Bicycle/Pedestrian Trip Generation Workshop: Summary

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FOREWORD

This report presents a summary of the workshop that the Federal Highway Administration (FHWA) sponsored in November 1996, in Washington, DC. The purpose of the workshop was to obtain input from a group of leading non-motorized transportation modelers on various research methods for promoting walking and bicycling as other modes of transportation.

The goals of the 1991 congressionally mandated National Bicycling and Walking Study are to double the percentage of total trips made by bicycle and walking, and to reduce by 10 percent the number of bicyclists and pedestrians killed or injured in traffic crashes. These are potentially conflicting goals. FHWA's Pedestrian and Bicycle Safety Research and Development Plan is focused on both of these desired outcomes—increased safety and increased use. Two keys to increasing use are understanding the factors affecting the use of non-motorized transportation and being able to predict future use.

The information contained in this report should be of interest to State and local bicycle and pedestrian coordinators, transportation planners, and engineers involved in the design of pedestrian and bicycle facilities within the highway system.

A. George Ostensen, Director
Office of Safety and Traffic Operations
Research and Development

NOTICE

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16. Abstract

In November 1996, the Federal Highway Administration (FHWA) sponsored a Trip Generation Workshop in Washington, DC. Many leading non-motorized modelers came to exchange insights on the state-of-the-practice for non-motorized transportation modeling. For example, Bruce Landis of Sprinkle Consulting Engineers discussed their latent demand score model. It estimates the probability of bicycle travel on individual road segments based on their proximity to and extent of adjacent trip generators and attractors. Henk Tromp from DHV in the Netherlands demonstrated their cycle network model. William Schwartz and Earl Ruiter of Cambridge Systematics discussed their experiences with: 1) incorporating bicycling and walking into regional travel demand modes; 2) treating bicycling and walking as part of transportation programs in downtowns and other activity centers; and 3) estimating benefits and costs of bicycle and pedestrian measures. Jim Ercolano of the New York State Department of Transportation introduced a "sketch-plan" method to estimate peak-hour pedestrian trips at intersection and midblock locations. Shawn Turner of the Texas Transportation Institute described a methodology that will provide personnel with the information and decision-making framework to assess existing and proposed travel demand by bicyclists and pedestrians. Michael Culp and Sam Zimmerman of FHWA discussed TRANSIMS, which makes microsimulations of trips on a regional basis. Michael Replogle of the Environmental Defense Fund covered the development of discrete choice models that are sensitive to bicycle and pedestrian factors. The workshop participants identified needs such as data collection; enhancing and updating existing data; and planning at the system-wide, corridor, and project levels. It was unanimously agreed that a follow-up meeting should be held in two years to evaluate progress in the United States and abroad in the area of trip generation modeling and application.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in²	square inches	645.2	square millimeters	mm²
ft²	square feet	0.093	square meters	m²
yd²	square yards	0.836	square meters	m²
ac	acres	0.405	hectares	ha
mi²	square miles	2.59	square kilometers	km²
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft³	cubic feet	0.028	cubic meters	m³
yd³	cubic yards	0.765	cubic meters	m³
NOTE: Volumes greater than 1000 l shall be shown in m³.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m²	cd/m²
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in²	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm²	square millimeters	0.0016	square inches	in²
m²	square meters	10.764	square feet	ft²
m²	square meters	1.195	square yards	yd²
ha	hectares	2.47	acres	ac
km²	square kilometers	0.386	square miles	mi²
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m³	cubic meters	35.71	cubic feet	ft³
m³	cubic meters	1.307	cubic yards	yd³
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m²	candela/m²	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in²

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

INTRODUCTION

In November 1996, the Federal Highway Administration (FHWA) sponsored a Trip Generation Workshop in Washington, DC. The workshop, attended by many leading non-motorized modelers, was held to exchange insights on state-of-the-practice for non-motorized transportation modeling.

Bicycling and walking account for nearly 8 percent of all trips made according to the National Personal Transportation Survey (NPTS), and nearly $1 billion has been spent on enhancing and providing facilities for these modes. In the last fiscal year alone, $179 million was spent on independent bicycle and pedestrian projects in the United States. The FHWA, via the goals set forth in the National Bicycling and Walking Study, has made a commitment to double the current percentage of total trips made by bicycling and walking, and to simultaneously reduce by 10 percent the number of bicyclists and pedestrians killed or injured in traffic crashes.

