Access to Destinations

2007 Conference Proceedings

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CTS

CENTER FOR
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UNIVERSITY OF MINNESOTA

Access to Destinations

2007 Conference Proceedings

Contents

Introduction

In 2004, researchers from around the world gathered in Minneapolis for the first Access to Destinations conference. Two days of presentations and dialogue provided a unique opportunity for experts in transportation, urban planning, geography, and public policy to exchange ideas on a broad range of topics related to the emerging paradigm of accessibility in transportation and land use studies.

The conference resulted in the publication of selected research papers in a book, *Access to Destinations* (Elsevier, 2005), and also launched an interdisciplinary research program at the University of Minnesota (www.cts.umn.edu/access-study).

Three years later, the second Access to Destinations conference again brought together researchers and policymakers from many fields. Those three years have clearly been a productive time for accessibility research, as evidenced by the breadth and depth of papers presented at this conference. From new methods and tools focused on measuring accessibility, to far-reaching and candid discussions of the policy implications of new research findings, the 2007 conference showed that accessibility studies are making great strides in academia and in the public discourse on land use and transportation issues.

Access to Destinations represents a new way of looking at the complex challenges that characterize transportation and land use in the twenty-first century—including congestion, economic development, transit service, and social equity. The research projects described in this document are characteristic of the work now underway in this diverse interdisciplinary field.

Several of the research papers presented at this year's conference will be included in the first issue of the *Journal of Transport and Land Use* (www.jtlu.org), a new peer-reviewed, open access publication launching in early 2008. Focusing on the intersections of transport and land use, *JTLU* will publish innovative work drawn from multiple scholarly disciplines, including engineering, planning, modeling, behavioral sciences, economics, geography, regional studies, sociology, architecture and design, network science, and complex systems.

Welcome and Opening Remarks

Robert Johns, Director, Center for Transportation Studies, University of Minnesota

Robert Johns

Robert Johns welcomed the participants and described the background for this second Access to Destinations conference. The first conference, held in 2004, resulted in the publication of a conference proceedings as well as the book *Access to Destinations* (Elsevier, 2005), containing selected scholarly papers.

The first conference also helped launch the Access to Destinations Study, an interdisciplinary research and outreach effort led by David Levinson and Kevin Krizek to measure accessibility for the Twin Cities region. Levinson is an associate professor and Braun/CTS Chair of Transportation Engineering at the University of Minnesota; Krizek is an associate professor at the University of Colorado, formerly with the Hubert H. Humphrey Institute of Public Affairs at the University of Minnesota.

CTS is coordinating the study with support from sponsors including the Minnesota Department of Transportation, Hennepin County, the Metropolitan Council, and the McKnight Foundation. Eleven research projects are under way as part of the study. "I think this will be very provocative information," Johns said.

The McKnight Foundation is funding the outreach components of the study, including mechanisms such as workshops, research summaries, and a Web site.

Selected papers from this second conference will be published in the inaugural *Journal for Transport and Land Use*, a new academic publication under development by Levinson and Krizek with assistance from CTS.
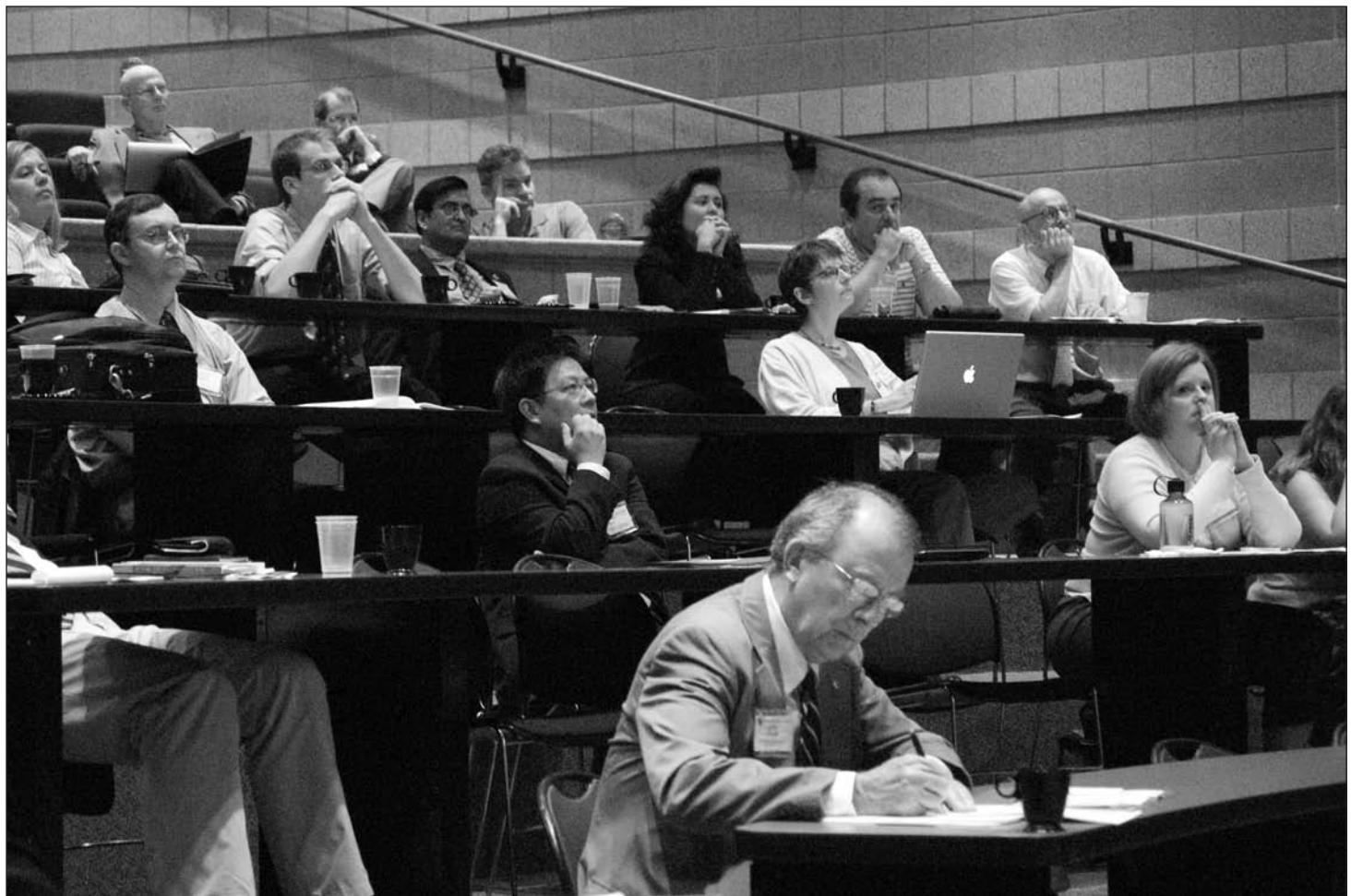
International Perspectives on Accessibility

Moderator: *John Adams,* Associate Dean, Hubert H. Humphrey Institute of Public Affairs, University of Minnesota

Accessibility: Long-Term Perspectives

Kay Axhausen, Professor, Institute for Transport Planning and Systems, Swiss Federal Institute of Technology ...

Kay Axhausen

Kay Axhausen began his presentation by contrasting access with accessibility. Access is the ability to find a service deliverer for any one occurrence, such as locating a hospital for a heart attack victim. It is a specific need at a specific point in time. "Accessibility is more usefully thought of as a composite good," he explained, "a joint statement of all the opportunities you have and the associated costs you have to get there." The concept isn't new, he said, as economists for some decades have suggested a "well-defined, well-proven" measure for accessibility that can integrate relevant factors such as monetary costs, travel time, reliability, and comfort.

Axhausen and his fellow researchers used this measure of accessibility in their study of Switzerland's development over past 50 years. Switzerland is small enough and so well documented, he added, that the research was able to look at data from the past 150 years.

Historically, rivers, lakes, and oceans provided cheap transportation throughout the world. Cities tended to form at the break points in the transport chain where goods had to be transferred from one mode to another. It was these locations that gave rise to opportunities for trade and transport innovations, Axhausen said.

Modern societies have sought to improve accessibility in order to capture the lower costs and greater prosperity it generally brings. The story of Switzerland, which increased and rebalanced its infrastructure investments to improve accessibility for the suburbs and Alpine areas, is no different.

Accessibility increased enormously between 1850 and 1888 when public transportation—railroads—ended the horse-and-buggy era. Public transport retained an advantage over roadways until 1950; only then, with big increases in auto ownership and higher traffic speeds, did roadways maintain a consistent advantage. Since then both public and private

systems have continued to grow to an extent that every point in Switzerland is reachable within three hours from any other. "Through investment in infrastructure and private investment in cars," he said, "Switzerland has essentially been halved in size."

The Swiss have responded to those changes. In 1950 a large portion of the population was concentrated in major cities, but by 2000 the situation had changed considerably, with much growth in the suburbs. This policy has started to run its course, however, as marginal gains are decreasing as the country reaches accessibility "saturation," he said. "Shrinking Switzerland further is becoming an increasingly costly way of supporting economic growth."

This holds true for the United States as well, even with its growing population. "Those big gains we had of a national system both in the U.S. and Switzerland will never be replicated, unless we find something exceedingly exciting," he predicted.

As space "shrinks," Axhausen continued, the reach of individuals should expand. His recent research looked at the distances between the homes of "social network members" (those claimed as important in each others' lives). The distribution shows a large portion of people close by, he said, but with a "very long tail" of others. About 40 percent of all trips and mileage in the United States and most of the industrialized world is for leisure purposes—including travel for maintaining social networks—and leisure is the fastest-growing market in transportation.

It's not just the developed world that is seeing this dramatic change in accessibility. "We don't think anything of vacationing in the Caribbean… or going to a conference in Minneapolis," he said, and very few of the Swiss in his research have only local relationships. "We have globalized our social life and we are acting on it to meet our friends," he said.

"Through investment in infrastructure and private investment in cars, Switzerland has essentially been halved in size."

Hong K. Lo

"We do have land. We just do not want to spread out."

On the Provision of Sustainable Public Transit Services: The Case of Hong Kong
Hong K. Lo, Hong Kong University of Science and Technology

Hong K. Lo discussed the policies that have allowed Hong Kong to buck the global trend of falling public transit patronage.

Eighty percent of Hong Kong is set aside as green space. The government is very conscious of land use and has employed a strategy of building new towns through land reclamation, all linked by a very efficient rail system. "We do have land," Lo said. "We just do not want to spread out."

Public transit attracts more than 90 percent of the 11 million daily trips in Hong Kong, which has a population of 6.9 million. The mean journey time is 39 minutes, and over half of all trips are completed within 30 minutes. All transit services are operated by private companies according to commercial principles and without direct government subsidies. "This is a very important fact and key result," he said.

What government does, however, is set a "level playing field" for all operators. Government defines a hierarchy of public transit services (including rail, buses, taxis, and ferries) "to avoid wasteful competition and ensure system efficiency," Lo said. The private sector provides transit services within a set of government regulations; government provides checks and balances through regulations while ensuring an enticing environment to the private sector.

This approach has been developed and modified over the past several decades. Policies during the 1980s gave strong priority to rail and even prohibited direct competition from other modes (or required bus fares to be the same as rail). This policy was designed to create sufficient demand to pay back the huge investment in rail over a reasonable time. The government was criticized, however, for seeming to favor big operators, and rail operators had no incentive for improvement.

The 1990s became a time of service proliferation and competition. "Before, you could hardly get a seat on a bus," Lo said, "but in the 1990s, too many were running to be profitable." People liked the additional services, but trip times lengthened because of congestion.

