In addition, the replacement of automobile trips by active travel helps reduce greenhouse gas emissions and traffic.

To create environments that foster increased active travel, planners must encourage developments that are well connected internally and to their surroundings. Zoning codes throughout the country often include provisions such as mandated buffers between dissimilar uses as well as limitations on direct connections between developments (especially to commercial areas). These codes also often lack provisions for pedestrian networks and connections to adjacent development.

The result is that many suburban multifamily developments are dominated by parking, have little infrastructure that supports active travel, and have few to no connections to adjacent properties. In addition, planners often review and evaluate proposed suburban multifamily housing projects without sufficient attention to adjoining development. Plan reviews are often based on documents that only show land use designations and not actual site designs of adjoining property, which negates any evaluation of possible connections between properties. To capitalize on the latent potential for active travel in and around suburban multifamily developments, planners will have to reevaluate their codes and their perceptions of the amount of walking and bicycling that can occur in suburbia.

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Poster Summary 28

WHAT MAKES A "COMPLETE STREET" COMPLETE?

Defining Completeness on the Basis of Context and Public Participation

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The concept of complete streets is gaining momentum as a way to make communities more livable. A complete street accommodates all users, including pedestrians, bicyclists, and transit users. Furthermore, a complete street considers the needs of children, the elderly, disabled persons, and those using the street as public space for leisure and socializing. If a street does not meet these diverse needs, it is not complete.

Despite the growing enthusiasm, there is little guidance for assessing "completeness." For example, many communities have streets without pedestrian benches, shade trees, or other amenities. Does this mean that those streets are "incomplete"? The National Complete Streets Coalition states, "Since each complete street is unique, it is impossible to give a single description [of completeness]. A complete street in a rural area will look quite different from a complete street in a highly urban area." But for communities trying to prioritize improvements, a "know it when you see it" definition is not clear enough.

It has been suggested that the *Highway Capacity Manual*'s level of service (LOS) can be adapted to assess completeness. However, although LOS might be useful for assessing the quality of service for a given demand, it falls short when demand is suppressed or unobserved (latent demand). For example, if a non-capacity-enhancing amenity such as a bicycle rack is added to an "incomplete" street, volumes may increase but LOS will decrease. Likewise, since LOS emphasizes the flow of users, an amenity such as a bench or a sculpture is considered an obstacle that can reduce pedestrian LOS.

Various demand-free assessment tools, or audits, have been developed to assess walkability or bikeability. The audits evaluate amenities and design not in terms of capacity but in terms of user satisfaction. Audits are advantageous because they encourage proactive planning rather than reactive "predict and provide" planning. In other words, an audit tells a planner whether a facility satisfies expectations, not because of warrants from demand predictions but because there is a vision for what the facility ought to be.

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Method

This presentation introduces a novel way of defining and assessing completeness by using a four-dimensional audit for automobile, transit, pedestrian, and bicycle users. The results of the audit can be plotted on four axes to depict the street's "status quo profile." By having all four axes on a common scale between 0 and 10, the plot readily illustrates whether the profile is dominated by one of the four user groups. For example, a status quo profile with a perfect diamond shape suggests an equal score for all user groups, while a kite shape suggests that the street is more favorable for one of the user groups.

The most significant innovation of this approach is the use of "desired profiles," which a community can create for the street types it defines depending on context and function. The desired profiles provide a standard with which a status quo profile can be compared to calculate a completeness score. For example, if the results of an audit show a low pedestrian score but the desired profile for pedestrians is also low, the street can still receive a high completeness score because it meets the expected standard for that particular context and function. On the other hand, if a street exhibits discrepancies between desired and status quo profiles, the street will receive a poor completeness score.

Any community can develop its own set of desired profiles, called the community's complete street "scheme." A community's scheme is its normative complete street typology.

In the case study, a focus group of citizens from the community developed 16 desired profiles for 16 street types by considering four levels of context (high, medium, low, and very low urban significance) and four levels of function (arterial, minor arterial, collector, and local). The citizens also helped customize the audit for their community by providing preference weights for various street attributes related to amenities and design.

Case Study Results

Sixty-seven streets were audited, and the community's scheme was used to calculate completeness. All of the streets exhibited deficiencies, and 20 percent received a low completeness score. The majority of the low scores were for local streets with missing sidewalks and arterials with few or no transit amenities. Some streets, because of context and function, received completeness scores better than expected.

The community participants gave valuable positive feedback. They enjoyed the instructive exercise of weighting amenities and helping to define desired profiles for their community. City leaders said that the plots of the profiles made it easier to identify problems and that in general the process was helpful in prioritizing improvements.

Poster Summary 29

EFFECT OF SUBURBAN TRANSIT-ORIENTED DEVELOPMENTS ON RESIDENTIAL PROPERTY VALUES

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Public transit systems are most effective in the presence of a high volume of potential ridership. This ridership generally requires high-density development at the ends of the system and along transit corridors. Transit-oriented developments (TODs) are being used to increase transit ridership.

TOD, apart from providing transit ridership, has also gained popularity as a smart growth tool that addresses the problems of traffic congestion, pollution, and other ills of automobile-oriented development. TOD's increasing popularity is evident in efforts at all levels of government to promote the coordination of transportation and land use.

The federal government, through the Intermodal Surface Transportation Efficiency Act, the Transportation Equity Act for the 21st Century, and most recently the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, has reinforced the need to integrate land use and transportation planning and to provide public transit. Other federal programs, such as the livable communities program and the new starts program, have given additional impetus to the development of public transit coordinated with land use.

At the state and regional levels, the past three decades have seen a dramatic increase in the number of new rail-based public transit systems. There are three general categories of rail transit systems: heavy rail [for example, Bay Area Rapid Transit (BART) in California], commuter rail (for example, Metra in the Chicago, Illinois, area) and light rail (for example, Santa Clara Valley Transportation Authority in California and TriMet in Portland, Oregon).

The development of successful TODs often encounters barriers. Among them are a lack of interjurisdictional cooperation, automobile-oriented design that favors park-and-ride lots over ridership-generating uses, and community opposition. Like any new high-density development, TODs are likely to face community opposition. Such opposition may be more vocal in suburban areas, where residents of predominantly single-family neighborhoods may feel that the proposed high-density, mixed-use development will bring noise, air pollution, increased congestion, and crime. Community opposition has been instrumental in stopping many TOD projects in the San Francisco Bay Area. Examples are plans for the Rockridge, Ashby, North Berkeley, and Pleasant Hill stations of the BART system.

Little research has been done indicating whether such opposition is well-founded. Economic theory suggests that if a TOD has a negative effect on surrounding residential neighborhoods, that effect should lower housing prices in those neighborhoods. Similarly, an increase in housing prices would indicate a positive effect of TOD on the surrounding neighborhoods.

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The Study: Methodology and Approach

This study used a hedonic regression method to estimate the impact of suburban TODs on surrounding single-family residential neighborhoods. It can be safely assumed that the impacts of the TOD would be more strongly felt on single-family homes that are relatively close to a TOD—roughly within 0.5 mile—with the impact likely to dissipate beyond that distance. The study objectives and economic theory suggest the following TOD selection criteria:

- Suburban location;
- Substantial single-family residences within a 0.5-mile radius of the TOD;
- A good mix of uses within the TOD, including residential, office, and commercial; and
- All or a major portion of the TOD built.

On the basis of these criteria, four California TODs—Ohlone Chynoweth TOD in San José, Pleasant Hill TOD in Contra Costa County, downtown Hayward TOD in Alameda County, and Bay Meadows TOD in the city of San Mateo in San Mateo County—were chosen for further analysis.

Findings

The study found that the Ohlone Chynoweth TOD positively affects the surrounding single-family residences. For homes within 0.5 mile of the TOD, every 100-foot decrease in the distance of a single-family home to the TOD increases the home sale price on average by $10,150. Since the average single-family home price for this distance band is approximately $660,000, this translates into a 1.5 percent increase in home prices. The remaining three TODs do not have any effect, positive or negative, on the prices of surrounding single-family homes.

This study will be of interest to local, regional, state, and national transportation policy makers as they plan, advocate, and allocate funding for TODs and to the technical staffs of the jurisdiction and the transit agencies as they measure the benefits of the TODs.

All levels of public officials and professional staff can use the study results as they educate residents about the impacts of TODs. Furthermore, accurate estimation of the monetary benefits of the TODs will help in assessing the use of these developments as an economic development tool.

Poster Summary 30

IMPLEMENTING COMPLETE STREETS

Lessons Learned

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State and local governments across the country are adopting complete streets policies and making a commitment to ensuring that all future projects account for the needs of all road users. Twenty-three states and more than 140 local jurisdictions nationwide have adopted complete streets policies, and the U.S. Department of Transportation has named complete streets policy adoption as a key performance measure of its own success.

Methodology

The National Complete Streets Coalition and the American Planning Association conducted interviews and analysis with local experts about the development of complete streets policies and effective implementation strategies. Case study communities were selected by using an inventory of the 80 known complete streets policies passed by the end of 2008. Planners, transportation engineers, and others generously shared their time and insights through extensive telephone interviews and document reviews. The report *Complete Streets: Best Policy and Implementation Best Practices* discusses successful strategies and draws out lessons learned in how to create complete, sustainable streets systematically. The report discusses the development and adoption of a complete streets policy and examines how to implement policies and integrate a complete streets approach into everyday practice.