FHWA is encouraging local planners to think of walking and bicycling as modes of transportation. This philosophy is exemplified by these quotes from several of the workshop participants.

> *"The past several years we have experienced a shift from our focus on safety to methods of encouraging bicycle and pedestrian travel."*
> — John Fegan, Bicycle Program Manager, FHWA

> *"Pedestrian and bicycle modes are marginalized, not recognized in travel demand models. There is a gap between the state-of-the-practice and the state-of-thinking ... we need to bridge this gap."*
> — Michael Replogle, Environmental Defense Fund

> *"The problem has two dimensions or levels—micro and macro. On the macro, we need to look at a whole MPO or region, and on the micro, the analysis is more at the neighborhood level."*
> — Bill Wilkinson, Bicycle Federation of America

> *"For a simple sketch fix, take a first cut at the regional level by defining the non-motorized network from the motorized network. At a more local level, separate the bike mode from the walk mode."*
> — Michael Replogle, Environmental Defense Fund

> *"The most urgent need is to have regional-level, multi-modal modeling capabilities. Until we have this, non-motorized modes will not be on a level playing field." ... "Who is this non-motorized population? Are they marginal and insignificant, or are they us?"*
> — Jim Ercolano, NYSDOT

WHERE WE ARE TODAY

There is a wide disparity in the sophistication of bicycle and pedestrian planning in the United States. Some progressive communities such as Portland, OR, and Seattle, WA, have gone to great lengths to plan and provide for non-motorized modes of travel. As a result, these communities have more advanced methods of modeling for these modes. All too often, however, transportation modeling is limited to motorized modes, and as a result, bicycles and pedestrians are marginalized to the degree that they do not even show up in the plans and considerations of the transportation system. Many transportation planners and engineers are totally fixated on motorized vehicles and leave out bicyclists and pedestrians. Those urban areas that do account for the bicycle and pedestrian modes in their regional transportation models are discussed in detail in William Stein's master's thesis, "Pedestrian and Bicycle Modeling in North America's Urban Areas: A Survey of Emerging Methodologies and MPO Practices."

There are several issues that contribute to non-motorized modes being left out of the modeling mix. First is the lack of available data. Bicycling and walking are local activities, and counts and surveys need to be conducted to supplement generalized data sets such as those provided by the U.S. Census. In addition, census data have been criticized for only capturing the principal mode choice for one day in the spring. This means that those people, for example, who walked or rode bicycles to transit probably did not have the bicycle or pedestrian element of the trip captured. The weather can also potentially skew the results of the census. Many have argued that early spring weather more often than not is rainy, cold, or even snowy — conditions that discourage bicycling and walking.

Bicycle and pedestrian counts are too infrequent to provide a consistent data source. And when they do occur, it is hard to gain a true measure of the number of trips that are taking place. Unlike automobiles, bicycles and pedestrians are not always confined to roadway space, but enjoy a mobility that makes them difficult to observe from any one counting station.

The following summaries are based on presentations and printed material from the 2-day workshop:

LATENT DEMAND SCORE (LDS) MODEL
Bruce Landis, Sprinkle Consulting Engineers

The LDS Model was developed to give bicycle planners the ability to quantify latent bicycle travel demand. The LDS Model differs from the classic four-step highway travel demand model in the following way: where the highway's gravity model requires extensive network coding and algorithms to simulate travel between its trip generators and attractors, the LDS Model quickly estimates the probability of bicycle travel on individual road or street segments based on their proximity, frequency, and magnitude of adjacent bicycle trip generators and/or attractors. The steps of the LDS are outlined below:

1. Establish trip-making thresholds of bicycle trip attractors and generators for the four trip purposes: (1) home-based work, (2) home-based shopping, (3) home-based recreational, and (4) home-based school trips. The attractors/generators include, respectively, home-based work markets per census block group, commercial employment per traffic analysis zone,

public parks (stratified into minor, staffed, and major), and elementary- and middle-school student populations (within their transportation exclusion zone).

2. For each segment, geo-code and/or map the attractors/generators and record (in the data base), the number of indicators, stratifying according to proximity using geographic information system (GIS) or computer-aided design (CAD) software.