In this decade, Hong Kong has tried to reimplement the policy of 1980s to make better use of rail and rationalize and consolidate services. The public, however, strongly objected to plans for bus service consolidation. "Once public transit service is offered," Lo said, "it is extremely difficult to consolidate its service. This is an important lesson to be learned."

Currently, infrastructure expansion has surpassed growth in passenger trips, so growth in one mode comes at the expense of others. Per passenger carried, the operating costs of bus and rail trips are comparable at about 50 cents. Bus companies, however, do not maintain highways, while rail must pay for fixed infrastructure such as stations. As a result, the cost of rail is 60 percent higher, and rail revenue is not enough to cover operations. To foster rail's sustainability, the government invests in start-up costs and grants rail companies the right to develop properties around stations. "This is how to get a win-win situation with companies and government," Lo said.

The government also controls land use tightly and directs growth to high-density neighborhoods, typically around stations along major rail or subway lines. Land developers like the guaranteed market of this approach, Lo said, which establishes a synergy between transportation and land use.

Private car ownership is also tightly controlled. Steep taxes on new cars and fuel contribute to a low rate of car ownership—roughly a tenth of the United States' rate, despite a similar GDP.

In closing, Lo pointed out several key lessons from Hong Kong's experience:

- First and foremost, the urban density of development is imperative to ensure financial sustainability.
- Managing provision of competitive services is critical. Rail services are costly but can be operationally cost-effective—as effective as buses—if infrastructure costs are subsidized.
- Bus services can achieve financial sustainability more easily but their externalities (congestion, pollution) cannot be ignored.
- The provision of public transit services should be staged with urban development.
- The synergy between real-estate development on top of railway stations should be exploited.

Sprawl and Accessibility
Robert Bruegmann, University of Illinois at Chicago

Robert Bruegmann took a different tack on sprawl and accessibility. Accepted wisdom has held that sprawl is recent, particularly American, and caused by the postwar rise of the automobile. Many believe sprawl is bad and should be stopped. These perceptions are based on a misreading of history, he declared, and actually distract us from real urban problems.

Sprawl is as old as cities themselves, Bruegmann began, and for good reason. From the earliest times until very recently, living at the center of most cities meant congestion, pollution, and highly unsanitary living conditions for most of the urban population. "As every new group could afford to move out, [it] did so," he said, whether in ancient Rome or 18th century Paris.

This process sped up after Industrial Revolution, as more people further down the socioeconomic ladder had a choice of where to live. The advent of the railroad—and public transportation—made it possible to vastly increase the outward migration. London, as the most prosperous city in the western world, decentralized the fastest. "For the working class, it was heaven," Bruegmann said. "For a smaller amount of money they had something like the choice of affluent urban dwellers." To the intellectual and artistic elite, however, these developments "defaced" the British countryside.

Every city in the world with political freedom and any kind of land market follows this pattern, Bruegmann continued, regardless of transportation mode or economic systems. What's more, there is a strong and growing convergence within and among countries: cities are becoming more like suburbs, suburbs like cities, the United States more like Europe, and developing countries more like developed ones.

For example, densities are growing the most quickly in the lowest density, fastest growing American Southwest, while older eastern cities continue to decentralize. Likewise, density is decreasing in European cities. "The average Parisian today lives in a house and travels by auto," Bruegmann said.

The projection of auto usage is nearly identical for the United States and Europe, only with a time lag because of the delay in postwar affluence. "Despite crushing taxes and billions in investment in transit [in Europe]," he said, "ridership in buses and transit is about flat while auto and air [use] have skyrocketed."

With one exception—Hong Kong—every affluent city in the world has decreased in density, Bruegmann said. He attributes Hong Kong's uniqueness to its former status as a British colony and its more authoritarian central government.

The most famous attempt at controlling sprawl in this country is Portland, Oregon, which invested heavily transit. "But the area still sprawls, and much development is jumping over the growth boundary," Bruegmann said. "The policy has not created any substantial increase in modal share of transit, and congestion has grown at least as fast as any American city… People like both the amenities of cities and the ability to use autos."

To Bruegmann, changing the built environment for the transportation system is the "tail wagging the dog"—land patterns remain for 100 years but transportation technology is likely to change in a decade. Possible technologies could include new fuel sources, personal rapid transit, or 200-mph guideways.

In conclusion, Bruegmann declared that sprawl is a bad diagnostic tool, and focusing on it distracts us from real urban problems—such as the one-third of the world's population that lives on less than $1 per day. "We can't see that these urban landscapes are the middle-class settlement of the world because we put this denigrating name [sprawl] to it," he said.

Robert Bruegmann

"People like both the amenities of cities and the ability to use autos."

Implications for Research and Practice

Moderator: *Robert Johns,* CTS
David Levinson, University of Minnesota
Kevin Krizek, University of Colorado
Anne Canby, President, Surface Transportation Policy Project
Samuel Seskin, Transportation Planning Director, CH2M Hill

David Levinson

Kevin Krizek

Anne Canby

Levinson began the panel with a review of the co-evolution of land use and transportation in the Twin Cities and changes in the area's accessibility. The Twin Cities metro has experienced significant development and population growth since the 1950s, in part due to the development of transportation networks that can support this growth, he said.

As part of the Access to Destinations Study, Levinson's team is using data from the Metropolitan Council and the U.S. Census to determine travel times between various points in the metro area. Early results indicate that many people can reach almost all of the region's jobs within a 30-minute drive.

In 1990, residents of the core centers could reach between 400,000 and 600,000 jobs within 15 minutes, and those in a few zones could reach 600,000 jobs or more. In 2000, this accessibility had increased somewhat for several reasons, Levinson said. One is that the transportation network added some capacity, although congestion ate into some of those gains. But more important is that jobs have redistributed to where people are, and development created more jobs for them to reach. "Accessibility is two-pronged sword: changes in the transportation network and changes in land use increase accessibility," he noted.

The picture of transit since 1990 isn't as dynamic. "You can't get hardly anywhere by transit," Levinson said, which explains transit mode share in the Twin Cities and the nation. People choose to drive "because accessibility is that much better than it is by transit," he said. "Individual people are behaving rationally."

Overall, Levinson reported, most areas have had a positive increase in accessibility for workers and employers while a few have lost accessibility.

Levinson also shared some early accessibility findings from his analysis of traffic patterns since the August 1 collapse of the I-35W bridge. For example, I-94 south of 35W is seeing a significant increase in flow while 35W itself has seen a significant decrease, as measured by Mn/DOT loop detector data. "We'll be looking at many interesting stories," he predicted.

For the work, Levinson is using a University of Minnesota version of a transportation-planning model with data from the Metropolitan Council to analyze system properties with and without the bridge. With the loss of just this one key link, regional accessibility is dropping by one to two percent, although much will depend on how well drivers adapt over time. "The accessibility and economic potential of the region are severely affected," he said. "We're in a mature system, and additional links won't make as much difference as earlier links, but this link… is a significant link."

Krizek, who leads the nonmotorized side of the Access to Destinations study, said a much more detailed-scale analysis of accessibility is needed if our goal is to foster more "environmentally benign" transportation modes. "That's where some of tensions between mobility and accessibility are evident," he said. While many planning initiatives call for both mobility and accessibility, they increase mobility almost at the expense of accessibility, especially for alternative modes.

Accessibility "gets gray quickly," Krizek continued, because it has three components: destinations, the networks that connect them, and "embedded assumptions" of how people go between them. For example, residents may desire to walk to the neighborhood store, but researchers have had little data about retailers until recent advances in geographic information systems. Ninety-five percent of shoppers bypass the closest grocery store for another, but details are limited about the reasons why. Likewise, there is faint information about nonmotorized networks such as bike paths, particularly their connections to origins and destinations. "Travel time is not the be-all and end-all," he said. "Some people want a quality travel experience at the expense of travel time."

Many of these normative assumptions can be clarified through accessibility measures, Krizek concluded. His portion of the Access to Destinations Study will provide a detailed analysis of transit, bicycling, and walking, specifically regarding origins and destinations.

Seskin said the steady decline in the cost

of travel and communication is reshaping accessibility in ways that aren't yet well understood in the planning community. Evidence is that large, traditional transportation projects are offering a declining return on investment as project costs rise much more quickly than inflation. Benefits are not as high as proponents claim, he said, whether for highway or transit projects.

The challenge for planners is to communicate the significant and changing nature of accessibility to policymakers and the public. "We are often caught up in mistaken emotional debates, such as transit versus highway or bus versus rail, which distract us from the real issues regarding accessibility," Seskin said. The debate shouldn't be about individual projects but about balancing a series of interests: large new projects versus infrastructure maintenance, mode versus network, real access versus virtual, regional and local access versus global and national, the economic side of access versus the social side, and benefits to the individual versus the costs to society as a whole, such as pollution. Regions will distinguish themselves with their answers.

Canby said "there are all kinds of communities all over the world and there always will be." The question is what residents want for their regions. Planning should be the tool to help people understand the kind of community they want, whether they are willing to pay for it, and what the consequences are. "I am convinced we must be much more transparent and help people think about this," she declared. "They care quite passionately."

Most of the nation's metro regions are not focused on the multidimensional nature of access or the breadth of beneficiaries of different kinds of access. Canby encouraged expanding our thinking beyond the work trip—which makes up a shrinking percentage of travel—to include other activities such as shopping on Saturdays or freight shipments at night.

Another issue Canby raised is the need for a network perspective. Currently planners think in terms of silos (such as light rail) rather than networks, which reduces the overall effectiveness and efficiency of the transportation system. "We haven't woven this together," she said. "This is a very important concept."

Other issues such as the social network, energy consumption, greenhouse gases, health care costs, and economic impacts are also important. And the nation's changing demographics, with increasing numbers of immigrants and older households needing access to a variety of activities, will have "huge implications," Canby said.

The panelists then fielded a number of questions, including one about the impact of telecommunications on accessibility.

Krizek said communication is possible—assuming everyone has computers and reliable networks—with anyone at any place at any time of day, so more travel would be expected. Many products are available through online shopping, but the transportation benefits haven't reached the extent predicted 5 or 10 years ago. And text-messaging won't replace dinner parties. "It's something we'll need to keep our eye on."

Axhausen said telecommunications is essentially a complement, not a substitute, for physical face-to-face meetings, which are essential to the social processes of trust building and conflict resolution. "Only after that's happened, a certain [number] of meetings and interaction can be moved to nonphysical means." Both travel and telecommunications will grow jointly together, he predicted, as they have for past 10 years. Telecommunications will increase travel because it expands the physical size of social networks. Technology had the same effect in the commercial realm, he noted, as firms are able to coordinate trade flows and logistics over much larger areas.

Seskin said oligopolies have caused the monetary cost of communications services to rise far faster than incomes. The challenge for public policy is to determine the public sector's role in providing technology at no cost or low cost for those on average household income.

Levinson pointed out that telecommunications could result in trip replacement—for example, workers may spend three days in the office instead of five but choose a longer commute. "It's hard to say if total travel goes up or down. It may be at different times, but organized differently," he said.

Levinson also shared a long-term look at technology. One day computers will be as advanced as the human brain and replace drivers. Anyone now unable to drive would have a new option (assuming they could afford the technology); everyone else could avoid the stress of driving— and perhaps choose to travel more.
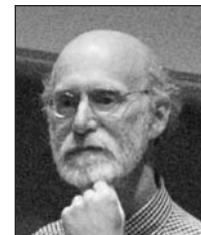
Sam Seskin

"We are often caught up in mistaken emotional debates, such as transit versus highway or bus versus rail, which distract us from the real issues regarding accessibility."