Findings, Lessons Learned, and Observations

The research project identified a number of findings that apply across many case studies. This poster focuses on findings of greatest interest to a Transportation Research Board audience, with photographs from example communities.

• Complete streets policies are a valuable tool in changing transportation priorities, establishing a new ideal for street function, and communicating with the public. Over and over again, interviewees talked about how the complete streets policy development process provided a new frame for the discussion of transportation needs in their community.

• Linking achievement of complete streets to funding eligibility helps institutionalize complete streets practices. In many communities, complete streets implementation is occurring by changing the criteria for spending existing funds. Funding requirements

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attached to new sources of money, such as mainstream transportation bond measures, have jump-started complete streets implementation in several communities; control of a funding stream, and a clear intent to use it to create a multimodal network, helps create visible on-the-ground projects that build community support. Specialized pots of money can also help speed complete streets retrofits in areas with extensive deficits. But if an attitude persists that this funding and these projects are separate from traditional highway funding programs, selection criteria, and project standards, the balancing act necessary to create a complete streets network will not take place. Nonmotorized and transit accommodations are likely to remain underfunded, and highway projects will continue to miss opportunities to create a multimodal network.

• Successful implementation reaches beyond the initial policy document to include changes in zoning codes, plans, standards, manuals, and procedures. Complete streets implementation is successful only if an initial policy statement is followed by changes across the transportation planning process. An initial resolution may be followed by adoption of an ordinance, revision of zoning codes, inclusion in mode-specific plans, and in some cases even the creation of a new design manual.

• Successful implementation at the local level is often marked by empowering planners and engineers to think through creative approaches to each project, with continued data collection and research to confirm success. Many places with complete streets policies are marked by a political and organizational culture that helps planners and engineers feel confident that they can try out new ideas as they aim for a multimodal goal. They discourage the traditional "cookbook" design approach that relies heavily on following design standards and avoiding "rocking the boat." Instead they may use more general guidelines, or cross sections without specific width requirements, as in Charlotte, North Carolina. This experiential approach is most often accompanied by close monitoring of projects to determine whether they meet the expected results for traffic flow, safety, and community acceptance.

Performance Measurement

Performance measures are an important tool in the implementation of complete streets policies, yet they remain a challenging area. Performance measures may be used in several ways to facilitate the implementation of complete streets policies.

First, performance measures can be used for needs assessment, to identify problems in the system and to assess their relative severity. In this case, performance measures are applied systemwide, usually as a part of the planning process.

Redmond, Washington, created a comprehensive monitoring system in its transportation master plan. The mobility report card measures a wide variety of indicators. Measured each year and posted on the Internet, the report cards allow the city to spot trends and see how it is progressing toward its goals.

Second, performance measures can be used to prioritize proposed projects for funding in the programming process. The methods in this application may be similar to those used for needs assessment.

Third, performance measures can be used in impact assessments as a part of the development review process. In this application, forecasts of the probable impact of proposed

development projects on the performance of the street system are used as the basis for impact fees or other exactions, such as requirements to provide bicycle and pedestrian facilities. For example, in Sacramento, California, traditional level-of-service standards for the impact of development on vehicle traffic have been relaxed to accommodate development that may improve conditions for other modes.

Fourth, performance measures can be used to evaluate the effects of a policy or project on the performance of the system and to assess whether it achieved its goal. These "before-and-after" studies are important for building a base of evidence on the effectiveness of the complete streets approach and can be instrumental in justifying further investments in complete streets projects. When they operate under a complete streets framework, jurisdictions can measure traffic volume of all modes, note any modal shift, and count the number of crashes and injuries incurred by all roadways. Seattle, Washington; New York City; and Charlotte, North Carolina, have all used this approach.

Poster Summary 31

GREEN MODES OF TRANSPORTATION FOR THE DELIVERY OF FAST FOOD IN CONNECTICUT'S MIXED-USE DEVELOPMENTS

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With air pollution continually rising and fossil fuel supplies dwindling, the use of the automobile in American society is becoming more and more difficult to sustain. The issue has gained prominence, but productive solutions are difficult to come by and even more difficult to fund. Members of academia have the opportunity to research alternative modes of transportation with funding from various granting agencies. Such research could result in the development of a new strategy before the nation's increasingly outdated systems crash. The University of Connecticut's (UConn's) Center for Transportation and Urban Planning (CTUP) is providing much-needed help and funding for such research projects.

The Green Modes of Transportation in Connecticut's Mixed-Use Developments grant provided by CTUP promotes work toward implementing smart growth transportation principles as well as interdisciplinary cooperation. The "delivering green" study is a research endeavor that professors at UConn have undertaken as an idea-to-implementation project. The case study focuses on the food delivery sector of Downtown Storrs (a commercial center on the UConn main campus). It reviews existing practices and investigates alternative systems. The Downtown Storrs food delivery service generates between 136 and 272 deliveries per day; on some of the busiest days the total exceeds 1,000 delivery trips. With the heavily used system relying on privately owned cars and trucks, this sector contributes approximately 100,332 pounds of carbon emissions each year. The study theorizes that the use of zero- or low-emission vehicles such as pedal bikes or electric cars for deliveries could have a significant impact on the carbon footprint without compromising the quality of delivery services.

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The case study of food delivery in Downtown Storrs was a joint effort between professors and students from UConn. Their expertise included graphic design and communication, business management, transportation and environmental engineering, and landscape architecture. Each team member contributed toward the project in a unique way. Together they designed a sustainable food delivery system for Downtown Storrs.

Communication Design

The graphic team designed a range of logos for the project that could be used in marketing strategies to raise awareness of environmental impact among the food delivery clientele. Various applications of logos were explored, including display at bus stops around campus, clothing of the delivery personnel, and decals on the delivery vehicles themselves. After these preliminary explorations were completed, the logos were analyzed by surveying students on the UConn campus in a two-step process. They were first shown a selection of logos and asked to respond to what they saw without any prior knowledge of the project. This served to identify which logos were most likely to convey the appropriate message. For the second portion of the survey, the project was explained to the same students, who were then asked to respond to the logos on the basis of visual appeal and message clarity. The responses were tabulated and the feedback used to develop the various logos into a smaller set, from which the team leaders could choose a graphic representation of the project.

Business Management

The business management group performed an analysis of the business models and potential application of low-emission vehicles in the delivery sector. Business owners were found to be apathetic toward issues of sustainability but were aware of the importance of "green practices" in the eyes of their clientele. As an opportunity to improve their marketability, businesses were willing to consider participation in a green delivery system if it was cost-effective. However, the implementation costs intimidated most business owners and outweighed the perceived benefits of a green public image. The main issues were the small scale of the businesses, which made capital for such a project scarce, and the fact that the current system costs little; investment ends with the hourly wages paid to the drivers and in some cases an insurance policy. The vehicles used for delivery are owned by the delivery personnel, mostly college students working their way through school. Thus the investment costs of obtaining low-emission vehicles were prohibitive to business involvement in a new delivery system. The model of a third-party delivery service was explored and is seen as an effective alternative for the Downtown Storrs–UConn campus area. The delivery service would be based on low-emission vehicles, and local restaurants would pay into that service instead of paying their own drivers.

Transportation Systems

The transportation group used geographic information systems technology to analyze delivery quantity and destination factors to determine the most efficient route management and vehicle selection methods for a delivery service. On the basis of scenarios of one-, two-,

and three-item deliveries, it was found that the use of gasoline-efficient vehicles could reduce carbon emissions by 119,686 pounds each year compared with making the same deliveries with standard fossil fuel vehicles. Pedal bikes are the most fuel-efficient method; however, concerns of speed and manpower may limit their use to on-campus dormitory deliveries. In addition, the studies showed that maximizing the number of deliveries per trip is essential in creating an efficient and sustainable delivery system.

Landscape Architecture

As project managers, the landscape architecture group worked on the various aspects of the project with the individual groups, coordinating efforts and assisting with research and graphic production. The work to date is an example of the benefits that interdisciplinary teams can provide in the advancement of sustainable transportation systems. By working with all groups concurrently, the group was able to guide the research to produce information that could be shared among disciplines and to ensure that each group had the data necessary to complete its work. The melding of experience with graphic representation, land use and circulation relationships, and management allowed the facets of the project to coalesce into a new business strategy for the food delivery sector.

Poster Summary 32

VALUE OF TRANSIT

Paying for Place-Making

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In recent years, national transportation planning and policy have shifted from the traditional automobile-oriented approach to a more sustainable, people-centered approach. Rising highway construction and maintenance costs, concerns about air quality, and ever-increasing highway congestion precipitated this shift. A well-developed transit system can foster the creation of livable neighborhoods and communities. A well-patronized transit system would also lead to a reduction in congestion and, eventually, to the reduction of vehicle emissions. Public transit stops can develop into centers of community life that rejuvenate and strengthen communities. This is commonly referred to as “place-making.”

A previous study by Yannes et al. investigated the value people assigned to place-making in a public transit system by using choice experiments administered in a stated preference survey. The study presented is a significant extension and expansion of the previous study. In the new study, the survey team used mobile electronic devices to deliver an in-person intercept survey. The shift to an electronic intercept survey format allowed for personalized scenario building, which resulted in better estimates of control service parameters. It also improved the reliability of results by increasing the plausibility of the hypothetical scenarios presented to respondents. A conditional logit model was estimated from the survey response data to identify which trade-offs the public is willing to make for specific transit service attributes and place-making features.