3. Compute the trip-making probability summation (TPS):

   a. Calibrate for the urban area the Trip Probability vs. Distance (impedance) curves for each trip purpose.
   b. Multiply, for each distance category, the number of indicators by its distance impedance.
   c. Sum, for each trip purpose, its value for the segment.

4. Normalize the demand indicator values (DIVs) to reflect their relative trip generation [average daily traffic (ADTs)] by:

   a. Estimating the average independent variable of each attractor/generator.
   b. Calculating the average trip generation of each attractor/generator using the *Institute of Transportation Engineers (ITE) Trip Generation Manual.*

5. Multiply the DIV by its trip generation and then multiply the product by the Demand Category Constant determined by the respective trip purpose's share in the study area.

6. Calculate the segment's latent demand score (LDS) by summing the results of Step 5.

The LDS model uses readily available demographic data, employing simplified geocoding and data input for spreadsheet-based gravity computations. It is important to note that the LDS Model estimates the relative latent demand of bicycle travel on each segment of a road network. It provides a clear indication of the relative level of desired bicycle use should a bicycle facility be provided on the road segment.

With regard to "Real-Time Human Perceptions: Toward a Bicycle Level of Service (LOS)," the essential variables for calculating bicycle LOS are:

- Longitudinal environment: volume, speed, vehicle type, and pavement condition.

- Transverse environment: proximity of bicyclists to motor vehicles, curb cuts, and/or on-street parking.

For data collection, a course was put together in Tampa, FL, and 150 participants rated each segment of the course by how comfortable they were riding on that segment. Traffic volumes ranged from 550 to 36,000 ADT. Among other items, they found that having a lane stripe makes a big difference in LOS.

Further research topics:

- Disaggregate model testing.
- High-speed rural highway:
  — Central business district (CBD) streets with on-street parking.
  — High truck-volume highways.

CYCLE NETWORK MODEL
Henk Tromp, DHV

This model is being used extensively in The Netherlands and is bicycle-specific computer software. The cycling model consists of a traffic model and an evaluation model. A personal computer is used for the calculations. In the traffic model, a calculation is made for all stretches of road, including separated facilities, to see how many cyclists use a particular stretch of road each day and where they come from and go to. The evaluation model includes calculations of how far cyclists deviate from the straight-line compass route. It also shows where cycling facilities are needed when taking traffic safety into account.

The traffic model and the evaluation model describe the present situation, simulate changes in the network or in the number of inhabitants, and calculate the effects on traffic safety and on cycling distance by adding a bicycle facility. In principle, improving traffic safety is always worthwhile, while shortening distance will attract new cyclists. The calculated results reflect a measure of increased traffic safety and a shift in modal split. The number of cyclists changes with travel times and cost. An important feature of the model is the option of presenting the calculations graphically.

For example, at a glance, one can see the cycling network and identify any gaps as well as the locations where accidents occur. Streets without a bicycle facility that carry a large volume of motor vehicles as well as bicycle traffic can be highlighted. If these streets are also proven to be high accident spots, these areas will be identified as urgently needing a bicycle facility.

Other observations made by Mr. Tromp include the following:

- The model takes into account traffic restraint when it is calibrated.
- The probability of an accident is calculated by using traffic volume, where accidents have occurred, how many bicycles interfere with cars, and what are the waiting times to cross roads.
- The model is being used by about 20 municipalities in The Netherlands, as well as in Germany, England, and Belgium.

FORECASTING BICYCLE AND PEDESTRIAN TRAVEL
William Schwartz and Earl Ruiter, Cambridge Systematics

Recommendations include:

- Expand the focus of modeling efforts beyond the four-step process to include more detailed consideration of individual and household activity patterns.

- Extend the traditional models to deal accurately with non-motorized modes.

- Models/effects that have been enhanced recently:

  — Vehicle availability/automobile ownership.
  — Trip generation.
  — Trip distribution.
  — Pre-mode choice: motorized vs. non-motorized.
  — Mode choice.