Technical Session 1A

Moderator: *Steven Polzin,* University of South Florida

Relationships between housing and employment centers, particularly as they relate to commuting, were featured topics of discussion in this session. Jobs-housing balance, traffic congestion, and access to employment opportunities were among the issues discussed.

Accessibility, Productivity, and Traffic Congestion: Findings for Major Activity Centers

*David Hartgen** and *Gregory Fields,* University of North Carolina at Charlotte ....

Quantifying accessibility and traffic congestion in metropolitan regions

Hartgen presented findings of research that investigated how accessibility and traffic congestion affect the economic performance of large urban regions. "That's what's on the minds of elected officials and business," he said.

The study quantified the extent of accessibility and congestion in the highway networks of eight regions, using drive-time contours to determine how many jobs and residents are within each five-minute interval of five key points, and how much that will change in the future or would be increased by congestion removal. The eight regions are Charlotte, Salt Lake City, Seattle, Denver, San Francisco, Detroit, Dallas, and Atlanta. The five key points are the central business district (CBD), major mall, large suburb, university, and airport. The accessibility of each point was then correlated with regional productivity, defined as gross regional product per worker. The study then quantified how much each region's productivity would improve if congestion were significantly reduced.

All the cities are expected to grow substantially over the next 25 years, and delay is expected to increase sharply in most of them. The estimated cost of removing severe congestion from each area ranges from a low of $1.2 billion to a high of $29.2 billion for San Francisco.

Accessibility in these regions varies substantially. The study found that the CBD is generally the most accessible place in each region, with typically 30 to 60 percent of jobs and 25 to 50 percent of residents within 25 minutes of downtown. Other regional points have typically half to two-thirds the percentage of CBD jobs or residents within 25 minutes. However, growing congestion and suburban growth together mean that key points in most regions will become relatively less accessible in the future. Removal of congestion would increase the access to key points by 2 to 30 percentage points, allowing most regions to

reverse the expected decline in access and making these key points relatively more accessible as the region grows.

The study also found that regional productivity is more dependent on access to suburbs, malls, and universities than on access to downtowns. Not only are models of productivity stronger for these generally suburban sites, but elasticities are higher, indicating that changes in access to these points will have a relatively greater effect than changes in access to the CBD. "The studies show we're looking at the wrong areas of metropolitan areas," Hartgen said.

Extending the findings, the study calculates that removal of congestion would boost gross regional performance by 6 to 30 percent if targeted at suburbs, malls, and universities, but 4 to 10 percent if targeted at CBDs, and just 2 to 8 percent if targeted at airports.

The 20-year tax "take" from the productivity gain caused by these improvements is likely to be several times larger than the estimated cost of congestion removal. For Charlotte, for example, improving the accessibility of major suburbs would increase regional performance by about 31 percent; over 20 years, the tax take from such an action would amount to $31.5 billion. On the other hand, improving access to the CBD by relieving congestion would yield just $4.6 billion over 20 years.

He noted several caveats of the study: it used a limited sample, with no small cities; regional productivity can differ for many reasons; and there are other ways to improve productivity besides congestion relief, such as transit, flextime, and land use changes.

The study is based on a larger report to the Reason Foundation.

*Presenter

'Optimal' Accessibility Landscapes? Developing a New Methodology for Simulating and Assessing Jobs-Housing Relationships in Urban Regions
Mark Horner, Florida State University ....

The jobs-housing balance—and its connection to land use and transportation—continues to draw substantial interdisciplinary attention, said Mark Horner. The thought is that making jobs and housing more accessible to each other will decrease travel, especially commuting. There is some debate as to the efficacy of such policies, however, and even whether such linkage exists at all.

Several recent research efforts have aimed at extending the excess commuting framework and its GIS-based spatial models to more prescriptive, policy-relevant situations. In his research, Horner developed the idea of a theoretical "optimal" urban jobs-housing balance and proposed a new spatial model for finding it. The developed model treats a region's theoretical minimum commute as a baseline indicator of jobs-housing balance. "The lower the theoretical minimum commute, the greater the jobs-housing balance," he said.

The model allows users to examine changes to urban structure (such as location of residences and jobs) to calculate an optimum jobs-housing balance, using the theoretical minimum commute as a benchmark. Alternative patterns of workers and jobs are simulated in order to improve this indicator.

Horner demonstrated the model in several scenarios using data from the decennial U.S. Census (2000). For example, Leon County, Florida (which includes Talahassee) added 17,000 commuters between 1990 and 2000, while the total capacity for adding commuters was 47,800. Were the additions optimal in either location or number? "The model shows how far off the landscape is from optimal," he said. "The model tended to add residences downtown and added jobs to the suburbs."

The results demonstrate the model's capability for finding "optimal" spatial distributions of jobs and housing, as well as pointing out the inefficiencies in existing urban structure. The model also allows users to explore different growth scenarios and optimal distributions for new workers and jobs. "We can't prescribe it politically," he said, "but it is interesting to know."

Spatializing the Dissimilarity Index to Measure Jobs Housing Balance: A GIS Approach
Bernadette Marion* and *Mark Horner,* Florida State University ....

Bernadette Marion described the development of a spatial dissimiliarity-based index of jobs-housing balance. The overall goal of the research is to improve the substantive measurement of jobs-housing balance and segregation generally.

Current measures of jobs-housing balance, such as the theoretical minimum commutes described by Mark Horner, are limited, she said. They fail to capture either the multidimensional opportunities for spatial interaction or the differential accessibilities to employment, given realistic commuting options. For example, the theoretical minimum commute finds the mean optimal commute by reassigning workers to new employment locations that minimize commute costs from fixed residential locations. The aggregate

pairings often fail to resemble actual commuting patterns.

Marion's research is developing a more sophisticated view of jobs and housing using the dissimilarity index, the dominant measure used in the social sciences, particularly for the study of segregation. In its traditional aspatial formulation, the measure describes segregation as a departure from an even distribution between two population groups. It is dominant in the social sciences because it "is very flexible and easily grasped," she said.

During the last several years, spatial scientists have extended its utility by infusing distance-decay concepts developed from the location-based accessibility literature. This infusion allows for user-controlled parameterization of the magnitude of

Modeling the relationship between housing and employment

*Presenter

Technical Sessions

interaction between subunits. The new index also increases the capacity of a global index to measure multidimensional facets of residential accessibility to employment.

To explore the utility of the new index, Marion analyzed jobs-housing balance on a database of 26 U.S. metropolitan areas. She found that the new index appears to be a relevant measure of urban spatial structure and hence, jobs-housing balance.

Technical Session 1B

Moderator: *John Ottensmann,* Indiana University-Purdue University

Presentations in this session took a variety of different approaches to understanding the influence of the built environment and transportation networks on travel patterns and accessibility levels. Among the key issues examined were the different ways people access needed services and make residential location decisions.

A Geo-spatial Methodology Used to Site Accessible Facility Locations for the Department of Home Affairs in South Africa

*Johan Maritz** and *Zaid Kimmie*, Council for Scientific and Industrial Research, South Africa

Planning for accessibility in rural South Africa must take into account the unique geography and history of the area, including settlement patterns influenced by the legacy of apartheid. Dispersed settlement patterns reflect the system of "homelands" where the black population was resettled. Today, the rural population is still spread out over large areas with few transport links.

With a history marked by severe inequities in public services, service delivery in South Africa is a highly politicized issue. The Department of Home Affairs commissioned this study with the objective of providing more services to the underserved rural population. Specifically, this study sought to find the most accessible sites to locate new facilities such as health clinics.

In addition to permanent facilities, the researchers also modeled the use of mobile service providers for certain types of service in remote areas. The research focused on basic so-called "cradle-to-grave" services. South Africa's Eastern Cape Province was selected as a pilot study area in order to evaluate the approach.

Using the Flowmap software package developed at the University of Utrecht, the researchers divided the study area into a fine-grained hexagonal grid and created a spatial interaction model incorporating travel time data. Ranges of travel times were used to define "catchment areas"—areas in which the population would be expected to access the same services, analogous to watersheds in which all drainage flows down into a single basin—for facility locations. For example, an area with a population of more than 20,000 residents within a threshold travel time was considered a candidate for a permanent facility.

Flowmap's several service location expansion models were used to evaluate alternative systems of facility siting with different objectives, such as maximizing population coverage or minimizing travel times. Consultation with stakeholders was critical, as not all variables affecting facility location could be modeled. The availability of different travel modes to target populations was also an important factor—many rural residents do not have access to private automobiles, and therefore rely on irregular shared transportation or on walking to access critical services.

The model produced two outputs: a map showing the spatial distribution of potential service facilities, and a set of accessibility measures for different areas. These products alone, however, were not sufficient to determine a rigidly defined set of facility locations. Local information provided by stakeholders was introduced into the process through consultation and review of the proposed siting scheme. This proved to be a critical step, as technical buy-in from stakeholders and local officials can make or break a large-scale public project.

Following the pilot study, the South African government proceeded to apply the geo-spatial methodology and planning process to all of the country's nine provinces in order to develop a complete set of proposed sites for permanent and mobile service providers.

*Presenter

The Role of Employment Subcenters and the Built Environment in Residential Location Decisions

Eun Joo Cho*, *Daniel Rodriguez*, and *Yan Song*, University of North Carolina at Chapel Hill

Commuting patterns and access to employment in polycentric cities have been the subject of considerable research; relatively little research effort to date has been directed at understanding the influence of polycentric urban form on residential location decisions. In this study, the researchers attempted to gain a better understanding of transportation and land development by studying residential location decisions relative to employment subcenters in the area around Charlotte, North Carolina (Mecklenburg County). Specifically, the researchers sought to understand how residents of polycentric cities value access to employment subcenters, and to determine the degree to which characteristics of the built environment influence residential location choices.

The researchers noted that much of the previous research on residential location decision has assumed that work locations are exogenously determined—that workplaces are selected before residential locations, and independently of them. However, recent research has called this assumption into question, pointing out that access to *potential* employment or activity centers may be more important than access to a worker's *actual* employment location in selecting where to live.

The study was based on cross-sectional analysis using discrete-choice models of residential decision-making. Data sources included household-level demographic and travel data from the 2001 Charlotte-region travel survey, and zonal data on demographics, employment, and the built environment provided by the metropolitan planning organization, county planners, and the department of transportation.

To define employment subcenters, the researchers used a technique suggested by earlier research on the Los Angeles metropolitan area, modifying the criteria to account for the study area's much smaller physical size and population. Subcenters were defined as connected sets of traffic analysis zones (TAZs) containing a minimum employee density and minimum number of total working residents. This analysis yielded ten subcenters (including the central business district) within Mecklenburg County.

Accessibility to these employment subcenters was then measured as the log-sum of a mode choice model estimated for the county. The multimodal nature of this model produced a generalized cost to access a given subcenter from a given location, accounting for the variety of transportation options available.

In order to characterize the built environment of each TAZ, the research team developed a typology of neighborhoods based on cluster analysis of several built-environment factors. This enabled the 373 block groups in the study area to be reduced to eight neighborhood types; the results were vetted by local planners. In addition to this typology, two additional factors ("walkability" and "local accessibility") were identified through exploratory factor analysis by combining several observed indicators.

Two types of discrete choice models were used to analyze residential decision patterns: a conditional logit model and a heteroscedastic conditional logit model. Estimating the two models for different measures of access, income levels, and choice options (all TAZs available for choice, or only a partial subset) resulted in a total of 36 different models. The researchers compared these results, searching for the modeling approaches that produced good consistency and fit.