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This study used four levels of place-making. Several digital images from Urban Advantage, a company that creates photorealistic visualizations of rich, walkable environments, were used to represent the levels of place-making. The selected images captured the various levels of place-making by including different combinations of on-street parking, shorter building setbacks, street trees, improved lighting, street lamps, and larger sidewalks.

The study found that the public values some combinations of place-making variables over others, suggesting that people may subcategorize place-making elements as either functional or aesthetic. In addition, a person's income and house ownership status were found to affect the person's willingness to pay for functional improvements (such as wider sidewalks and on-street parking) and what may be considered aesthetic improvements (such as reduced building setbacks and trees and greenery). The results also indicated that the public places a high value on the reliability and comfort of transit systems.

Poster Summary 33

SUSTAINABLE PUBLIC TRANSIT INVESTMENTS

Increasing Nonmotorized Access and Multiple Trip Type Usage

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Public transit is a key method for increasing sustainability in the transportation sector; transit can decrease emissions harmful to the environment and increase social equity by providing improved mobility. Given the limited resources available for building and operating public transit, it makes sense to meet multiple sustainability goals simultaneously. Transit that is accessible by nonmotorized means and serves multiple trip types can reduce vehicle usage and increase mobility for everyone. This research assesses whether transit systems with high nonmotorized access rates and nonwork trip usage are meeting social and environmental goals and what factors affect nonwork and nonmotorized access rates.

Eight criteria were used to choose 17 metropolitan regions that represent a range of transit conditions in the United States. Nonparametric correlations were calculated between nonwork usage and nonmotorized access and a data set of 30 continuous and 11 categorical variables that measure regional characteristics, transit efficiency, land use, rider demographics, and transit operations and design. In-depth case studies, including site visits and interviews, were done for Denver, Colorado; Minneapolis–St. Paul, Minnesota; and Sacramento, California.

The correlations and case studies confirm that transit systems with high nonwork usage and nonmotorized access are not meeting social or environmental sustainability goals. These systems primarily serve low-income riders, are less well funded, and provide limited service. Only systems with higher per capita funding levels meet social goals, and higher funding is correlated with higher-income riders. However, having higher-income riders does not imply that social goals are met. Regional policies concerning the operation and design of transit can

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increase usage for nonwork trips and nonmotorized access and are necessary for ensuring that both social and environmental goals are met.

Poster Summary 34

METHODOLOGY FOR SITING AN INTERMODAL TRANSPORTATION FACILITY IN THE UPPER VALLEY REGION OF VERMONT AND NEW HAMPSHIRE

Lessons Learned in Fostering Livability

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The Upper Valley region of Vermont and New Hampshire is a vibrant and diverse micropolitan area. The region's economy is driven in large part by the presence of Dartmouth College, the Dartmouth Medical School and regional medical center (New Hampshire's largest private employer), and numerous high-tech companies with ties to the college and medical center. The region sits at the crossroads of two Interstates and is served by a regional airport, an extensive local public transit system providing fare-free service, numerous regional public transit connections, two intercity coach providers, and a well-used Amtrak station. With all of the transportation options provided in the region, the Upper Valley lacks a central hub where travelers can seamlessly transfer between modes to make efficient multiservice trips. To address this need, a comprehensive planning effort was conducted in 2010 to develop a detailed assessment of all the transportation services in the region, identify the optimal location for an intermodal transportation facility, and develop preliminary engineering plans for the facility. The assessment was a two-phased effort that examined close to 50 potential sites across the region. It was highly detailed and included metrics based on specific site characteristics; transit serviceability; reductions in vehicle delay, emissions, and vehicle miles traveled (through the use of a regional microsimulation transportation model); impacts on adjacent neighborhoods; and site-specific construction costs. Although it was initially focused on providing transportation connections, the investigation of various sites stimulated an important regional discussion on the link between transportation and land use and their fundamental relationship to community and livability.

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Poster Summary 35

PERFORMANCE MEASURES FOR COMPLETE, GREEN STREETS

Initial Findings for Pedestrian Safety Along a California Corridor

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This poster reports on the initial findings from research aiming to identify performance measures for complete streets in California. The concept of complete streets has been promoted to encourage walking and bicycling by providing safe spaces for those activities, especially in urban areas. However, many transportation agencies lack the ability or resources to ensure that such facilities are built. In the case of California, performance for key goals is measured on an annual basis—yet there are no measures of pedestrian and bicyclist safety or mobility. This project was sponsored by the California Department of Transportation to develop measures to fill the gap. Because reconfiguration of the roadway is prohibitively expensive in most cases, this study focuses on roadside design features that can enhance user safety and mobility. The research is being conducted on San Pablo Avenue, a 9.5-mile state route that runs through six cities and two counties along the east side of the San Francisco Bay. Although the route is entirely urban, it varies in terms of employment and residential densities and contains a variety of roadside design features.

The project examines pedestrian and bicyclist safety and mobility from two angles. The first is through analysis of 11 years of pedestrian and bicyclist crash data (a total of 437 reported injury crashes) with regard to the roadside design features along the corridor. The second is through pedestrian and bicyclist intercept surveys that will measure perceptions of safety and walkability–bikability given a range of complete streets features; this survey is in progress.

To date, the safety analysis has found that previously identified major contributors to pedestrian safety (e.g., the presence of sidewalks, number of traffic lanes, and traffic speed) continue to be the most influential. After controlling for these major influences, the researchers have been unable to identify combinations of roadside design elements that contribute further to completing a street and are significantly related to pedestrian safety. In particular, design elements that may create a more comfortable or pleasant environment for walking, such as street trees, landscaping, and public benches, have yet to show a significant connection to traffic safety. In the same vein, street trees, which have been previously targeted as potential traffic safety hazards, appear to have no negative effect on safety.

Through the intercept surveys, these features will be examined for their impact on mobility and perceptions of safety and comfort among pedestrians and bicyclists. Although they have thus far been found to be neutral in terms of safety, they may encourage walking and bicycling along the corridor and may thus contribute to overall public health goals for communities that install them. The surveys will help the researchers understand the overall value of such features to roadway users.

These results may be both encouraging and discouraging for complete streets advocates. They appear to reinforce what the literature has found about pedestrian safety—that a handful of factors are the major influences and that those influences are so strong that they cannot

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be mitigated through roadside design features. One of these influences is the presence of a sidewalk, which is a critical part of a complete street. However, beyond building sidewalks, the major influences on safety appear to have less to do with roadside design features and more to do with reducing automobile level of service so that the level of service for other modes may be improved. Along those lines, pedestrian and bicyclist mobility and perceptions of safety may be significantly related to the presence of roadside design features, thus making them an important part of a complete street from a different angle. The intercept survey will inform the study about the impact of such features on mobility and perceptions of safety.

Next steps for this research include examining bicyclist injury crashes along San Pablo Avenue, as well as analyzing the results of the intercept survey. The project aims to use this greater understanding of pedestrian and bicyclist safety and mobility to create defensible and reliable performance measures for the California Department of Transportation's urban roadways. These performance measures can then guide future roadway design to be wholly, rather than just technically, "complete."

Poster Summary 36

THE "FIX THIS TOOL"

Empowering Citizens to Spatially Assess Their Active Transportation Environment

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Supporting livable cities is a key priority of the Obama administration, is fully embraced by the U.S. Secretary of Transportation, and necessitates increased active transportation (walking and cycling) in communities across the country. Transportation data that support active transportation planning are lacking for most communities. With the increasing pervasiveness of smartphones that are graphically rich, spatially accurate, and simple to use, transportation and livability data collection can be approached in a new way by engaging citizens directly in the process.

This poster describes the development and testing of an iPhone-based transportation livability audit tool called the Fix This Tool. The Fix This Tool is designed to engage citizens across the country in collecting active transportation data to help local communities and transportation agencies meet the needs of the livability era. The tool requires no training, is spatially specific, and focuses both on the subjective perception of place and on some of the objective variables that may be important to note.

Initial development and testing indicated that the tool was intuitive for people to use and data robust. In addition, the combination of features available on a smartphone-based tool provides a rich set of opportunities for the engagement of both citizens and public agencies in improving their active transportation system. However, active transportation data can be complex and "messy" and will require approaches toward use that are different from the traditional, objectively assessed regional scale measures used for transportation modeling.

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Poster Summary 37

UNIVERSITIES AS CATALYSTS FOR RETROFITTING COMMUNITIES TOWARD LIVABILITY

The Sustainable Cities Initiative

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Sustainable Cities Initiative

Many communities and cities are interested in moving toward a sustainability and livability context in which active transportation plays a more important role in meeting local transportation needs and city design better supports transit. Much know-how about such issues can be found within universities, from faculty research to courses across disciplines that address some aspect of the built environment. Thus, there is a potential to match the community need with university resources. However, the connections between the town and the university are often weak and isolated by discipline.