- Types of model enhancement strategies:

  — Change the variables used in the model so that there is less reliance on area-type dummy variables and more reliance on density and accessibility variables. Define pedestrian/cyclist environment variables to include building setbacks, street connectivity, ease of street crossings, topography, availability of sidewalks and bicycle paths, and auto ownership.
  — GIS-based, point-to-point non-motorized variables for estimation.
  — More careful formulation to predict intra-zonal travel.
  — Consider non-motorized LOS in composite impedance variables.

- Work on activity-based model systems is underway in Portland (Oregon), San Francisco, and at the Massachusetts Institute of Technology.

Current techniques and approaches at both the facility level and the regional level were presented. Facility-level techniques include:

- Use of journey-to-work data.
- Facility locator models:
  — Impact estimation.
  — Latent demand score.
  — Roadway condition index.
  — Bicycle stress level.
- Facility level of service.
- Statistical analysis:
  — Accidents.
  — Counts.

Issues of incorporating non-motorized modes into regional travel models include answering the following questions:

- What are the trade-offs between bicycle/pedestrian trips and automobile ownership?
- How does the number of trips per household change when the bicycle/pedestrian trips are counted?
- How does the distribution of trips to alternative destinations change?
- What factors affect the choice of bicycle/pedestrian modes versus motorized modes?
- What are the differences for work vs. non-work vs. recreational travel?
- How does use vary with characteristics of the facility design?
- How can the levels of service for bicycle and walking trips be measured more accurately?
- What aspects of level of service are important and how do these change for different climates, age of traveler, etc.?
- How can GIS and other new analytical capabilities be utilized?
- How should national versus local data be used?

Technical challenges for incorporating non-motorized modes into regional travel models include the following:

- Traffic analysis zones are too large.
- Bicycles and pedestrians are often considered as a single group.
- Levels of service are not accurate enough; no bicycle/pedestrian networks or link characteristics.
- No estimates of facility volumes—non-motorized trips are not considered beyond separating them from motorized trips.
- Non-motorized trips are under-reported.
- The focus is on "utilitarian" non-motorized trips only.
- There is little or no consideration of the following "unique" factors: weather/climate, topography, student populations, age of travelers, households without cars, and facility design characteristics.

ESTIMATING PEDESTRIAN TRAFFIC FOR CENTRAL BUSINESS DISTRICTS AND SUBURBAN GROWTH CORRIDORS: A SKETCH-PLAN METHOD
Jim Ercolano, New York State Department of Transportation

Better tools for estimating pedestrian traffic are needed to improve transportation safety, access, and mobility. This paper introduces a "sketch-plan" method to estimate peak-hour pedestrian trips at intersection/crossing (node) and sidewalk/midblock (link) locations. The procedure uses standard traffic data to quantify pedestrian trip activity for integration into routine trip-estimation work. The methodology presented is based on access/egress mode trip generation and applies peak vehicle/hour turning movements, transit vehicle or passenger counts, and walk/bicycle counts or projections to produce total peak pedestrian/hour (PPH) trips. The new method updates and replaces a 20-year-old technique that required detailed land-use data, and did not distribute or assign pedestrian trips. The new technique was applied to a case study suburban-growth corridor in Plattsburgh, NY, illustrating how projection of pedestrian travel demand, in addition to vehicular traffic forecasting, helps in adopting balanced facility treatments to benefit mobility and safety needs for *all* transportation modes.

Mr. Ercolano distributed a memo by Chris O'Neill, a senior transportation planner with the Capital District Transportation Committee (CDTC). This memo pertained to "Estimation of Potential Bicycle Travel Markets."

The relative market size for potential bicycle use was identified through "divertable" vehicle trips from the CDTC's regional trip file. The CDTC maintains a base year (1990) p.m. peak-hour vehicle trip set. This trip set represents a 500 zone-by-500 zone origin-destination matrix, and is the summation of 500-by-500 trip sets for home-to-work, work-to-home, home-to-other, other-to-home, other-to-other, and through trips.

This total p.m. peak-hour trip set was converted to a divertable trip set by checking the trip distance in miles for the origin and destination, and factoring the total trip set into a divertable trip set, based on the trip purpose and trip distance.

Setting the "factor" at 1.00 (100 percent) for all home-to-work and work-to-home trips less than 8 km (5 mi), a steep decay curve was used: factor = $(5.0)^3 / (\text{distance})^3$. Using this equation, a trip of 9.7 km (6 mi) would have a factor of 0.58; a trip of 16 km (10 mi) would have a factor of 0.13; and a trip of 32 km (20 mi) would have a factor of 0.02.