This research revealed consistent association between access to employment subcenters and residential location choice, suggesting that individual employment subcenters function as important determinants of residential location decisions for all households. The results also suggest that different preferences are associated with different income groups—a pattern that may be explained by existing patterns of transportation, land use, and economic specialization of subcenters. While the study's use of cross-sectional data and the unique characteristics of the study area limit the generalizability of these findings, the nuanced picture of residential location choice it provides may contribute to future planning for regional access.

Examining the influence of polycentric urban form on residential location decisions

Technical Sessions

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Measurement of Accessibility for Business Establishments: An Empirical Evaluation

Kazuya Kawamura, University of Illinois at Chicago

"Accessibility" has become a key component of many regional transportation plans in recent years; however, while a consensus on the general meaning of the term appears to exist within the planning and regulatory communities, a rigorous operational definition of accessibility remains elusive. Kawamura asserted that little empirical evidence is available linking accessibility improvements to economic benefits or other planning goals, and little is known about the efficacy of accessibility measurements in capturing travelers' experiences.

To address these knowledge gaps, Kawamura's study examined the efficacy of current "state-of-the-practice" accessibility measures in a specific context: quantifying the accessibility experienced by business establishments. Businesses were asked to rate the level of accessibility to their locations by a variety of travel modes, and these results were correlated with a variety of accessibility measures.

Overall, Kawamura found a generally poor fit between the results of accessibility calculations and the reports of traveler experiences. Several possible explanations exist for this discrepancy, he noted, but suggested that the most plausible explanation appeared to be differences in the way the concept of accessibility is understood by planners and survey respondents. His interpretation of the results suggested that what respondents were evaluating was neither accessibility (in the way commonly understood by planners) nor mobility in the conventional sense; instead, he suggested that lay persons associate the term "accessibility" with levels of convenience or frustration experienced while traveling.

In conclusion, Kawamura recommended that planners and researchers re-evaluate the use of accessibility measures in the planning process in light of the apparent mismatch between the technical and popular understandings of accessibility. In a larger context, these results may be seen as highlighting the limitations of accessibility as a planning tool, and begging the question of whether improvements in measured accessibility for a particular project will actually achieve the stated plan goals.

Technical Session 2A

The presentations in Session 2A provided insight into some of the differences between European and American cities in research, transportation behavior and urban form. Researchers looked at the complex factors that influence travel behavior and residential choice and introduced the notion of stability into decision-making and the complexity of decision-making when it comes to home ownership.
Moderator: *Daniel Baldwin Hess*, State University of New York at Buffalo

How Stable are Preferences for Neighborhood Characteristics and Accessibility?: Analyzing Residential Location Decisions

Ryan Wilson and *Kevin Krizek**, University of Colorado and *Ahmed El-Geneidy*, McGill University

Kevin Krizek and his team examined relocation decisions and preferences for a sample population in Hennepin County, Minnesota, US (in which Minneapolis is located) by conducting a survey of 1,000 randomly selected households. They surveyed homeowners in urban, inner suburban and outer suburban locations, achieving a response rate of nearly 50 percent. The researchers then evaluated and assigned neighborhood types, looking at both where respondents lived previously and where they moved to, using factor analysis and cluster analysis. Next, they assigned previous and current addresses to neighborhood types, and finally analyzed the choices of moves. Ryan Wilson described the three areas as fairly typical urban and suburban settings.

The study found that 66 percent of

*Presenter

respondents moved within their geographic area (inner, inner suburban or outer suburban). An evaluation of the moves within neighborhood types or clusters showed that only 53.6 percent were within the same neighborhood type. Those who stayed within the same neighborhood type prized race over home ownership, and they moved smaller distances from downtown to areas of lower home value. They also are cyclists and prefer short commutes. People who moved, moved to areas with greater numbers of homeowners, higher estimated home market value and, if they moved a greater distance from downtown, they moved between neighborhood types.

According to Wilson, these results are important for land use research and for transportation travel research because they shed light on the role of accessibility and neighborhood characteristics in general. "We want to be able to understand the nature of moves because people move often," said Wilson. US Census Bureau data reveal that more than half of all people move every five years,

according to Wilson. "These moves happen often, and the better we can explain the nature of those moves, the better we're going to be able to plan for them, and the better people will understand the markets they move to."

In the question-and-answer session following the presentation, some audience members took issue with the research, insisting that factors such as crime, schools, taxes, and race play a greater role in neighborhood selection than was addressed in this research. Wilson said he was in no way suggesting that "access to a regional trail system trumps issues of race or school quality when it comes to residential location decisions." He said he was merely suggesting that "those who are more physically active in their transportation are a little bit more attuned to their physical environment." He allowed that while "you may not like our sample and you may not like our methods, but the variable came up significant, which is why we're discussing it."

Relative Space and Sustainable Mobility: Using Accessibility Disparity as an Explanation of Commuter Patterns

David Vale, Newcastle University, United Kingdom

In his presentation, David Vale introduced accessibility disparity, a concept he created and used to explain commuting patterns in Lisbon, Portugal's capital and largest city. Accessibility disparity is a comparison-based indicator of a place's accessibility based on two dimensions: the transportation mode and the spatial scale. Arguing that the term "sustainable urban form" lacks a clear definition, Vale proposed that the term is a relative one, and can be used to compare different cities or a particular city over time.

Using 2001 data, Vale evaluated the commuting patterns of Lisbon's 2.6 million inhabitants. Forty-seven percent commute by car and 31 percent by transit, with a total of 85 percent using motorized modes. Vale used accessibility disparity to explain commuter patterns in Lisbon, evaluating them by transportation mode (car and non-car) and spatial scale (regional and local destinations).

While we normally assume that this travel behavior is a function of socioeconomic and land

use factors, Vale evaluated commuter patterns using conceived and perceived land use/space calculated by parish (a smaller municipality division in Portugal) and added car and transit accessibility. He created models to explain car and transit commuter patterns. Because he used 61 variables and had only 207 parishes, he used a step-wise multivariate statistical model. Though this generalized his findings to some degree by collecting variables relevant to his sample, he said he still found it useful.

Vale found that socioeconomic factors explain 76 percent of total variability for car commuting in Lisbon with no accessibility variables found relevant. Household composition and occupational status were the main factors affecting car use, with mixed use also relevant.

"The more interesting findings," explain why people use transit, said Vale. In this case, socioeconomic factors explained 36 percent of total variability while land use explained 52 percent of total variability. Vale is still working to understand this. Parishes that are more self-

Discerning the influence of land use patterns on travel behavior

contained use less transit, although it's not clear whether they are driving or walking instead.

In conclusion, Vale sees commuting as an expression of the population's lived-in space, which he believes can help us understand why people make certain choices. The way people commute is the way they live and relate to the space, "so it's really hard to try to change it"–at least through land use alone.

Since different factors explain car and transit commuting, it may be easier to achieve change by focusing on increasing transit use rather than by reducing car use. Accessibility disparity can also highlight places within a metropolitan area where lack of transit practically imposes car use on people. Lastly, a focus on accessibility may increase the acceptability and feasibility of a more sustainable urban form as different urban land use and transportation policies could achieve the same objective.

Urban Form and Travel Behaviour Relationships in Tyne and Wear, Northeast England, United Kingdom

*Paulus Aditjandra** and *Corrine Mulley*, Newcastle University and *John Nelson*, University of Aberdeen, United Kingdom

Paulus Aditjandra's presentation used a case study approach to focus on the impact neighborhood design had on travel behavior, "with the aim of encouraging low carbon-based travel," said Aditjandra. The idea is to encourage people to get rid of their private cars, he explained. "[T]his is a bit provocative in the US," said Aditjandra, because the country has very high car dependency. While extensive American literature on this topic already exists, it has limited applicability to European practices because of the difference in urban form variables such as street layout and car use. In the UK, there has not yet been much research on travel attitudes and preferences.

The study was confined to Tyne and Wear, a metropolitan area in Northeast England around the mouths of the Rivers Tyne and Wear. The area has five districts of authority. The researchers obtained primary data from residential households across the five districts and 10 neighborhoods of the Tyne and Wear metropolitan conurbation. They picked two areas of each district—one traditional grid layout and one suburban—to be as representative as possible. They distributed 2,557 questionnaires and received a 32 percent response rate. Questionnaires captured a number of transport dimensions of several behaviors: urban form relationships, socioeconomic characteristics, travel patterns, neighborhood characteristics, and travel attitudes/preferences.

A comparison of sample characteristics to population characteristics (based on the 2001 British Census) showed that the results are quite similar, though their results suggested that the population is aging. There also was a trend toward more people having more cars.

They then used a cross-sectional design to investigate the relationship between neighborhood characteristics and travel behavior using travel and neighborhood preferences as explanatory variables. Multivariate analysis confirmed that socioeconomic variables as well as travel attitudes can explain the differences between suburban and traditional neighborhoods, and this allows a comparison of American and UK experiences. Comparing the results to the US evidence, this British case study shows a significantly lower level of car dependency in the United Kingdom than in the United States.

At this stage of the research, it appears that a traditional neighborhood has a greater probability of being sustainable in terms of lower car dependency than the suburban neighborhood. Further analysis will help to provide an understanding of how to create more sustainable neighborhoods.

*Presenter

Technical Session 2B

Moderator: *Hong K. Lo*, Hong Kong University of Science and Technology

Modeling and data analysis were the overall themes of this session, with research presentations giving particular attention to public transit access and the development of new community areas.

Access to Railway Stations and Its Potential in Increasing Rail Use

Moshe Givoni, Martijn Brons*, and *Piet Rietveld*, The Free University of the Netherlands

Efforts to increase rail use usually focus on the characteristics of the rail service itself, Martijn Brons asserted, while giving little attention to potential riders' ability to access the rail network through its stations. In the context of large declines in rail mode share, the researchers asked what factors would be most effective in encouraging rail use, and in particular, what role could be played by the accessibility of rail stations.

More than 360 rail stations provide the Netherlands with a high density of stations per square kilometer, and more than 90 percent of the population lives less than 10 kilometers from a station. Nonetheless, the share of trips by rail is low (although still better than the EU average). The researchers posited that potential riders' choice of rail is a function of three factors: the level of rail service, the accessibility of rail stations, and the characteristics of the areas each station serves.

In order to determine how important rail station accessibility is to passengers as part of their overall satisfaction with the rail journey, the researchers used survey information collected by the Dutch national rail operator. Statistical analysis of these data revealed ten major dimensions of the rail journey that affected customer satisfaction. Of these, accessibility ranked seventh in terms of importance for all passengers; for infrequent rail passengers, however, accessibility appeared to be much more important, ranking third overall.

For policymakers, focusing on station accessibility may be more difficult than emphasizing rail service, because while policies can easily be changed to increase the frequency of train service, it is often much more difficult to influence station accessibility. Brons also noted that the factors examined in this study—service, station accessibility, and origin characteristics— represent only half of a picture of rail use. The other half is filled in by destination activities, a topic beyond the scope of the present study.

Exploring the Availability of Public Transportation Services through Analysis of the National Household Travel Survey Appended Data

Stephen E. Polzin* and *Edward Maggio*, University of South Florida

Data from the National Household Travel Survey (NHTS) and the U.S. Census have enabled researchers and planners to examine the relationship between public transit use and numerous demographic characteristics such as race and ethnicity, household income, automobile availability, and gender. However, said Stephen Polzin, these data sources have been largely unable to shed light on the relationship between transit supply factors—such as the accessibility of transit service—and transit use.