The Sustainable Cities Initiative (SCI) at the University of Oregon is an effort to alter the function of the public university to serve the public good by catalyzing community change specifically related to the emerging livability and sustainability agenda. SCI is cross-disciplinary. It brings together students and faculty in planning, public policy, architecture, landscape architecture, business, law, and journalism (so far) to work together and to work directly with communities to help accelerate changes toward livability. This work is carried out through a variety of efforts:

• Sustainable city year: This is a program that asked a simple question: What would happen if existing courses across a university that had some connection to livability and the built environment all worked with the same city over an entire academic year? The result after the first year was that 16 professors from six disciplines dedicated 24 courses to work with the city of Gresham, Oregon, on a variety of transportation and other livability projects. In all, it is estimated that 100,000 hours of student and faculty time were given to Gresham, which has been significantly affected through the diversity and depth of work and ideas. Topics of projects included streetscape design, light rail and public transit planning, urban ecology, and economic development. Five cities in Oregon applied to be the focus for the 2010–2011 academic year, which clearly illustrates the demand for ideas and expertise in this topic area.

• Policy engagement: SCI has been directly engaged in national policy issues. It has reviewed legislation for members of Congress, submitted white papers to federal transportation agencies, and met directly with members of Congress and staff about upcoming legislation focused on livability.

• Research: SCI faculty enjoy a national reputation as experts on transportation and livability. They have recently been the focus of the Research and Innovative Technology Administration's livability newsletter, they are the core of the Oregon Transportation Research and Education Consortium's growing national reputation as "the livability university transportation center," and they are known through more traditional research

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outlets and networks. A white paper on transit livability prepared for the Federal Transit Administration (FTA) has recently been turned into funded research with the goal of providing FTA with a series of performance metrics for assessing how well the nation's transit systems serve the livability needs of their communities.

In short, SCI is a cross-disciplinary effort integrating research, education, service, and public outreach with issues of sustainable city design. SCI represents a reconceptualization of the research university as catalyst for sustainable community change. The multidisciplinary, applied learning, and engaged community orientation makes SCI a new model for universities around the world. (SCI was recently one of five organizations nominated for a prestigious Globe Forum environmental award, and several universities in the United Kingdom are organizing to send a delegation to Oregon to see SCI's work firsthand.)

The model combines scientifically rigorous research and exceptional student instruction and transforms them into a robust, energetic state-of-practice and knowledge catalyst for helping cities transition to more sustainable practice. SCI tackles issues related to multimodal sustainable transportation systems, climate change, healthy communities, sprawl and its impacts on land and energy consumption, economic development, and ecological health and restoration by advancing a three-pronged strategy of research, civic engagement, and community collaboration.

Poster Summary 38

MOVING FROM "COMPLETE STREETS" TO "COMPLETE COMMUNITIES"

A Study of Customer Mode Choice at 20 San Francisco Bay Area Retail Pharmacy Stores

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This study of customer travel behavior at 20 San Francisco Bay Area (California) retail pharmacy stores suggests that major increases in walking and bicycling for routine shopping trips will require the transportation profession to expand its emphasis beyond "complete streets." While complete streets efforts help improve pedestrian and bicycle safety and comfort, they focus mainly on the street environment. These efforts are unlikely to create major shifts in travel behavior outside of urban centers unless broader "complete communities" strategies are adopted. Complete communities strategies should improve roadway conditions for walking and bicycling and modify community land use patterns, change individual and cultural perceptions of nonmotorized transportation, reduce street crime, and use automobile parking pricing strategies to promote walking and bicycling.

A mixed-methods approach was applied to understand why people choose a particular mode of transportation for multistop tours. Travel data were gathered from an intercept survey of 1,003 customers at Walgreens retail pharmacy stores in 20 San Francisco Bay Area neighborhoods in fall 2009. The data included the location of the respondent's home, the location of all stops made before and after visiting the store, and all transportation modes used between each stop. Respondents also reported their socioeconomic characteristics,

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attitudes toward transportation and the environment, and perceptions of neighborhood traffic safety and personal security. The responses were analyzed with a mixed logit discrete choice model. Follow-up interviews were conducted with 26 survey participants to gain a deeper understanding of factors that influenced their transportation decisions. While the survey and interviews also addressed public transportation, this poster focuses on walking and bicycling.

Approximately 90 percent of survey respondents at all stores believed that reducing automobile use is a good way to improve the environment. However, customers at certain stores were more likely to act on their environmental values—more than 55 percent of customers at three San Francisco stores walked or bicycled, but more than 85 percent of customers at seven suburban stores arrived by automobile. What explained these differences in travel behavior?

Survey and interview responses showed the importance of complete streets. Study participants enjoyed walking in areas with sidewalks or other pedestrian pathways and little or no traffic. They liked to bicycle on low-speed, low-volume streets and on pathways away from traffic. Many interviewees said that they would bicycle more if there were separated spaces for bicycling on streets. In contrast, missing sidewalks, fast traffic, difficult street crossings, and a lack of barriers separating bicycles from cars may have impeded walking and bicycling to stores. In addition, model results showed that more bicycle facilities within ½ mile of a store were associated with a higher likelihood of customers bicycling to the store. However, mode choice decisions were motivated by many factors beyond those typically targeted by complete streets strategies. Time and cost were statistically significant factors associated with retail pharmacy store mode choices. Of customers who traveled on a tour that was longer than 2 miles, 77 percent used an automobile as their primary travel mode and 9 percent walked or bicycled. However, for tours shorter than 1 mile, 22 percent drove and 78 percent walked or bicycled.

After travel characteristics (e.g., tour distance, number of stops, number of bags being carried) and socioeconomic characteristics (e.g., gender, income, automobile ownership, student status) were controlled for, several store area characteristics were associated with walking and bicycling. Customers were significantly more likely to walk to stores that were surrounded by greater employment density, greater population density, and metered on-street parking and that were located closer to a transit station. Customers were more likely to bicycle to stores surrounded by greater employment density and metered on-street parking and with more bicycle parking. People who perceived a high risk of crime near the store were significantly less likely to travel by public transit, possibly because of danger in walking to and waiting at bus stops. These model results were supported by interview responses. Some interviewees living in low-density neighborhoods suggested that driving provided access to a dispersed set of activities in a reasonable amount of time. Many interviewees living in compact neighborhoods said that they walked more because it was convenient and because driving and parking were hassles. Suburban participants who had free parking at most of their activity destinations drove regularly, and some reported avoiding traveling to San Francisco because of expensive parking. Personal security concerns deterred several interviewees from walking to bus stops, the store, and other locations in high-crime neighborhoods.

In addition, attitudes toward walking and bicycling were statistically associated with mode choices. Individuals who reported enjoying walking were more likely to walk to the store, and respondents who thought their neighbors had a negative view of people who bicycled were less likely to bicycle to the store. These model results were echoed by interviewees. Some said that they enjoyed getting exercise and being "environmentally friendly" when they walked to stores and other errands. Others reported that bicyclists were "risk takers," part of a "counterculture," or "too poor to own a car," and some indicated that they would feel self-conscious if their neighbors saw them riding a bicycle on local roadways. Therefore, improvements in individual and cultural attitudes would help in promoting sustainable transportation.

This study underscores the importance of a complete communities approach in promoting walking and bicycling for routine shopping trips. In addition to complete streets, compact, mixed-use neighborhoods should be promoted to make it convenient for people to walk or bicycle to their entire set of daily activities. Social marketing campaigns could help change the view that walking and bicycling are primarily recreational activities and modes of transportation only for people who cannot drive. Increased police enforcement could be used to reduce street crime. Parking policies should be revisited to limit off-street parking and increase on-street parking prices to reflect market rates.

Poster Summary 39

TRANSIT-FRIENDLY DEVELOPMENT GUIDE, STATION AREA TYPOLOGY (CHICAGO TRANSIT AUTHORITY AND CITY OF CHICAGO)

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Chicago, Illinois, is known for its transit. It is a part of the city's history. Some of its active transit system is more than 100 years old. Yet there is an opportunity to increase ridership at many stations and increase development in the areas around the stations. To address this, the City of Chicago and the Chicago Transit Authority (CTA) partnered to create a model to encourage transit-friendly development (TFD) at CTA stations. This typology study was the result of that partnership and provided a classification of all 144 CTA stations—19 of which are actually outside Chicago—and described appropriate development opportunities for each classification.

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Objectives of the Study

The typology study had three objectives:

- Encourage TFD in the vicinity of CTA rail stations and other CTA transit nodes.
- Provide a tool for elected officials and private developers to use in attracting appropriate, desired development to station areas.
- Identify opportunities for development of CTA- and city-owned properties.

All 144 CTA rail stations were included in the study, including two new planned stations. The opportunity for new infill development varies at station areas. Vacant parcels and development sites under public and private ownership offer an opportunity to reinforce and enhance a neighborhood's character or typology with TFD. In some cases the holdings, especially by the city, create a foundation on which development partnerships can be built.

A Word About Transit-Oriented Development in Chicago

One of the premises of the typology study was that Chicago already is transit oriented. Certainly in the heart of the city, but also in neighborhoods throughout the city, there is a rich network of transit, including CTA bus and rail, Pace bus, and Metra rail. The term TFD has been adopted in Chicago to acknowledge the uniqueness of transit and land use in Chicago. TFD focuses on a more specific set of guidelines including accessibility, connectivity, scale, and a series of development incentives and partnerships focused in the area immediately surrounding the station. Defining station typologies and developing TFD guidelines can help indicate how that station area should be developed to be consistent with the goals of CTA, the city, and individual neighborhoods.