For non-work trips, a shorter distance threshold was established. "Trip chaining" of short work-to-shop (other-to-other) and shop-to-home (other-to-home) trips would create overall trip chains of more than 8 km (5 mi). For non-work trips, the threshold was set at 4.8 km (3 mi), with a factor for trips of more than 4.8 km (3 mi) = $(3.0)^3 / (\text{distance})^3$.

The factored trip set reflects the decreased potential for bicycle travel to serve long trip lengths. The resulting trip set represents a reasonable estimate of the maximum potential for diversion of vehicle trips to bicycles in the study area. A full accommodation of bicycles on appropriate facilities would result in diverting a percentage of these "divertable" trips.

The location of the strongest markets for bicycle travel was determined using the TMODEL2-based STEP model to assign the trips to highway links. This was accomplished using a 24-km/h (15-mi/h) speed on all highway links (except Interstate highways, which were assigned a value of 3.2 km/h [2 mi/h]) and allowing the model to select the shortest time paths for each trip.

BICYCLE AND PEDESTRIAN TRAVEL DEMAND FORECASTING FOR EXISTING AND PROPOSED TRANSPORTATION FACILITIES

Shawn Turner, Texas Transportation Institute

The research goal for this Texas Department of Transportation (TxDOT) study is to develop a methodology that will provide personnel with the information and a decision-making framework to assess existing and proposed travel demand by bicyclists and pedestrians. The research objectives are to:

- Review the literature and interview national experts to obtain information about bicycle/pedestrian travel demand forecasting.
- Collect bicycle/pedestrian counts for facilities in small, medium, and large urban areas within Texas.

- Evaluate the forecast utility of selected demand modeling techniques in matching collected bicycle/pedestrian count data.
- Adapt or modify an existing demand modeling technique to Texas conditions.
- Prepare documentation for use of the technique by TxDOT.

The project will use mostly screen-line and existing data. Following the literature review, data collection will start in Spring 1997.

Disaggregate, sketch planning, and facility locator (treating bicycle facilities as destinations) models are being considered. The basic questions are, "What are the needs?" and "How are we applying these models?"

TRANSIMS
Michael Culp and Sam Zimmerman, Federal Highway Administration

The focus of the Travel Model Improvement Program (TMIP) is to provide tools to meet regulatory needs.

TRANSIMS is a new modeling system that makes microsimulations of trips on a regional basis using aggregate census data. It synthesizes characteristics of trip makers. These characteristics vary by the size of the area and by geographical location. A simulation component tracks travelers.

INCORPORATING BICYCLE AND PEDESTRIAN FACTORS IN REGIONAL MODELS: RESEARCH AND DEVELOPMENT NEEDS
Michael Replogle, Environmental Defense Fund

In most regions, models do not consider non-motorized trips, or mention them and throw them away. An example is Washington, DC, where the model takes into account only vehicle trips and transit; it doesn't include non-motorized trips.

About 10 years ago, they worked on developing a model for Montgomery County, MD. The model overestimated transit use in suburban activity centers. It didn't include the quality of the pedestrian environment.

Then they developed another model that included building setbacks and the quality and connectivity of sidewalks and bicycle facilities. They considered alternative scenarios of bicycle and pedestrian transportation, and showed that the non-automobile mode share could be doubled over a 30-year period.

In addition, they have worked with others to incorporate pedestrians and bicycles into a sketch model. The LUTRAQ model in Portland, OR, used a pedestrian environment factor. This factor was statistically significant in explaining automobile ownership. Sacramento, CA, picked up the pedestrian environment factor.

The longer term action agenda should include the following:

- Ensure that TRANSIMS and other advanced models are sensitive to bicycle and pedestrian factors.
- Integrate GIS with network and matrix analysis travel modeling software packages.
- Tackle walking trip under-reporting problems in travel surveys with better activity-focused designs and global positioning systems (GPS) checks.
- Develop multi-city, multi-national GIS-based disaggregate discrete choice models.