Appending additional geospatial variables to the NHTS and Census datasets provides a tool for examining these questions. The researchers appended data on distances from households to the nearest rail stations and bus lines, drawn from the National Transit Database, to the 2001 NHTS dataset. Polzin noted that the resulting dataset is limited by the fact that only straight-line distance data is available; the presence of multiple or convoluted routes to transit stops, as well as additional variables affecting transit service such as frequency, cost, and speed, are not captured.

The researchers' analysis, Polzin said, revealed significant differences in access to transit service (both from home and from the workplace) as a function of race, age, automobile ownership, and urban area size. In addition, he said, the findings suggest that the share of transit-accessible trips is smaller than previously believed, making transit accessibility even more critical than has been acknowledged by transit planners.

*Presenter

An Application of the Accessibility Indexing Model: Coomera, Australia

Tan Yigitcanlar*, Queensland University of Technology; *Rick Evans* and *Neil Sipe,* Griffith University (Australia)

Highlighting the existence of national differences in approaches to planning for transportation and land use, Tan Yigitcanlar described how Australian planning methodologies today represent a mixture of American and British models and are "struggling to find an identity" that reflects the needs and circumstances of Australia.

One planning tool native to Australia is the Land Use and Public Transport Accessibility Indexing (LUPTAI) Model, a decision support tool developed to help local and state governments optimize the integration of transport and land use. Yigitcanlar described how LUPTAI was applied to a study area within the city of Coomera (Queensland) in order to gauge the model's effectiveness as a planning tool.

LUPTAI is a GIS-based model that operates independently of the underlying GIS package. In contrast to models that focus on road travel, LUPTAI is designed to produce measurements of access to particular land uses dispersed throughout an area via walking or by means of public transport. Walking can be analyzed either as a direct mode of travel to a destination, or as a way to access public transit. The specific land use destinations used by LUPTAI to measure accessibility are: employment (commercial zones); health care; shopping; financial and postal services; and educational destinations.

In the Coomera project, LUPTAI was used to develop a composite accessibility map supporting planning activities. While the results painted a convincing picture of accessibility in the area, Yigitcanlar noted that future work on LUPTAI would attempt to address current limitation in its modeling strategy and also focus on methods for cleaning and preparing data. In particular, the addition of bicycle use to the model, as well as demographic traveler characteristics and the potential integration of LUPTAI with the four-step planning methodology remained to be explored.

Technical Session 3A

Moderator: *Kazuya Kawamura,* University of Illinois at Chicago

All three presentations in this session addressed the aging population, which will significantly increase in the coming years. Two of the studies focused on accessibility issues facing older persons in London, and one of the studies focused on the location decisions being made by the group described as "pre-elderly" in metropolitan Ohio, US. There are some indications that baby boomers are going to become a different kind of elderly, noted both moderator Kazuya Kawamura in his comments about the presentations and Morrow-Jones in her presentation.

Understanding the specific accessiblity needs of the elderly

Accessing the Extent of Transport Social Exclusion Among the Elderly

Helena Titheridge*, Kamal Acuthan and *Roger Mackett,* University College, London; *Juliet Solomon,* London Metropolitan University

Helena Titheridge's presentation discussed work undertaken as part of the AUNT-SUE Project (*Accessibility and User Needs in Transport for Sustainable Urban Environments*), which focuses on how land use and transportation interventions can improve inclusion of different groups of people within society. Work carried out in the context of AUNT-SUE shows that Department for Transport (DfT) indicators taken for daily access to destinations such as work, education, health, etc., may be suitable for some socially excluded groups (e.g., the unemployed, those without a car) but may be inappropriate for older persons. National DfT accessibility indicators, developed as part of the accessibility planning process that England requires local governments to follow, require a percentage of a certain group to access a certain activity within a specified set of minutes.

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Using National Travel Survey statistics, a survey of older people in Hertfordshire and focus groups in the north of England, researchers found that older people are less concerned with saving small amounts of time on journeys. Mobility is crucially important to their quality of life.

Based on an initial focus group of older persons in Rotherham and input from community officers there, the researchers created a preliminary set of benchmarks based instead on the frequency of trips in a given period—per week, per month, or annually for holidays. They then worked with focus group participants to identify journeys important to them such as food shopping and social activities. The researchers checked the validity of these provisional benchmarks during additional focus groups in London and Hertfordshire. These groups agreed with identified trips and proposed frequencies.

A study of St. Alban's City, north of London, evaluated accessibility to key locations for residents over the age of 60, analyzing data such as access to buildings, the existence of

dropped curbs, and steepness of curb gradients. "It comes down to all these micro-level details," said Titheridge. These micro-level criteria are being incorporated into AMELIA, a tool based on geographic information systems (GIS) being developed for assessing policy actions.

In conclusion, Titheridge said that most of the UK national indicators do not apply to older people. Very few of them were relevant or correctly specified for this group. In addition, indicators based on time thresholds do not reflect older people's attitudes toward travel. The approach of using minimum journey frequencies seems to work much better for the needs of older people, according to Titheridge. "It's quite clear from the research we've done," said Titheridge, "that the success or failure of a policy, such as putting in a new bus route, depends on micro-level details and things like the walking environment. It's not enough to look just at where buses go to and from. We've got to look at the walking elements of the journey."

Determinants of Residential Location Decisions among the Pre-Elderly

*Hazel A. Morrow-Jones** and *Moon Jeong Kim*, The Ohio State University

Hazel A. Morrow-Jones and Moon Jeong Kim discussed determinants of residential location decisions among the "pre-elderly"—early baby boomers between ages 50 and 64 in 2006. Their survey of repeat home buyers in metropolitan Ohio, focused on intra-metropolitan mobility within this group. According to Kim, they used a life-course model which holds that people's roles and household characteristics lead to different preferences at different stages.

The researchers used a dataset based on properties bought and sold in an 18-month period between 2004 and 2006 in Franklin County, Ohio, US, the central county of the larger Columbus, Ohio metropolitan area. They received a return rate of approximately 22 percent, analyzing 505 largely white households.

The researchers divided their dataset into three groups: under age 50, ages 50-64 (pre-elderly) and ages 65 and older (elderly.) Morrow-Jones reminded listeners that the pre-elderly, a baby boomer group, have redefined every age they've reached in the United States, and even expect

markets to cater to them.

Researchers asked respondents to rate factors affecting their home and neighborhood choices and the role that accessibility played. Respondents rated factors on a one to seven scale of importance.

When choosing a home, the size of the house, the cost and the resale value were important to all three groups. Researchers found that three things decrease with age: desired house size, desired lot size, and desired price. The importance of accessibility features increased with age. Ease of maintenance and energy efficiency mattered only to the two older groups.

In choosing a neighborhood, safety, economic characteristics, and general appearance were very important to all three groups. The youngest group cited the importance of schools, traffic, and parks. The elderly found local trash collection very important. Both the pre-elderly and the elderly respondents cited the importance of quality local police service.

Accessibility reasons for buying or selling

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Technical Sessions

were "simply not as important as other things we gave people the option of," according to Morrow-Jones. The researchers found that the importance of the role that distance to work played decreased with age. The distance to recreation mattered most to the youngest group. Availability of public transit was only slightly more important to the elderly.

In general, as expected, the pre-elderly are sometimes more similar to the young and sometimes more similar to the elderly. Holding other factors constant, though, the pre-elderly are more concerned with ease of maintenance. According to Morrow-Jones, this may support their argument that they bring different attitudes to their elder years. They already show different attitudes than the other age groups, according to Morrow-Jones, making it important that "we understand pretty well what they are going to be looking for when they get into retirement."

Mode Choice of Older People Before and After Shopping–A Study with London Data
Fengming Su, Jan-Dirk Schmöcker*, and *Michael G. H. Bell*, Imperial College, London

Schmöcker's presentation evaluated older people's mode choices for shopping trips, which he said are especially important for them, representing 46 percent of all of their outgoing trips. The growth of this population makes providing mobility to them crucial, according to Schmöcker. The researchers were especially interested in trip chains and mode choices before and after shopping trips because older people may be motivated to walk to stores and take public transportation when returning with heavy packages.

Unlike most existing literature, this study investigated combined mode choices before and after shopping, since a trip chain rather than a single trip often determines mode choice. Researchers fitted data from the 2001 London Area Travel Survey to multinomial logit (MNL) and nested logit models. The models focused on the importance of accessibility variables such as bus and rail stop density and service quality for specific areas of London.

Using MNL for simple trips they found that, in general, older people are cost-sensitive and that travel time is significant, but of less importance. Using two nested logit models they first found that it is reasonable to assume older people initially choose whether to walk only one way to the shopping center before choosing specific mode combinations. Their second model suggested that older people first decide on whether to change mode for the two trips before choosing a specific mode combination. All models assumed that all things being equal, people would prefer driving a car. The researchers found that mode combinations where people change mode occur with "multi-stop shopping tours."

The results also show that bus stop density is of more significance to older people than attributes describing the quality of the bus services, like service frequency. According to Schmöcker, one of the policy implications of their results could be that closer bus stops are more important to older people than frequent bus service. The combination of walking to shop and taking public transportation on the homebound trip is not very frequent, except maybe for some more complex shopping trips. Nested logit models were quite useful for these complex journeys, said Schmöcker. Their research confirmed their literature review findings, including the importance of car availability: older people with high income are less likely to use public transportation. Finally, they found that a central London residence, with access to fewer traditional corner stores than in outer London, seems to reduce walking and use of public transport and encourages car usage.

*Presenter

Technical Session 3B

Moderator: *Robert Bruegmann,* University of Illinois at Chicago

This session provided an opportunity to discuss the effects of planning documents and practices on the land-use planning process; topics included regional planning documents, the potential use of accessibility models as planning tools, and measuring the impacts of different planning ideologies.

The Effects of State and Regional Mandates on Local Accessibility Planning

David A. King, University of California, Los Angeles

State and regional master plans serve as the legal basis for many transportation and land use decisions that are implemented at the local level. As provisions governing accessibility take on greater prominence in regional transportation and land use planning documents, the impact of these documents on local planning remains unclear in many cases. David King examined the content of planning documents from California's South Bay area and Minnesota's Twin Cities region in order to determine the effects of these mandates on local planning.

Clarity and consistency, King said, stand out as the two most important determinants of effective planning documents, according to the published literature. He outlined three distinct yet related types of consistency in planning documents: vertical consistency, meaning the degree of consistency between plans at different levels of government, from the local, to the regional and state, and finally the federal levels; horizontal consistency, or how well plans fit together across different cities within a region; and internal consistency—how well a plan "holds together" in itself.

The methodology used to analyze general plans consisted of indexing a variety of terms related to accessibility and determining whether the measures were required or merely suggested. This enabled King to construct an index of

planning documents, ranking each plan in terms not only of what terms were included, but by how strongly the plans mandated accessibility goals.

Regional differences appear to exist in the language of planning documents, making direct comparisons more difficult, King noted. For example, many California plans refer to "jobs-housing balance"—a term which, while controversial in some senses, is nonetheless better defined than the roughly equivalent term "connectivity" that frequently appears in Minnesota master plans.

King pointed out an example of clear and unambiguous language from the Burbank municipal plan in which specific transit-related measures are required; in contrast, language from the Minneapolis general plan sets recommendations for transit service—despite the fact that the governmental entity that developed the plan in question does not operate or exercise regulatory authority over the area's transit system.

While the research under discussion is largely concerned with vertical consistency, King continued, the issue of internal consistency leads into a second phase of research, currently underway, which focuses on the implementation of general plan priorities in zoning codes.