Features Unique to Chicago

The history of transit in Chicago has created certain features of the CTA system that are unique. The unique features create special challenges—and opportunities—in encouraging TFD.

Neighborhoods

Chicago's array of diverse neighborhoods is well serviced by rail and bus transit. The rich fabric of transit throughout Chicago is not common to other cities. Nonetheless, many neighborhoods around stations are mature and have few, if any, vacant parcels.

Configuration

Chicago's transit system is elevated for the most part. The elevated rail lines and stations have few direct connections to adjacent buildings. The stations are closely spaced—in some cases only blocks apart—serving a greater density and mix of uses on the blocks adjacent to transit stations.

Land Use Pattern

Chicago's land use patterns are concentrated in a high-density core, served by the "Loop," to a much greater extent than most other major metropolitan areas. Most other major metropolitan areas have a smaller downtown core and higher-density nodes of development around the periphery, creating other opportunities for higher-density TFD at those outlying stations.

CTA Ownership

Because the transit system is elevated above streets, for the most part, rail lines and stations lie within public rights-of-way. Portions of the Orange, Blue, and Red Lines were built by the City of Chicago and are operated and maintained by CTA, leaving few CTA-owned parcels to leverage for TFD. Large stretches of two new lines run parallel to or are within the rights-of-way of either commercial rail lines or Interstate divided highways. This is significantly different from new transit systems built in other metropolitan areas, where excess land was purchased around stations for the explicit purpose of TFD construction.

City Ownership

Some station areas within Chicago are adjacent to undeveloped properties owned by the city as a result of the elimination of blighted conditions throughout the years. This creates the potential for larger-scale developments not normally found in urbanized areas.

Overall Organization

Generally, the CTA rail stations fall into categories including those in the downtown core, those defined by the activities around them, those serving neighborhoods, and those predominantly serving employment districts. Stations were defined as being in one of four categories: downtown core, activity center, neighborhood, or employment district. From these four categories came the following seven subcategories to better define the station areas:

- Downtown core,
- Major activity center,
- Local activity center,
- Dense urban neighborhood,
- Urban neighborhood,
- Service employment district, and
- Manufacturing employment district.

Conclusion

Assigning each of the CTA rail stations one of seven typologies is a significant component of a broader initiative by the City of Chicago, which includes the following:

• Using the recommended guidelines from the station area typologies to consider a series of zoning code changes to support and implement TFD,
• Creating a similar discussion about typologies for bus corridors, and
• Expanding the reach of TFD to a corridor perspective by initiating corridor studies along a few key arterials in the city.

The typologies that have been assigned each station inform developers and elected officials as to the potential development types that should be considered in these station areas and provide planners and designers with a set of guidelines by which this development should occur.

Recommendations

On the basis of the typology guidelines and the conclusions of this study, the following recommendations were offered:

• Identify station areas where property ownership is such that aggregation and other incentives can be leveraged to encourage future TFD.
• Identify infill development opportunities where existing development around the station is less dense than envisioned by the station area's typology.
• Encourage development around intermodal and park-and-ride stations that makes better use of the land surrounding the station while improving integration among transit functions and connectivity to the station.
• Create standards and templates by which existing surface parking can be converted to structured parking, with at least as much station-oriented parking integrated with transit-friendly multiuse development.
• Examine and evaluate station connectivity for all modes, focusing on connections to existing surrounding development and potential future development.
• Actively look for ways to better connect the stations to the community at the street level and to the adjacent buildings at the platform level.
• Incorporate walkability, integrated mixed-use buildings, and open space into station areas.
• Refine TFD guidelines and incorporate them into the appropriate municipal codes, especially the City of Chicago Zoning Code.

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NEIGHBORHOOD WALKING

Does the Network Matter?

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Can estimates of neighborhood "walkability" be affected by how distances to walkable destinations are calculated? How would walkability estimated by using "as-the-crow-flies" Euclidean distances compare with walkability estimated by using grid distances? This project involved development of a walkability regression model calibrated with data collected for Ames, Iowa. Ames has a population of 52,000 and is home to Iowa State University (ISU). Data either collected or derived included the following:

- Walk scores as calculated by the online web tool Walk Score for 245 sampled locations in Ames,
- Coordinates of commercial amenities downloaded from Google Earth that are within 1 mile of each of the 245 sampled locations,
- Euclidean distances to each amenity from each sample point,
- "Idealized" grid distances to each amenity from each sample point, and
- Aggregated number of amenities within four distance categories.

The online web tool will calculate a measure of walkability for any address on the basis of the Euclidean distance to various commercial amenities—closer destinations are weighted more than destinations further away (maximum 1 mile). The first step was to create a contour map of walk scores of the city of Ames on the basis of the Walk Score website. Within a 3-mile radius of the ISU campus, 245 walk scores were sampled online. Walk score contours were created via an ordinary kriging method found in ArcINFO's Geostatistical Analyst extension.

Next, a multivariate linear regression model was calibrated to predict walk scores by using four predictor variables based on the number of commercial amenities found within Euclidean distance bands around a given walk score sample location (245 locations):

- Within a 0.25-mile band,
- Within a 0.25-mile to 0.50-mile band,
- Within a 0.50-mile to 0.75-mile band, and
- Within a 0.75-mile to 1.00-mile band.

Coordinates of commercial amenities were determined by searching on Google Earth, downloading the Keyhole Markup Language files, and extracting latitude and longitude coordinate information. The coordinate data were then imported into ArcINFO as a point shapefile, and the Generate Near Table tool in ArcINFO was used to locate businesses within 1 mile of each walk score sample point. After this table was joined with the walk score

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attribute table, more than 24,000 records were generated, one for each business within 1 mile of each of the 245 walk score sample points. These records were aggregated to produce the number of businesses within each Euclidean distance category for each sample point.

Through least squares regression, the following linear model resulted:

$$Y = 0.5978 * X1 + 0.4970 * X2 + 0.2998 * X3 + 0.2742 * X4$$

where

Y = predicted score for walkability,
X1 = number of amenities within a 0.25-mile band,
X2 = number of amenities within a 0.25-mile to 0.50-mile band,
X3 = number of amenities within a 0.50-mile to 0.75-mile band, and
X4 = number of amenities within a 0.75-mile to 1.00-mile band.

Two goodness-of-fit measures for a regression model are the *R*-square value and the percent root mean square error (%RMSE). The *R*-square value is the percentage of total variation in the sampled walk scores that can be explained by the linear model. The model given above has a high *R*-square value of 0.94. The %RMSE is a measure of how closely the walk scores predicted by the model above match the actual sampled walk scores.

The model achieved a %RMSE of only 39 percent. The lower the %RMSE, the closer the predicted values would be to the actual sampled walk score values from www.walkscore.com. A smaller %RMSE would have been desired so that the sensitivity analysis of the effects of Euclidean versus Manhattan grid distance would be more powerful.

The number of amenities within each distance band was then recalculated on the basis of an idealized Manhattan grid distance. The resulting “Manhattan grid” walkability scores for each of the 245 locations in Ames were then compared with the Euclidean walkability scores based on the model.

Finally, the possible relationship between walk scores and the amount of sidewalk coverage in Ames was explored. With a sidewalk polygon shapefile supplied by the city of Ames, the amount of sidewalk area found inside each walk score category boundary was calculated. While there is some apparent association between the percent area covered by sidewalk and walk score category, an attempt was made to assess the association further by disaggregating the study area into 100-meter-square grids and calibrating a univariate linear regression model to predict walkability on the basis of percent of sidewalk coverage within each grid cell.

Poster Summary 41

NEW APPROACHES TO QUANTIFYING LIVABILITY BY USING STATE-OF-THE-ART SURVEY AND ANALYSIS METHODS

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Livability is a broad topic that can encompass many issues and themes. Therefore, it can be difficult to quantify and analyze. However, livability must be properly considered and analyzed to make good planning decisions on how best to maximize livability and to optimize livability investments.

In previous work for the Transit Cooperative Research Program (in Salt Lake City, Utah), the Chicago Regional Transit Authority, New Jersey Transit, and Portland Metro, Resource Systems Group (RSG) has been able to quantify "nontraditional" transit attributes, such as protection from the weather; lighting; real-time information (either at a stop or on the web); transfer quality (distance, protection from the weather); heating, ventilation, and air-conditioning performance; maps and schedule information; comfort; cleanliness; proximity to amenities; and onboard wireless fidelity. RSG has also used artistic renderings of neighborhoods and stations and stops so that the land use attributes can be incorporated into user preferences and perceptions.

Through the use of these techniques, RSG believes that many livability issues can be quantified so that decisions can be made on the value of investing in what creates the "most livability for the buck." Livability comprises aspects that are both tangible and amorphous. They range from concrete projects such as infrastructure to ephemeral but critical notions of community cohesiveness. This paper suggests that for many aspects of livability, the same advanced techniques used in RSG's recent transit studies to evaluate nontraditional attributes can be applied to other aspects of livability planning, such as understanding preferences for different types of land use and valuing those attributes (e.g., how much value do sidewalks provide? what about a tree-lined street versus one devoid of trees?).