Efforts to cross-fertilize should take place in the following areas:

- Expand knowledge of bicycle/pedestrian planners of discrete choice analysis techniques and GIS, and expand the knowledge of travel modelers and researchers of bicycle/pedestrian factors.
- Add bicycle-/pedestrian-sensitive consultants to the TRANSIMS effort at the Los Alamos National Laboratory.
- Package and disseminate quick sketch analysis techniques sensitive to bicycles/pedestrians (PROMO) in the Comsis/FHWA traffic demand management (TDM) software package.

Top action priorities are:

- Include bicycle/pedestrian factors into regional models and sketch analysis (LUTRAQ, PROMO).
- Expand use of microsimulation of travel behavior at the household level.
- Expand use of GIS and disaggregate traffic/street/parcel data to measure quality of bicycle/pedestrian environments and proximity measures.
- Expand use of SP/RP survey data to support discrete model development.

Related Intermodal Surface Transportation Efficiency Act issues should include:

- Ensuring that all metropolitan planning organizations (MPOs) are required to meet minimum modeling requirements, including treating all person trips and modes in the analysis.
- Require disclosure of model "blind spots" as part of the conformity analyses and Congestion Management Systems.

- Focus congestion mitigation and air quality (CMAQ) evaluations on motor vehicle trip and vehicle-miles traveled (VMT) reduction—not changes in vehicle speeds—for emissions analysis.

Explore model transferability:

- Ensure that Portland METRO's new models provide a sound foundation for the next generation of practical regional models sensitive to bicycle/pedestrian factors.

- Package and disseminate transferable model coefficients and simplified methods based on empirical research in Eugene/Portland, OR.

- Evaluate transferability with other regions, such as Denver/Boulder, CO; Sacramento/Davis, CA; and New York City.

WHERE SHOULD WE GO FROM HERE?

Data collection is a big need. Specific areas of need include the following:

- Pedestrian/bicycle characteristics.
- National compendium of statistics.
- Update Kagan's numbers, which are 20 years old.
- Information on the effects of different uses (such as CBDs, college towns, edge cities, and suburban activity centers) on trip generation.
- Effects of land use and site planning on travel.
- How roadway condition indexes affect travel.
- Find a location that wants to do LUTRAQ over again.
- Evaluate Philadelphia's bicycle network.
- Investigate how to utilize emissions in the models.

What is the effect on trips of building a facility? For example, how much activity can you expect from adding a sidewalk? Issues here include the following:

- Need tools that one can apply as soon as possible.
- How close to being available are some of the tools? What needs to be refined?
- Develop tools using regional models.
- Some kind of regional multi-modal trip-estimation procedure.

In the area of GIS applications, a compendium of state-of-the-practice is needed, including:

- Aggregation and management of data.
- Models/GIS tools for data analysis.
- GIS as a presentation tool.

WHAT IS NEEDED

The following were identified:

- Regional analysis — simple approach, long range.
- Validity testing of existing methodologies.
- Purposes of planning.
- Prioritization among projects.
- Quantification of response to a facility.
- Data collection — comparability across jurisdictions:
  — Does it already exist?
  — New sources.
  — Pedestrian data.
- Supply side information needed, also GIS.
- ITE trip generation model needs bicycle/pedestrian input.

A quick response tool is needed that would allow one to evaluate projects in a simple way. At the same time, non-motorized modes need to be included in established motor vehicle models, as well as TRANSIMS. At a minimum, there is a need to store and manage existing data in a GIS and build from there. Inventorying the existing non-motorized facilities is a first step in this direction.

- Expand the use of stated preference and real preference surveys to enhance existing data. When doing surveys, ask people how safe they would feel walking or bicycling on a particular facility.

- Develop a method for analyzing the impact of traffic calming on emissions.

- Include bicycle and pedestrian factors in the *ITE Trip Generation Manual.*

- Incorporate updated bicycle and pedestrian techniques in the *Highway Capacity Manual* (HCM). It should reflect person capacity, not just vehicle capacity. (There are situations where a lower vehicle LOS is preferred because of higher person capacity and reduced crash rates.)

- Incorporate traffic count language in the *Manual on Uniform Traffic Control Devices* (MUTCD).

- FHWA should create a motivation for quantitative analysis of the bicycle and pedestrian modes.