Planning for Accessibility: Finding the Right Balance Between Rigor and Relevance

Thomas Straatemeier, Amsterdam Institute for Metropolitan and International Development Studies

Accessibility, said Thomas Straatemeier, is a powerful concept with the potential to link together different planning cultures and disparate approaches to transportation and land use. However, significant barriers exist to implementing accessibility in the planning process. These obstacles include the difficulty of using many current accessibility models,

the long-standing institutionalization of the conventional four-step transportation planning model, and the lack of political capital attached to accessibility today.

Furthermore, Straatemeier asserted, a "cultural divide" exists between land use planners and transportation planners—the two groups most concerned with accessibility. "It seems difficult

Implementing

accessiblity

concepts in the

urban planning

process

for people who think in terms of places and activities and people who think in terms of networks and flows to communicate with each other. They…come from different educational backgrounds; they use different models…and this may be one reason why transport and land use integration is difficult to achieve."

To overcome these obstacles, Straatemeier's research explored ways of using accessibility within the planning process that balance scientific rigor with practical usability. Working directly with planning teams, Straatemeier evaluated how planners used various accessibility analysis techniques in their work.

The planning framework that emerged from this process, dubbed "joint accessibility design" by Straatemeier, consists of three steps: first, conceptualize the accessibility measure in light of wider goals—social, spatial, and environmental; second, collectively analyze and interpret the accessibility issues involved in the project; third, consider interventions and strategies, in order to understand the effects of changes. Straatemeier implemented this process in a series of iterative workshops with

practitioners of both transportation and land use planning, gathering data through participant observation of the planners as well as through post-workshop surveys.

In working with the planning teams, Straatemeier discovered that rigorous scientific measures of accessibility often did not translate into usable planning tools. Instead, simpler measures—such as cumulative opportunity— were preferred by the planners for policy design purposes, because their understandability made them easier to incorporate into the planning process.

This research led him to conclude that four factors are necessary to achieve successful planning for accessibility: first, data and measures should be collectively agreed and transparent, not "black boxes"; second, teams should start by working with simpler measures and move on to more complex ones after the simple measures are understood; third, accessibility measures must be scientifically valid and must clearly relate to the planning goals; and fourth, teams must be able to see the usefulness of accessibility measures.

Accessibility, Travel Behavior, and New Urbanism: A Case Study of Mixed-Use Centers and Auto-Oriented Corridors in the South Bay Region

Kenneth Joh* and *Marlon G. Boarnet*, University of California, Irvine

Does the "New Urbanist" approach to planning represent a step toward creating more livable communities, or is the movement toward neo-traditional and transit-oriented development really a form of "boutique planning" with few transportation benefits? While influential studies carried out in the 1990s appeared to validate many of the claims of New Urbanism, Joh said, later studies have challenged certain assumptions made in the initial research.

In light of the many benefits claimed for "New Urbanist" approaches to transportation and land use planning, Kenneth Joh and Martin Boarnet asked what empirical evidence is available to support the assertion that New Urbanism produces more usable systems of transportation and development. Joh explored this question by examining communities in the South Bay area near Los Angeles, California.

Within their study area, the researchers identified several mixed-use centers that appear

to embody New Urbanist design principles, as well as several automobile-oriented corridors that exemplify the car-centric approach to development. The researchers analyzed data on travel behavior (from surveys and travel diaries) from these disparate zones, using statistical regression on selected sociodemographic and attitudinal variables, in order to look for significant differences between the two types of residential development.

The results, said Joh, both confirm and challenge many of the central claims of New Urbanism relative to travel behavior. While higher numbers of walking trips were reported in mixed-use centers, the study failed to uncover significant differences in individual driving trips. These findings suggest that aspects of the built environment do influence travel behavior, particularly pedestrian activity. Joh suggested, that policymaking in these areas would benefit from additional research.

*Presenter

Technical Session 4A

Moderator: *Mark Horner,* Florida State University

Age as a factor in accessibility was the dominant theme of this session, in which presentations dealt with the accessibility needs of both young and elderly populations. Transit accessibility, transit service characteristics, and safety issues were among the topics discussed.

Measuring Accessibility as Experienced by Young People

Sarah Wixley*, JMP Consulting; *Helena Titheridge* and *Peter Jones*, University College, London; *Georgina Christodoulou*, University of Westminster (UK)

Through studying the travel patterns and needs of young adults, Sarah Wixey and other researchers carrying out an English government-funded study were able to identify barriers facing that population.

The two-year survey included interviews and focus groups of people ages 16–24 in West Yorkshire. Like other groups in the study, they used the transit system to get to education, employment, commerce, and health, but also identified leisure as a major destination (but interestingly didn't classify non-food shopping as part of this category).

The group expressed lower time thresholds for walking to and waiting at transit stops, asking for increased service frequencies of buses and trains. The area has twice-hourly bus and train service; respondents in surveys and interviews said they would prefer service every ten minutes. Taxis were seen as reasonable alternatives to transit when the cost could be shared among friends on the same trip.

In addition to increased frequency, the group identified solutions to safety and other concerns they had with transit. They wanted changes to make trips safer: seating and shelters (with shatterproof glass) at all stops; better lighting and walking routes with unobstructed views; and conductors and cameras on buses (with police onboard at night). Policies, they thought, should be changed to ban food and drink on buses, make schedules available in different languages and with start/end times, set up fare machines before boarding so exact change payment is not the only option, and institute driver training for diversity awareness.

An interesting finding of the study is that unlike other groups, youths suggested a seat volunteering program where riders would be encouraged to give their seats to those who, for instance, are pregnant or disabled.

Influence of Proximity and Access on Transit Ridership for Older Adults

Daniel Baldwin Hess, State University of New York at Buffalo

With the population of older adults in the United States expected to double to 70 million by 2030, Daniel Hess investigated barriers to riding fixed-route public transit for this age group. His study, a comparison of a fast-growth area (San Jose, CA) with a slow-growth area (Buffalo, N.Y.), identified ways to make public transit more convenient for older adults who don't drive.

The primary question was if distance to or from a transit stop could predict transit ridership. More of those surveyed in Buffalo than San Jose were non-transit riders, and San Jose had a great share of frequent (monthly) or infrequent (yearly) riders of transit. Walking times to transit as estimated by survey respondents were as much as 55 percent longer in San Jose than Buffalo, however.

Regression analysis reveals influences on transit ridership: men, respondents with lower incomes, non-drivers, and those with shorter walks to transit ride more frequently. Race was not a statistically significant factor in determining ridership in either city, and crime in Buffalo was also a non-factor.

Nearly 60 percent of Buffalo respondents agreed that public transit would be a difficult alternative to driving for travel needs. Slightly more than 70 percent of San Jose respondents had the same opinion.

Hess concluded that urban planners can achieve increased accessibility for older

adults by increasing densities of utilitarian destinations and designing and planning safer walking environments that connect residents with their communities, allowing older adults to travel with greater autonomy.

What Do I Consider Safe?: Analyzing Perceptions of Violence by Space, Time, and Type Among Teenagers in Providence, R.I.

Talia McCray*, *Farhad Atash*, *Charles Collyer*, and *Don Cunnigen*, University of Rhode Island

Talia McCray and her collaborators investigated high schoolers' perceptions of personal space and aggressive behavior. While a full analysis is ongoing, some preliminary results may help explain how youths evaluate whether a place is safe.

The students in the study logged their activities to record the type of activity, location, travel mode, time, and participants. Fast-food dining was the most popular destination, with visiting family and friends near the top. In addition to recording where in Providence, R.I. the students went, they also identified places where they felt safe. Groups, divided by gender, discussed their perceptions of safe spaces and marked maps with highlighters denoting safe or unsafe places in the community.

Female students identified broader areas of safety and more extreme ratings, while both groups expressed safety concerns at night. Females were more likely to describe a space using indicators of danger (presence of "bad people," drug activity), while males relied on indicators of safety (familiarity with place/people, police presence). Female students were also more sensitive to lighting issues and the presence of sexual predators than their male counterparts. Violence sensitivity plays a role in space perceptions. Boys had a higher awareness of violence than girls, and developed increased levels of sensitivity as they aged.

Technical Session 4B

Moderator: *Jan-Dirk Schmöcker,* Imperial College, London

In this session, researchers provided insight into the complex relationship between expanding transportation networks and changing land use practices. The research, focused on Madrid and London, also introduced a European perspective on network growth.

Accessibility Impacts of Orbital Motorways on Metropolitan Areas: A Case Study of M-30, M-40 and M-50 in Madrid

Juan Carlos Martín* and *Concepción Román*, University of Los Palmas de Gran Canaria; *Javier Gutiérrez*, Complutense University of Madrid

Orbital or "beltway" highways around major metropolitan areas have emerged over the past 50 years as key links in the surface transportation system and as important structuring elements in the developed landscape of metropolitan areas. The construction of orbital roadway has been widely seen as facilitating the transition from monocentric to polycentric urban forms; originally used largely to move goods and travelers around city centers, orbital roads become important intra-urban corridors as cities expand outward.

Martín and his collaborators examined the effects of orbital roadways on accessibility within the metropolitan area of Madrid. Beginning in the 1960s, three concentric orbital highways have been constructed around the city, each of which has had an impact on the accessibility levels and development patterns of the surrounding region.

The first of Madrid's orbitals, the M-30, was constructed in the 1960s and 1970s and initially served primarily to route traffic around the densely developed central area. Outward expansion of the city, however, led to the

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construction of the M-40 in the 1990s and to the eventual transfer of the M-30 to the jurisdiction of the Madrid city government, as it is now an orbital in name only and serves primarily as an intra-urban corridor. The M-50, with an even larger radius, is currently under construction.

In their analysis, the researchers employed a geographic information systems (GIS) approach to calculate a variety of different partial accessibility indicators focusing on population and employment, economic factors, and travel times. A dense road network was modeled, based on geometric and traffic-flow data for major roads and streets throughout the metropolitan area; in addition, the model incorporated socio-economic data for the 21 districts of the municipality of Madrid and the 48 suburban municipalities in the surrounding area.

To synthesize these partial measures into a complete picture of accessibility, the researchers developed a methodology termed cross-efficiency data envelopment analysis (DEA). Based on mathematical programming techniques previously used to evaluate the operation of business firms or other decision making units that use multiple inputs to produce multiple outputs, where a clear identification of the relationship between inputs and outputs is not feasible. The result of applying this methodology was an accessibility index for each centroid within the study area.

In studying how these indices changed over time, the researchers asked whether the M-40 and M-50 orbital roadways increased or decreased accessibility disparities within the Madrid metropolitan region. They concluded that both roadways tended to increase accessibility levels for the area, although the M-50 has to date produced more modest accessibility increases than its predecessor. These improvements are discernible in terms of the population's access to employment, economic potential, and travel times.

The Coevolution of Land Use and Transport in London
David Levinson, University of Minnesota

Do land use patterns determine the development of transportation networks—or does network growth drive changes in land use? David Levinson argued that the correct answer to both questions is "yes": transport and land use are interdependent shapers of urban form, and understanding this interdependence is key to moving beyond "chicken and egg" debates about which is more important.

Levinson studied land use and railway construction in the 33 boroughs that make up metropolitan London, aggregating the data every decade, to create a historical view of the interactions between land use and the rail network (including both the Underground and surface rail lines). Based on these data, Levinson identified a positive feedback relationship between network density and population density: the addition of new rail stations to the network led to subsequent population increases in the surrounding areas, and population growth spurred the construction of more rail.

Evidence for this relationship appeared in the form of rank-order correlation between boroughs' population density and the density of rail stations.