This paper also presents the results of RSG's recent transit studies that have quantified various nontraditional attributes. Examples include the value of well-lit bus stops versus unlit stops and the value of real-time information at a station on a digital sign versus a web-based real-time information system. Although transit alone does not constitute livability, it is applicable to all of the six guiding principles of the livability initiative listed in the call for papers and on the Federal Highway Administration's website, and therefore it is a critical component of livability. The paper will present findings on the values of nontraditional attributes and how they can be used to create a transit livability evaluation. The paper also envisions the conduct of more research on other types of livability attributes as noted previously.

RSG has found that nontraditional attributes contribute significantly to transit mode choice. For example, travelers are willing to trade about 5 minutes of travel time for real-time arrival information and about 4½ minutes for a modernized station and stop design; premium onboard amenities can be worth 4 minutes or more. These attributes can also have strong interaction effects depending on trip length, wait time, transit mode, and the type of transit

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environment (highly dense areas versus less dense suburban land use). The longer the wait at a transit stop, the more real-time information is worth to a traveler; similarly, the longer the trip, the more valuable onboard amenities become. These transit findings on their own can produce values that can be used to help measure, evaluate, plan, and ultimately increase livability.

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HOW TO DEFINE AND MEASURE LIVABILITY FACTORS

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Livability is a concept that integrates community, environmental, economic, and transportation goals. Being strongly correlated with quality-of-life considerations, livability has been a feature of planning for years. However, the comprehensiveness of livability has proven challenging to define and operationalize in practical ways.

As federal, state, and local governments embrace livability as a value, how do they ensure that the notion will not collapse under its own weight—or result in plans that are interesting but not actionable?

This presentation will explore and advance the state of practice with regard to livability in transportation planning. The session will explore two broad definitions, the first from the U.S. Department of Transportation Strategic Plan for Fiscal Years 2010 through 2015, *Transportation for a New Generation*, where livable communities are "places where transportation, housing, and commercial development investments have been coordinated so that people have access to adequate, affordable, and environmentally sustainable travel options," and the second from the conference's definition of transportation for livable communities: "a transportation system that works with land use to give everyone multiple travel choices for meeting their daily needs affordably, safely, conveniently, and efficiently." The session will examine how transportation planners have successfully framed the concept of livability and what lessons can be learned to further refine the concept.

The authors will discuss three examples of how planners at various levels are working to incorporate livability into transportation decisions:

1. Designing performance measures of livability: The federal government and local governments are working to define livability performance measures that are flexible, focused, and actionable. How do efforts of the interagency partnership and performance measures developed with the Federal Highway Administration support action on the ground?
2. Collaborating across disciplines to establish common objectives for livability: Is it possible to develop a common vision among practitioners in transportation, ecology, and community development? What can be learned from the work of environmental resource

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agencies and transportation agencies attempting to conduct integrated planning? How does climate change fit in? The results of interagency workshops give clues concerning the opportunities and obstacles involved in working across disciplines.

3. Equity as a guiding principle for place-based definition of livability: How do planners ensure that full access and opportunity are embedded in community plans? The session will highlight a regional initiative in the Richmond, Virginia, metropolitan area to prioritize brownfields and abandoned properties for redevelopment, a state planning initiative, and the U.S. Environmental Protection Agency's Environmental Justice Showcase Communities Initiative to explore effective means of incorporating equity in distinct communities' plans.

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BICYCLING AND TRANSIT

A Marriage Unrealized

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Cycling continues to increase in usage and gain attention for its ability to achieve environmental, health, and congestion mitigation benefits for communities. While the growth in both cycling and transit may be attributed in part to bicycle and transit integration, it is difficult to measure. Given the variety of bicycle and transit integration strategies—increased parking at stops, increased bicycle capacity on transit vehicles, and shared bicycle infrastructure, to name a few—which ones are more cost-effective? Which strategies will yield the largest number of cycle transit users?

To fill a void in the literature about the integration of bicycling and transit, this paper describes and assesses four common bicycle and transit integration strategies, develops a framework for evaluating each of them, and conducts a preliminary cost-effectiveness assessment. The cost-effectiveness assessment encompasses costs and cyclists' preferences for each of the strategies. The preferences were gathered through stated preference surveys from focus groups in five case study communities and calculated with the analytic hierarchy process, a multicriteria decision-making tool. Results of the cost-effectiveness measure suggest that bicycle aboard transit is most cost-effective. However, the limited growth potential for bicycles aboard transit requires further consideration of the alternatives. The overall importance that cyclists assigned security suggests that there is considerable room for creative solutions in improving the favorability of the three additional strategies, thereby addressing some of the inherent capacity limitations of the most popular strategy, transporting the bicycle with the rider on transit.

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HIGHWAY 92 CORRIDOR LIVABLE CENTERS INITIATIVE

A Case Study in Implementing Viable, Livable Multimodal Networks

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Highway 92 is one of the most significant corridors in Douglas County, Georgia. High levels of accessibility, combined with large tracts of vacant land, made the corridor a popular location for new development at the beginning of this century. In response to emerging growth pressures, the county applied for and was awarded a livable centers initiative (LCI) grant to develop a plan for the Highway 92 corridor.

Consistent with the LCI's objectives, the resulting Highway 92 corridor plan recommends a series of accessible, walkable, mixed-use centers that put jobs, shopping, residences, civic places, and parks all near each other. Supporting the corridor vision is a multimodal network of streets and off-road trails. The network is critical to the success of the plan because it represents the following:

- The framework for the development of walkable, pedestrian-scale blocks;
- A confluence of the public and private realms creating valuable spaces for people to interact;
- Safe, comfortable facilities for walking, bicycling, and riding transit; and
- Street connections that distribute traffic efficiently and provide alternatives to travel on US-92 itself.

The Highway 92 corridor plan sets a clear vision for the corridor. The transportation network recommendations follow sound network planning principles and are consistent with the land use and urban design context.

The plan recommends more than 50 intersection, sidewalk, streetscape, trail, transit, and street network projects. While each project is important to the overall development concept for the corridor, practical considerations require that each project be phased in over time. Furthermore, national and regional shifts in market conditions since the initiation of the study have created the need to consider the market impact of each project.

In response to this need, the county applied for and was awarded a supplemental LCI grant by the Atlanta Regional Commission. The Highway 92 Corridor Supplemental LCI Study allowed the county to move forward with a more focused set of tasks for implementation. Among the tasks were further analyses of the costs, benefits, and impacts of the network recommendations and development of a better understanding of the relationships between transportation projects and market demand, culminating in a "game plan" for implementation that includes prioritization, phasing, cost, and responsibility.

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Methodology

The study team's approach to the Highway 92 Corridor Supplemental LCI Study was based on a careful balance between the four main factors that affect implementation of the recommended transportation projects: livability, mobility, market impact, and physical and environmental constraints. The study team used a series of innovative, low-cost methods, both qualitative and quantitative, for evaluation of each transportation project in the Highway 92 corridor.

For example, instead of traditional corridor-based automobile level-of-service measures, the team used areawide quality-of-service standards. The areawide approach balances automobile measures of level of service with consideration of the vehicular capacity of an entire interconnected network of streets, rather than a single arterial. The quality of bicycle, pedestrian, and transit networks was also taken into account and quantified.

To demonstrate the benefits of an interconnected multimodal network, the mobility impacts of the recommended network were compared with capacity improvements to US-92. SYNCHRO and other analytical tools were used to derive evaluation measures, which included delay on Highway 92, areawide volume-to-capacity ratios, and access to bicycle and pedestrian facilities.

This effort had three purposes:

1. To establish the nexus between the proposed network and corridor mobility benefits,
2. To establish evaluation measures that can later be used to gauge network performance as the plan begins to come online, and
3. To get a better sense of the relative importance of each project to overall network performance.

Many qualitative measures were also used to evaluate the recommended transportation projects. For example, each project was evaluated for its ability to

- Promote design at a human scale (streets, blocks, etc.),
- Connect to open space and public places,
- Provide gateway treatments and other "branding" elements, and
- Contribute to a mix of uses and building orientations.

Findings and Results

The result of this evaluation is a clear set of project priorities for the near team (2 to 5 years), the medium term (5 to 10 years), and the long term (beyond 10 years). The objective, transparent, and comprehensive process resulted in broad approval from and support of the recommendations by staff, citizens, property and business owners, and elected officials.

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COORDINATING LIVABILITY, ACCESSIBILITY, AND MOBILITY IN RURAL AMERICA

What Works? A Presentation of Best Practices and Lessons Learned from NCHRP Report 582: Best Practices to Enhance the Transportation–Land Use Connection in the Rural United States

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A wide array of research is available on the subject of integrating land use and transportation to promote urban livability, but few studies have investigated integrated planning approaches in rural communities. To begin filling this gap, in 2007 the Transportation Research Board published *NCHRP Report 582: Best Practices to Enhance the Transportation–Land Use Connection in the Rural United States*.

The study identified a planning framework and best practices, illustrated by 12 case studies, for coordinating transportation investments and programs with land use strategies to achieve rural community development goals that optimize regional mobility, improve local accessibility, and enhance community livability.

On the basis of surveys and analyses of demographic and economic trends in rural America, the study identifies three types of rural communities, each of which faces a distinctive set of accessibility, mobility, and livability issues:

1. Exurban communities exist on the fringes of most U.S. cities. Many have shifted from a local economic base to some level of dependence on accessibility to jobs and services outside of the community. They are primarily concerned with improving connections to jobs and services in adjacent urban centers by providing higher-speed transportation facilities or by locating jobs and services nearer residential areas.