A notable exception to this pattern appeared in the central business nexus known as the City of London, where the additional accessibility produced by rail construction encouraged commercial (rather than residential) development, leading to a net loss of residential population following the end of the nineteenth century. As population density declined in this area, employment density greatly increased.

Transport network growth and land development seldom occur in perfect synchrony, however; on an area-by-area basis, either transport or land use may appear to lead the way. In some cases, Levinson found densification of developed areas after the completion of new transport links (a situation conventionally known as "induced demand"), while in other cases, new links appeared to follow development (induced supply).

These observations led Levinson to develop a set of hypotheses about the "leads and lags" experienced by different areas, and to incorporate these hypotheses into a model of the relationship between land development and network growth in London.

Tracing the historical relationship between transport networks and land use

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Technical Session 5A

Moderator: *Kay Axhausen,* Swiss Federal Institute of Technology

All three presentations in this session evaluated transportation networks, and two of the presentations described specific tools to do so. Researchers presented their recent findings on the role of the development of transportation compared to land use concentration, the use of GIS tools to measure accessibility through a multi-modal transportation system, and methods for analyzing the efficiency of road networks.

The Coevolution of Land Use and Road Networks

Feng Xie*, David Levinson, and *Shanjian Zhu*, University of Minnesota

Feng Xie's presentation examined whether the development of transportation reinforces or counteracts the concentration of land use. Xie pointed out that history does not provide a clear answer to this question. The introduction of streetcars and subways increased population activity and density in the city center while the introduction of the US highway system in the 1950s and 1960s served as a counteracting factor, moving people out of the city centers.

To study this question, they developed a tool called a Simulator of Integrated Growth of Network Growth and Land-use (SIGNAL) to simulate the co-evolution of land use and road networks. It implements a bottom-up process that incorporates independent route choices of travelers, location decisions of individual businesses and workers and investment decisions regarding autonomous roads. In particular, it examined the evolution of road networks under the context of the co-evolution of network and land use. The model was kept as simple as possible to capture prominent components of the co-evolution, while enabling them to display and analyze the emerging patterns of land use and networks. "This differentiates this study from the current integrated land use models which incorporate comprehensive factors in the co-evolution," said Xie. This model framework included three major component models: a travel demand model, a road investment model, and an accessibility and land-use model.

Accessibility to jobs and workers were incorporated as the criteria in land use redistribution. Experimental results showed that the degree of both the employment and the population concentration is reinforced when road networks are allowed to vary rather than remain constant. Contemporary integrated transportation and land use models that neglect road dynamic models could underestimate the concentration of land uses, according to Xie. "So this study could be a good complement to these contemporary integrated models."

After the presentation, Xie was asked whether they have an investment decision process that assumes that "these are all toll roads." He said that they do. "To implement the road dynamics, we assumed that there are independent agents that tolled the traffic," he said, although they have relaxed this assumption in at least one of their other studies. So far, they have also assumed that the workers and jobs are homogeneous, although they are "building more ambitious models to incorporate heterogeneous agents," said Xie.

Cities as Organisms: Allometric Scaling in US Urban Road Networks

Horacio Samaniego* and *Melanie E. Moses*, University of New Mexico

As a biologist working in computer science, Horacio Samaniego acknowledged that he brings a very different background to the conference and has "a really strong skew about living things." The researchers used a statistical approach to their research inspired by recent developments of allometry and Metabolic Scaling Theory (MST). Howard and Eugene Odum pioneered comparisons on cities to organisms in the 1970s, acknowledged Samaniego, when they suggested that the flow of energy and materials in society can be analyzed in the same way that we analyze organisms and ecosystems.

In his presentation, Samaniego discussed how MST is a theory of delivery networks shaped

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by evolution. "We use this theory to understand how efficient road networks are," he explained, and "to identify how traffic occurs within cities, and to identify that centrality is a key feature of a city that determines its efficiency."

To evaluate urban network accessibility they studied movement dynamics throughout the urban network across 425 different-sized US cities. They used data compiled by the Federal Highway Administration from the 2004 US Census. Specifically, they analyzed how decentralization affects transport efficiency to show that decentralization is an important difference between road networks and biological vascular networks.

Samaniego created two traffic flow models, one based on MST, which assumes a complete centralized model of traffic flow, and another based on a completely decentralized model of traffic flow. "So when we look at the data and at the built lane miles," explained Samaniego, "we would expect to be on the one-to-one line if we divide by population size. Instead, we see that they are almost completely decentralized." When looking at the miles driven per capita,

he explained, "we plug in the prediction for a centralized city and a decentralized city, we see that the 425 cities in the US respond to an intermediate pattern." This may reflect a mixture of different traveling patterns, according to Samaniego. "You don't only go downtown for work, you also do some leisure travel and this leisure travel might be decentralized," he said. These results suggest that both commuting and recreational traffic somehow are a mixture of both centralized and decentralized components.

"So, basically, we're saying that road networks scale differently than how they are used," explained Samaniego. The United States is in the middle of the spectrum regarding centralization versus decentralization, according to Samaniego. This may be because big city road capacity "isn't picking up with the usage." Because they used census data for freeway lanes miles and estimated arterials and surface streets, discussion in the question-and-answer session focused on some ways they could obtain more precise data, including navigation systems and other measurements, such as travel times instead of distances.

Accessibility Analysis of Multimodal Transport Systems Using Advanced GIS Techniques
*Colby Brown** and *Tor Voraas*, Citilabs

While the first two presentations used simulations to explain what we think should or does happen given certain assumptions or data, Colby Brown said his presentation described a tool that can help guide people in making decisions.

Brown defined accessibility planning as a subfield of transportation planning that focuses on how the transportation system provides access to basic needs. In the early 2000s, the English Department for Transport (DfT) issued guidelines about accessibility planning for local transport use to help excluded groups access basic services. Needing an analytical tool to facilitate cross-sectoral planning, DfT commissioned the delevelopment of the Accession modeling software, released in 2004.

Accession uses readily available GIS data to measure accessibility to and through the multi-modal transport system. It calculates indicators of accessibility and uses travel time information

to describe the quality of the transport system and how it services the public. While Brown acknowledged that his kind of analysis has been done before, he said, the new tool gets right to the heart of the question. "It can be used to analyze access from a particular location for a particular purpose, but it also provides a region-wide picture of accessibility" through contour maps which can be combined with demographic data. "Rather than creating one index that summarizes an entire region's accessibility, it's a matter of identifying the qualitative differences inside a region," he said.

Accession is used "truly cross-sectorally" in the United Kingdom, according to Brown. "It's incredible the different types of agencies that are using this," he said. Accession is being used, for example, by London borough of Harrow for planning magistrate (legal) services, by British Telecom for managing travel and parking and

improving access by all travel modes to its Adastral Park site, and by the Bedfordshire County Council in identifying optimal locations for waste treatment plants.

"It's truly integrated across all forms of government in the UK," said Brown. "It's perhaps something to learn from in the US as we think about taking the lessons from conferences like these and start to make accessibility part of the language of planning in a more routine way."

Technical Session 5B

Moderator: *Qing Shen,* University of Maryland

Presentations in this session covered accessibility analysis related to a range of travel behavior, emphasizing nonmotorized travel modes and trip chaining. Researchers analyzed the use of urban trail networks, methods for measuring accessibility for bicyclists and pedestrians, and factors influencing commuters' likelihood to carry out multiple travel tasks during their commute trips.

Situating non-motorized travel in the discussion of accessiblility

A Use-based Measure of Accessibility to Linear Features to Predict Urban Trail Use
*John R. Ottensmann** and *Greg Lindsey*, Indiana University-Purdue University

What motivates people to use urban trails? The ability of residents to access the trails is an important factor, said John Ottensmann. As with other types of urban facilities—such as libraries and parks—people are more likely to use trails if a higher level of service is provided, or if the facility is closer to residents' homes.

However, said Ottensmann, measuring the accessibility of trails is challenging because of two factors. First, the level of service provision (or the extent of the trail network in an area) is likely to have an effect on area residents' decisions to use trails. Second, many current measures of accessibility are designed to deal with point locations such as businesses rather than linear features like trails. To effectively measure accessibility to trails, Ottensmann and Lindsey developed a use-based accessibility measure specifically for linear features.

Ottensmann and Lindsey based their study on the urban trail system of Indianapolis. Development of the trail system began in the 1990s; it currently includes over 50 kilometers of trails located primarily in the central and northern parts of the city. A network of monitoring stations established by the Indiana University-Purdue University Center for Urban Policy and the Environment record the passage of persons along the trails using infrared sensors, providing valuable data on trail use. For this study, survey data on area residents' trail use and demographic characteristics were also employed.

The researchers applied their linear accessibility measure using two sets of models—logistic models (predicting whether or not a person used a trail) and negative binomial models (predicting the amount of trail use). The use-based measure allowed the researchers to reliably estimate accessibility and elasticity coefficients in both sets of models; models using this measure outperformed alternative models based on distance, linear accessibility without use-based measures, and point-based measures.

Ottensmann noted that the use-based measure employed in this study was based on the assumption that all trail segments were equally attractive to trail users. While this is obviously not the case, he explained that the form of the accessibility measure would allow for the inclusion of differential attractiveness measures, as well as the incorporation of disincentives such as local variations in crime rate.

Such use-based accessibility measures, Ottensmann concluded, are likely to prove particularly useful in evaluating the potential impacts of the construction of new facilities.

*Presenter

Measuring Nonmotorized Accessibility: Issues, Alternatives, and Execution

Michael Iacono*, University of Minnesota; *Kevin J. Krizek,* University of Colorado; *Ahmed El-Geneidy,* University of Minnesota

Accounts of accessibility measurement in the transportation planning literature are dominated by the measurement of automobile-based accessibility, said Michael Iacono, while relatively little attention is given to the challenge of describing and predicting travel via walking and bicycling. Iacono and other members of the Active Communities/Transportation (ACT) research group have been working to develop accurate distance-decay functions for nonmotorized modes and different types of travel destinations.

Distance-decay functions are critical for accessibility modeling because people's willingness to travel to a given destination depends both on the mode of travel that they select and the characteristics of the destination. In essence, distance-decay functions link together modes, destinations, and traveler behavior in a modeling framework.

The researchers' recent work has been guided by the idea of an accessibility matrix in which a variety of modes—including nonmotorized modes—are correlated with a variety of destination types. Constructing a set of accessibility matrices for the Minneapolis-St. Paul metropolitan region is among the goals of the Access to Destinations Study, currently underway at the University of Minnesota.

Iacono discussed several types of decay functions that can be used in accessibility modeling, and explained that his group's current work focused on negative exponential functions. He also discussed the concept of network impedance as it relates to travel time and distance.

To estimate accurate distance-decay functions, the researchers organized detailed data about the nonmotorized transportation network into a GIS street layer with assumptions about travel speeds. Origins and destinations were identified based on census-block-level data. Land use and activity data were developed by merging parcel-level land use data with establishment-level business data including employment, sales, and industrial classification.

Among the challenges faced in this research, Iacono said, was the difficulty of modeling pedestrian and bicycle travel accurately using travel speed assumptions. In addition, the decay parameters developed do not fully account for variations in the spatial structure of the transportation network. Finally, he said, assuming that travelers select minimum-distance routes may not accurately capture the complex behavior of travelers selecting routes.

In spite of these challenges and the need to make compromises in some areas to develop a working model, Iacono concluded that modeling nonmotorized accessibility is possible. Such research offers potential benefits including identifying "accessibility-poor" areas where planning interventions can have a positive impact.

Differentiating the Influence of Accessibility, Attitudes, and Demographics on Stop Participation and Frequency During the Evening Commute

Xinyu (Jason) Cao*, University of Minnesota; *Patricia L. Mokhtarian* and *Susan L. Handy,* University of California, Davis

Commuting trips account for an important part of daily travel in the United States and worldwide, so understanding commute trip behavior is important for the development of better travel demand models and management strategies. These trips are often not simply direct journeys from an origin to a single destination; instead, they frequently include stops along the way. The effects of accessibility-related factors on commuter stop-making behavior is not well understood, said Cao.

The researchers analyzed survey data from commuters in several California communities; in each community, an area of "traditional" land use was paired with a nearby area of "suburban" development, in order to help identify effects

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arising from the nature of the built environment. The survey asked respondents to report characteristics of their neighborhoods, and on their attitudes toward those characteristics; factor analysis reduced the response data to six significant factors. Following the survey, the researchers estimated objective measures of accessibility for each respondent. The survey also gathered data on attitudes toward travel, commute behavior, and sociodemographic variables.

To identify factors influencing stop participation and stop frequency, the researchers modeled a two-stage decision process: first, estimating the propensity of an individual to engage in stops during commuting; second, estimating the relative frequency of stopping.

Using a bivariate selection model, they determined that several socio-demographic variables are likely to influence stopping behavior. Likewise, mode choice emerged as an influencer, consistent with earlier studies.

Preferences related to accessibility appeared to correlate with stopping behavior, with those who valued accessibility being more likely to engage in commute stops. In terms of objective accessibility measurements, the presence of certain types of businesses appeared to increase the likelihood of stopping. While a high-accessibility neighborhood appeared to facilitate stopping, Cao said, the intensity of stopping behavior depends primarily on household characteristics and individual time constraints.

Technical Session 6

Moderator: *Helena Titheridge,* University College, London

Presentations in this final session dealt with issues of accessibility measurement in the context of analyzing and comparing metropolitan areas. Researchers explored the spatial awareness of urban residents and the possible effects of social networks on residential and employment patterns, and also looked at the difficulties inherent in comparing accessibility across different metropolitan areas.

Uncovering

the effects of

cognition and

social networks

on accessibility

Accessibility and Cognition: The Effect of Transportation Mode on Spatial Knowledge
Andrew Mondschein*, Evelyn Blumberg, and *Brian Taylor*, University of California, Los Angeles

Cab drivers in London, noted Andrew Mondschein, have been shown to possess unusually large hippocampi—the hippocampus being a brain region closely associated with long-term spatial memory. While accessibility is often thought of in economic or engineering terms, Mondschein said, there is also an important cognitive element to accessibility: a person must know what is out there in order to go there.

Because accessibility is fundamentally shaped by human knowledge of destinations and routes, Mondschein argued, cognitive mapping and spatial cognition are integral parts of the transportation-land use connection. Recently, research has examined the role of cognitive mapping in route choice; however, he said, because spatial cognition encompasses individuals' knowledge not only of routes but of destinations, it effectively shapes their access to

opportunities.

In this study, the researchers examined the question of whether differences in cognitive maps could be explained, at least in part, by differences in typical travel modes. They hypothesized that people who navigate a city on foot or using public transit would develop very different mental representations of their environment than people who habitually drove from place to place. Further, they questioned whether these differences in cognitive mapping could produce radically different levels of "functional accessibility."

To investigate these questions, the researchers conducted a survey of spatial awareness and travel behavior in a South Los Angeles neighborhood with a large low-income and minority population. At the time of the survey, this neighborhood was facing a significant change in health care accessibility due to the

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impending closure of a hospital. By setting up in an area adjacent to a popular shopping center and near a transit station, the researchers captured data from travelers with a high level of transit use as they engaged in normal daily behaviors.

Respondents were asked for information on their travel mode choices and socioeconomic characteristics; in addition, they were asked to estimate the distance to a central urban landmark (City Hall) and were asked to describe the location of their residences using terms of their own choosing. Analysis of the resulting data revealed differences in the distance estimates and location descriptors depending on respondents' usual modes of travel. Such differences, Mondschein said, suggest that the use of different travel modes may lead to qualitative differences in individuals' cognitive maps.

Among the implications of these findings, he said, was the potential to provide different types of spatial information to different groups, such as transit users; also, different planning approaches may benefit groups with different cognitive mapping styles.

Social Networks and Location Choice
*Nebiyou Tilahun** and *David Levinson,* University of Minnesota

Questions about the relationship between people's home locations and their work locations affect many accessibility calculations. In this study, the researchers set out to determine whether people who live near each other also tend to work near each other. The hypothesis that residential locations and employment locations are linked together, Tilahun said, was based on research into the role of social networks in decision making.

In order to analyze the possible correlations between home and work locations, Tilahun explained, two things are required: first, a set of data covering both residential and employment locations; second, a suitable means for measuring the relationship.

The researchers used block-level data on home and work locations in the Minneapolis-St. Paul metropolitan area derived from the U.S. Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) dataset. Additional demographic census data and block-level economic data on home sale prices were also incorporated.

To measure the extent of alignment between home and work locations of persons living near each other, it was first necessary to define the relationships between individual residents. For the purposes of this study, two persons were said to be related at the home location if they share the same block for residence; similarly, there were deemed related at the work location if they share the same work block. These relationships were used to construct undirected adjacency matrices for the residents of a given area.

The hypothesis of non-random correlation between residential and work locations was then accomplished using quadratic programming assignment, a method for comparing the observed correlation between adjacency matrices against a correlation distribution derived by repeatedly permuting one of the matrices and recalculating the matrix-matrix correlation. If the observed correlation between the actual residential and employment matrices is outside the distribution produced from comparing permuted matrices, it indicates non-random correlation between residential and employment locations.

Testing on several block collections of 500 residents revealed a higher degree of correlation in the observed matrices than in the permuted matrices, supporting the hypothesis that a correlation exists between residential and work locations across urban areas.

The researchers then attempted to ascertain what block-level characteristics might account for these correlations by modeling several demographic and economic variables. The results of these tests indicated that older populations, larger households, and higher numbers of owner-occupied households all lead to higher incidences of residents sharing the same work block. Tilahun noted that this result does not necessarily extend to persons sharing the same workplace, but does point to the possibility that households "settle" over time in non-random ways.

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Accessibility Measures for Comparative Analysis of Metropolitan Areas

Qing Shen, University of Maryland

For those interested in accessibility measurement, comparing the accessibility levels of different cities may seem like an obvious application of accessibility research. Aside from accessibility, many indicators are commonly used to compare cities—ranging from simple measures such as population to composite indicators like cost of living or the congestion index. But devising indicators that facilitate meaningful comparisons between different areas is difficult, said Qing Shen.

Shen cautioned that no single best measure can represent the multiple key dimensions of the built environment on which accessibility depends. For meaningful comparison, he recommended the use of multiple measures—each dealing with a different dimension of the accessibility issue. The choice of which measures to use, he continued, must depend on the particular dimensions of the built environment to be compared, and ultimately on the purposes of the study.

In his own recent work on transportation planning, Shen explained, accessibility is conceptualized as a multidimensional link between sustainability and the built environment, encompassing dimensions of environment, economy, and equity. Therefore, the researchers have attempted to develop a set of accessibility measures that facilitate transportation decision-making around these dimensions. In order for intermetropolitan comparisons to be meaningful, he continued, numeric outcomes of such a multidimensional measure must be values on a common scalar.

Shen proposed three complementary measures of accessibility for this purpose: minimum required travel (the built environment), potential for spatial interaction (economic efficiency), and the intermodal transportation gap between private auto ownership and transit use (social equity).

The benefits of creating such integrated indicators of accessibility, Shen concluded, include helping planners to have meaningful conversations about the built environment in different urban areas, and supporting better transportation planning and policymaking.

Closing Panel

Moderator: *Robert Johns*, Center for Transportation Studies

CTS director Robert Johns opened the concluding panel by thanking all the presenters who had traveled to Minnesota to provide "a great breadth of perspective and a variety of approaches to understanding the important concept of accessibility." He then called on the panelists—including the general session presenters and conference organizers—to offer their concluding thoughts.

Describing himself as "probably the person in the room furthest from transportation planning," due to his background in architecture and traditional land use planning, Robert Bruegmann observed that the emphasis on modeling and data analysis coming from the disciplines of engineering and the social sciences often seemed foreign to him. He encouraged researchers to think carefully about the assumptions underlying their models and not jump too quickly to decisions driven solely by the interpretation of data.

Speaking from the perspective of a "hard core traffic engineer," Hong K. Lo said that he had learned a lot from the past two days, and offered three main observations based on his experiences at the conference. Lo noted that the concept of accessibility as it is understood by modelers and planners may not correspond with how people experience accessibility in their daily lives. He recommended that researchers include "reality checks" in their work to ensure meaningful match-ups between model predictions and human experiences. Second, from a public transit perspective, Lo argued for the need to look beyond the description of accessibility and develop ways of managing it so that accessibility can have a useful role in the lives of residents. Finally, Lo touched on the potential for economic analysis of accessibility, asking how the concept could be understood in

terms of hedonic pricing—for example, when do higher levels of accessibility tend to increase land values and drive out residents and small businesses? Economic methods, he concluded, could contribute to a richer analytical framework for accessibility studies.

Returning to a theme from his general session presentation, Kay Axhausen cautioned against the tendency to confuse access and accessibility in the discussion of land use and transportation issues. The majority of current analytic tools, he argued, are designed to look at access rather than accessibility in terms of long-term decisions and trade-offs. Secondly, he encouraged researchers to investigate how standards for accessibility are derived, with an eye to understanding the costs and benefits of different approaches—and identifying the beneficiaries of accessibility policies. People often make trade-offs that are difficult to explain using accessibility models, he said, and understanding these decisions will require better knowledge of what people actually value; choice models, he said, may prove to be an important tool in this pursuit. Talking about accessibility, he said, is not only a discussion of economics but of human dignity—an inherently political topic. Understanding how standards are set, he concluded, is key to developing standards that are affordable and acceptable to all stakeholders.

Looking to the future, Kevin Krizek spoke of the Access to Destinations conferences as one way of building a cadre of researchers equipped to take on accessibility issues. Accessibility, he said, appears to be emerging as an empirically founded goal that can bring together many sectors of the planning and engineering communities. With a common goal, he continued, common measures are needed, and to develop such measures will require a

Establishing a cadre of researchers equipped to take on accessibility issues

better understanding of human behaviors and preferences as they relate to transportation and land use choices. Behavior and preference have many important implications, such as how opportunities and networks relate to each other, and how behavioral norms vary across different population segments. From a modeling perspective, the use of impedance functions other than travel time or cost—such as aesthetic or cultural factors—presents a challenge for the future.

Much of the current understanding of accessibility has been built on modeling, said David Levinson, but now is the time for researchers to go farther and develop effective measurement tools. The application of models calibrated for travel distance or cost to questions of aesthetic and cultural trip factors—a more pleasant walking route, for example—does weaken the foundation beneath current accessibility theories. Levinson urged researchers to undertake more ambitious empirical studies in order to develop a better picture of what people actually value in their travel and land use decisions. The fact that accessibility is perceived rather than objectively calculated by travelers implies that simple linear measures may not adequately capture this complex phenomenon; empirical measures and hedonic studies, as suggested by the other panelist, may help to address this issue. In addition, the existence of a number of different indexes of accessibility begs the question of whether they are all measuring the same thing, and future studies should attempt to correlate these disparate approaches. Finally, reflecting on the conference as a whole, Levinson thanked the staff of the Center for Transportation Studies and College of Continuing Education who had "done the really hard work in putting this conference together."

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