Exurban communities are growing at an above-average rate of 5 percent per year. Livability issues tend to focus on often-conflicting desires to preserve local culture and green space while also embracing new people, jobs, and opportunities.

2. Destination communities are in locations that feature natural amenities such as mountains, lakes, or beaches attracting seasonal residents, retirees, and tourists. They are located primarily in the West, the Upper Great Lakes, and New England. The economic base in these communities has shifted from traditional rural industries (agriculture, manufacturing,

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or mining) to the provision of access to natural amenities and the support of a recreational or leisure culture. They tend to focus on regional mobility strategies to bring visitors into the community and on multimodal connections within the community to improve accessibility for tourists and employees.

Destination communities are growing at an above-average rate of 6 percent per year. Their livability issues concern the need to keep from "killing the goose that lays the golden egg" (i.e., protecting the natural assets that attract rapidly growing numbers of people, jobs, and traffic).

3. Production communities are typically found in remote areas such as the Great Plains, the Corn Belt, the Mississippi Delta, and Appalachia. They depend on a single industry that has experienced decline, such as agriculture, manufacturing, or mining. It is difficult to diversify their economic base and to access faraway job centers. Production communities seek strategies to improve connections between local producers and target markets and to cultivate new economic engines that can thrive within the existing transportation framework.

With a below-average growth rate of 2 percent per year and a loss of jobs, their livability issues are focused on the desire to keep the community alive, with sometimes conflicting desires to resuscitate traditional industries or to create new ones.

The study recommended the following planning framework and best practices to address rural accessibility, mobility, and livability at three scales:

1. Set the regional framework for optimal development patterns by coordinating growth management, preservation, and access management strategies.
2. Improve local accessibility to daily needs such as jobs, shopping, services, and health care through practices such as development standards and plans to promote mixed-use, walkable community centers. The practices would be reinforced by transportation improvements to street connectivity, pedestrian and bicycle facilities, and transit services.
3. Enhance community livability through practices such as context-sensitive roadway design techniques that complement natural and built environments and by coordinating access management and community design strategies to manage traffic and improve aesthetics along key commercial corridors.

The processes by which rural communities achieve results featured several common elements:

- Collaborative (often regional) partnerships,
- Active public engagement and education,
- A focus on quality of life and long-term sustainability, and
- Strong local leadership (both grassroots and government).

Case studies for 12 communities discuss the key issues, catalytic events, and planning processes involved in coordinating land use and transportation strategies to improve mobility, accessibility, and livability:

- Burlington, Iowa (main street revitalization);
- Cutler–Orosi, California (community development charrette);
- Edgartown, Massachusetts (transit-oriented development);
- Hayden, Colorado (community visioning and scenario planning);
- Hutchinson, Minnesota (reclaiming main street from a state highway);
- Lincoln City, Oregon (U.S. highway as community gateway);
- Moss Point, Mississippi (post-Katrina communitywide reinvention);
- Northwest Vermont (regional scenario planning and visioning);
- Sedona, Arizona (community-based transit);
- Traverse City, Michigan (community-based car sharing);
- Unity, Maine (linking downtown revitalization and rural preservation with greenways and transit); and
- Abingdon–Damascus, Virginia (Virginia Creeper Trail tourism development).

The study advisory panel included the following members: Shelley Mastran, Chair, preservation planning consultant and codirector of National Endowment for the Arts "Your Town: The Citizens' Institute on Rural Design" program; George Smith, California Department of Transportation (American Association of State Highway and Transportation Officials liaison); David Boyd, MSA Professional Services; Charles Carr, Mississippi Department of Transportation, Public Transit Division; Stephen Hoesel, Mid-Iowa Development Association Council of Governments; Polly McMurtry, Vermont Department of Transportation; Rosemary Monahan, U.S. Environmental Protection Agency Smart Growth Program; Melisa D. Montemayor, Texas Department of Transportation; Beth Osborne, representative of Sen. Carper; David Sears, U.S. Department of Agriculture; Elizabeth Fischer, Federal Highway Administration; Kimberly Fisher, Transportation Research Board liaison; and Chris Hedges, project manager, National Academies.

Poster Summary 46

SCHOOL DISTRICT POLICIES AS BARRIERS TO WALKING AND BICYCLING TO SCHOOL

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There are many benefits to students walking or cycling to and from school. Schools built in walkable locations near housing help unite neighborhoods and community life because they are easily accessible and can serve as a community crossroads. However, in today's climate of liability and legal considerations, schools and school districts have instituted policies that discourage or prohibit walking and bicycling to and from school even in walkable communities with neighborhood schools.

While Safe Routes to School programs are developing and flourishing in many communities around the country, some communities are discovering barriers to active transportation because of school policies. A policy that discourages or prohibits bicycling

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or walking can stop a Safe Routes to School program in its tracks. There is a great variety in what school walking and bicycling policies do and do not cover. Some schools have no formal policy; others have a policy that includes a complete ban on bicycling with no explanation as to why the ban is in place.

The approach to researching this topic was twofold. First, legal and liability concerns were researched through case law, existing state policy, and school personnel's legal duty of care toward students. Second, 165 schools and 25 school districts in Middlesex County, New Jersey, were surveyed to obtain current school policy or lack thereof for students walking or bicycling to and from school.

Policies tended to fall into two categories: official school district policy and individual school procedure. No school districts in Middlesex County had policies about walking to school. Policies with regard to bicycling were different. Although many school administrators did not know whether a policy existed, a significant number of policies delegate the decision to allow or prohibit the use of bicycles to the principal or building administrator. In this situation, individual school rules become official policy. However, this apparently created confusion when some principals within the district grant students permission to ride and others in the same district prohibit riding. In addition, some school administrators noted that individual school policy changed when school principals changed, leaving school personnel and parents confused.

On the basis of a collection of walking and bicycling to school policies, the poster presents the reasons behind barrier policies, including land use, urban form, and liability concerns. The poster also showcases positive examples of model walking and bicycling to school policies, including details concerning how model policies can support livable communities.

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TRAVEL DEMAND FORECASTING FRAMEWORK FOR ASSESSING SMART GROWTH STRATEGIES

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This paper develops an enhanced four-step travel demand forecasting framework that is sensitive enough to assess the impact of smart growth strategies in enhancing the transportation and environmental sustainability of communities. The refinement focuses on individual travelers' destination choice and mode choice decisions that play significant roles in shaping the overall travel pattern of a transportation system. In modeling the destination choice decisions, different discrete choice models were developed for different trip purposes. The impact of various land use attributes on intrazonal and interzonal trip-making behavior was taken into account. In addition, separate mode choice models were developed to capture the influences of land use on mode choice behavior. The enhanced modeling framework was tested in the Greater Buffalo–Niagara area in New York, with the 2002 Buffalo household

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travel itinerary survey data as the input. The modeling results indicate that the balance and diversity indicators of land use in terms of the population and employment distributions have a significant impact on destination and mode choice decisions. Balanced and diverse land use will encourage more intrazonal trips, shorter travels, and use of transit and nonmotorized modes, and thus it will help reduce the overall vehicle miles traveled.

Poster Summary 48

METHODOLOGY FOR ASSESSING AND REPORTING THE IMPACTS OF TRANSIT INVESTMENT ON COMMUNITY SUSTAINABILITY AND LIVABILITY

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The gas tax fund, a key component of the Building Canada infrastructure plan, provides funding for municipal transportation infrastructure that contributes to the sustainability and livability of Canadian communities. As a recipient of gas tax funding for its capital projects, TransLink is required to report annually on the impacts of gas tax investments on sustainability and livability in the Greater Vancouver area. TransLink initiated the development of a reporting template that sets out the indicators and methodologies to be used in annual reporting. The reporting template and methodologies developed are unique in that they enable postimplementation reporting across a range of livability considerations.

Methodology

Methodologies for assessing the greenhouse gas and air quality impacts associated with transit improvements are well documented; however, approaches to monitoring and reporting on other sustainability and livability impacts are not as well defined, understood, or codified.

As a starting point, the key impacts associated with transit improvements were identified in cooperation with federal, provincial, and regional agencies. They included environmental, social, and economic impacts and covered issues such as physical activity, social inclusion, disabled accessibility, transit–land use integration, public realm quality, pedestrian connectivity, safety, security, journey quality, enhanced property values, and efficient goods movement.

Indicators, metrics, and methodological approaches for measuring and reporting these impacts were developed by Halcrow and TransLink, with reference to academic research and global best practice. Data requirements and collection methods for reporting purposes and the need to enable applicability across a range of types of transit investment (e.g., new vehicles, light rapid transit schemes, and bus infrastructure such as bus lanes) were critical considerations. These methodologies were developed into a reporting template designed to provide guidance and enable a consistent and transparent approach to impact assessment.

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Findings, Lessons Learned, and Observations

The template allows assessment and reporting in respect of the full range of sustainability impacts and livability benefits in a single reporting framework. It includes a one-page summary table allowing quick review of the range of impacts of infrastructure investment. The template was piloted as part of the gas tax reporting process in 2009 and was refined on the basis of the experience of users.

The presentation will include a high-level overview of the methodologies used for the performance evaluation of key livability indicators. It will also focus on the following observations and lessons:

- Assessing the impacts of transit investment necessitates the ability to forecast accurately the impacts under a "without scheme" scenario, which constrains the range of impacts that can be assessed.
- Data and resource availability was a crucial factor in template development and refinement. The utilization of existing data collection and management systems was maximized to improve efficiency and reduce resource demands. Where data were unavailable or only partially available, proxies provided useful indications of trends.
- In the early years after transit infrastructure investment, greenhouse gas reduction benefits may be realized slowly, while other livability impacts may be more keenly felt. Follow-up reporting is necessary for the full range of livability impacts to be confirmed. However, in successive years after implementation, direct attribution of livability benefits to the transit investment may become more difficult.
- Not all effects are quantifiable. In some cases (such as with respect to impacts on the public realm), the possible range and extent of qualitative improvements require assessment. The template includes metrics that allow this.
- In many cases, qualitative observations played a useful role in "telling the story" and complementing the account provided through quantitative assessment. In addition, a clear definition of the project scope (in terms of both service and geography) is required to ensure that all impacts are assessed within a consistent frame.

Poster Summary 49

MOVING GOODS AND PEOPLE IN URBAN CENTERS

Reducing Transportation Impacts with Shared-Use Services

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While urban planning has begun to consider the relationship between land use patterns and traffic demand, much of the work in this field has focused on personal travel. Communities must also be able to move goods efficiently to thrive. This research examines alternative transportation services to move goods and people and reduce the environmental impact of travel without negatively influencing economic well-being. These services also support social goals by providing residents with additional flexibility in meeting their daily needs efficiently and by providing mobility-challenged residents with access to goods and services.

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Communities and businesses are starting to examine the benefits of aggregating personal vehicle trips into shared-use vehicles. Trips made with shared vehicles, such as those made in school buses and vanpools, incur fewer vehicle miles traveled than do corresponding individual trips (see Cairns 2005). However, delivery and transit vehicles have larger societal costs per mile traveled, including greater emissions of greenhouse gases and more significant infrastructure degradation.

The research described here uses grocery store shopping in Seattle, Washington, as the first case study to quantify and compare carbon dioxide (CO_2) emissions due to personal versus shared-use travel and identify the conditions under which CO_2 emissions savings could be realized. The results of the study can inform policy development as communities attempt to encourage economic development while minimizing environmental impact.

Project Scope

Grocery store shopping is used as a case study because it is a regular activity for most households and is highly regional (most shoppers visit a proximate store). Advances in computing technology and logistics management have enabled cost-effective online consumer shopping. In addition, most grocery shopping is done in a traditional retail environment, in which consumers drive personal vehicles to and from supermarkets. A survey (Nielsen Company 2008) showed that the average household made 97 trips to grocery, supercenter, or warehouse stores in the preceding year, or approximately two trips per week. This rate of shopping corresponds to 25 million trips annually by Seattle households alone. Addressing the transportation option chosen for this trip type will have significant implications for greenhouse gas emissions.

Research Methodology

The model compares CO_2 emissions of individual driving versus shared-use vehicles by using land parcel and zoning data. Travel costs are calculated by using the Network Analyst tool in ArcGIS along with customized network decision variables to allow for optimization based on financial cost, time, or emissions. Costs are estimated from publicly available data and reflect values of time, hourly wages, and mileage costs. Emissions estimates are developed by using Motor Vehicle Emission Simulator model emissions factors (U.S. Environmental Protection Agency 2010).

Calculating shared-use distance traveled is influenced by the logistical details of the service. Delivery service schedules dictated by customer preference will include households distributed throughout the service area, while delivery service schedules dictated by the service provider will have the households geographically organized to obtain logistical efficiencies. Customer-directed service was estimated by random sampling of the households within the service area. Provider-directed service was estimated with proximity-assigned samples of the households. The two methods of selecting customers reflect a best case and a worst case in terms of logistical efficiency. Although a customer-directed service would allow customers to dictate their delivery time, a delivery service would assign customers to routes

as efficiently as possible given fleet size and time constraints, so this worst case does not reflect the expected outcome in all cases. The provider-directed service represents a best case for logistical efficiency, with customers highly concentrated spatially.

To estimate the distances traveled and the associated CO_2 emissions, routing tools within ArcGIS Network Analyst were used. Customer-directed service and provider-directed service were estimated with the household sampling techniques described above.

To complete the routing estimates, the Network Analyst Closest Facility tool was used to calculate the distance traveled to each grocery store for each household in the sample. The StreetMap North America network was loaded for use with Network Analyst. Output from Network Analyst includes the one-way distance traveled for each residential unit and the one-way CO_2 emissions associated with each residential unit's grocery store trip when the trip is optimized for shortest time. These outputs were doubled to reflect round-trip distances and CO_2 emissions.

To complete the routing estimates, the Network Analyst Routing tool was used to calculate the distance traveled by one delivery vehicle starting and ending at the study grocery store and serving a sample of 35 households (estimated truck capacity). The analysis reordered the stops to identify the fastest route to serve the given households but kept the first and last stops (the grocery store serving as the depot) constant. Output from Network Analyst includes the distance traveled for each delivery vehicle and CO_2 emissions associated with each tour, with the route optimized for shortest time.

Outcomes

The analysis of grocery delivery demonstrates a significant reduction in vehicle miles traveled and CO_2 emissions when personal vehicle travel is replaced by delivery service. The reductions are largest in delivering to a proximity-assigned set of customers. In this case, delivery service can reduce CO_2 emissions by 80 to 90 percent, compared with 17 to 75 percent when customers are randomly assigned. The analysis considered the relationship between personal vehicle travel replaced by one delivery vehicle. This unit of analysis allows for scaling according to adoption level, but it does not reflect the efficiencies gained by larger customer populations served by a fleet of delivery vehicles. In these situations, reductions in CO_2 emissions are expected to fall between the randomly selected and proximity-assigned cases, since customers within a self-selected delivery window can be grouped by the provider into proximity-based routes.

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Poster Summary 50

DEVELOPING A METRIC FOR TRANSPORTATION SUSTAINABILITY TO SUPPORT LIVABLE COMMUNITIES

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As the understanding of the value of transportation expands beyond its role of providing mobility and the focus moves to how it affects livability, new criteria and metrics are needed to assess the performance of transportation systems. While conventional metrics are primarily concerned with mobility and the monetary costs of transportation, this research focuses on creating and testing a framework for assessing the sustainability of the broader aspects of transportation systems in terms of environmental, social, and economic outcomes. Working toward sustainability advances livable communities and vice versa.

The results show the performance of (*a*) the 50 states and (*b*) the 50 largest urbanized areas with respect to the economic and financial indicators outlined in the metric. The economic components assessed are as follows: (*a*) transportation is affordable for individuals, (*b*) the transportation system provides efficient movement of people and goods for economic activity, (*c*) transportation finance is locally self-sufficient, and (*d*) the transportation system does not contribute to the economic vulnerability of society. The analysis will also consider how economic performance is related to the urban characteristics, such as population density and travel mode shares, of these places.

The initial results exhibited regional geographic patterns in performance for the 50 states, which suggests that regional attitudes may be responsible for affecting land development and transportation patterns. To improve understanding of the urban characteristics and physical infrastructure of the states, the spatial distribution of population and commuter mode shares was examined. By using these measures to compare the results, the best-performing states were found to have a larger portion of population residing in central cities and the surrounding metropolitan area. Furthermore, with the exception of the most rural, states with more modes of transportation available performed better.

Next, the 50 largest urbanized areas, which consist of the core city and adjacent dense development, were examined. These areas were also evaluated for performance by using variables similar to those of the analysis at the state level. Again, a relationship was found between better-performing areas and more diversified transportation mode choice. With regard to other descriptive parameters, population density and vehicle ownership show little correlation with the results, while a lower number of vehicle miles traveled (VMT) per household leads to more favorable performance.

In terms of the economic components identified, a better-performing state or urbanized area has the following characteristics: lower total out-of-pocket transportation costs per household, greater economic growth than VMT growth, and a smaller burden on the overall economy attributable to gasoline expenditures. The following are some of the observed trends for the urbanized areas: households that spent more on transit had a lower total transportation cost; most urbanized areas averaged a 1:1 ratio between gross domestic

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product (GDP) growth and VMT growth, but the best performing saw a 20 percent reduction in VMT with 10 percent growth in GDP while the worst saw 200 percent growth in VMT with a 25 percent growth in GDP; on the basis of the average price of gasoline from 2007, in some cases expenditure on fuel made up 4 percent of GDP. Altogether, these measures assess the economic concerns from the transportation perspective that includes personal and overall economic quality.

Data quality issues are the major limitation of this work and for development of performance measures in general. The types of data necessary for evaluating transportation systems properly in terms of sustainability and livability objectives are sparse to nonexistent. Where available, data are often inconsistent or insufficient. This research endeavor, coupled with these gaps in information, highlights the need for standardizing data and collecting new data across a range of scales. Currently, data for congestion, monetary costs, and economic indicators are the most available, because those concerns historically have been the focus of transportation planning. As attention begins to shift toward planning for sustainability and livability, there is a need for a complementary shift in data collection.

APPENDIX B

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