- Develop a short-range model in the context of a long-range model and data needs. The design constraints are decision-maker acceptance, planner/practitioner acceptance, and budget acceptance.

Other needs mentioned by workshop participants include:

- Stratified planning into three levels with their different needs—system-wide, corridor, and project or site.

- Enhance existing data:

  - TIGER files fall short where there are new developments (developments since 1989 or 1990 are not included).

  - Expand the NPTS and turn it into a revolving panel or use it as a longitudinal study.

  - Geo-reference PUMS data in order to analyze proximity relationships.

  - Recommend that the U.S. Census Bureau add questions about access mode and line-haul mode.

  - Need good case studies in places with high bicycle use, such as Davis, CA, and Boulder, CO.

  - Use aerial photography to do bicycle/pedestrian counts.

    - Need to develop data bases identifying sidewalks or bicycle paths.

    - Is the option to walk and bike there? What external factors are there to prompt a mode shift?

    - How many people ride bicycles to access transit? Need surveys to find out modes of access.

    - Relationship between land-use information and bicycle/pedestrian use; bicycle/pedestrian trip generation rates by land-use type.

    - Short-range data needs to be applicable to long range.

    - Tools to assist with network (area-wide) planning.

    - Model with bicycles AND pedestrians would be useful in making regional decisions.

    - Corridor, route selection, project prioritization, assessing potential impacts, trip assignment.

    - How do we integrate consideration of land use, pricing of competing modes (time, money, hassle factor)?

    - Some way of measuring network connectivity.

- How do you handle trips for the trip itself?

- Include bicycle trips, trips by access mode.

- Don't have enough observations to build discrete choice models — need to oversample.

- Need to identify impediments to bicycling and walking.

- Need to keep in mind who the users are.

- Framework of utility/dis-utility.

- National strategic community planning initiative.

WHAT'S THE MESSAGE FOR FHWA?

- Everyone needs to be pro-highway, with the highway as a multi-mode system.
- Bring home point that everyone walks.
- It is in our personal interest to be pro-bicycle, pro-walking advocates.

The fundamental problem is data — where do you find it, how do you collect it, and what do you do with it? Possible solutions:

- Use full potential of GIS.
- Work with U.S. Census Bureau to get better TIGER files.
- Biases in the *Highway Capacity Manual* and the *Trip Generation Manual* have to be rectified in order to put non-motorized modes on level playing field.
- Information on trip generation, e.g., what impact would secure parking have?
- Case studies.
- Site and corridor analysis.
- Latent demand.

Models:

- System-level model is needed; bicycle/pedestrian modes are currently being ignored.
- Make sure models incorporate cutting edge.
- Develop a sketch planning approach.
- Tie in with regional models.
- Develop bicycle-/pedestrian-sensitive trip generation factors.
- What will system produce in mode split?
- Link latent demand with supply.
- Vary methods by scope and levels of technical expertise.

Planning:

- Encourage people to do strategic planning.
- Do a lot of talking with decision-makers.
- Utility of meeting, communication among practitioners.

RECOMMENDATION

It was unanimously agreed that a follow-up meeting on the subject of trip generation should be held in 2 years to evaluate progress — in the United States and abroad — in this important area.

PUBLICATIONS

A Compendium of Available Bicycle and Pedestrian Trip Generation Data in the United States: A Supplement to the National Bicycle and Walking Study.

Chesapeake Bay Foundation and Environmental Defense Fund, *A Network of Communities: Evaluating Travel Behavior Effects of Alternative Transportation and Community Designs for the National Capital Region*, May 1996.

A Project of the Chesapeake Bay Foundation, Environmental Defense Fund, American Council for an Energy-Efficient Economy, and Washington Regional Network, in cooperation with Cambridge Systematics, Inc. and MCV Associates. *Evaluating Travel Behavior Effects of Alternative Transportation, Land Use, and Urban Design: A New Approach for the Washington, DC, Region.*

Julie Mercer Matlick, "Forecasting Pedestrian Use and Flows: If We Build It, Will They Come?", *Pro-Bike/Pro-Walk '96 Resource Book.*

Michael Replogle, *Integrating Pedestrian and Bicycle Factors Into Regional Transportation Planning Models: Summary of the State-of-the-Art and Suggested Steps Forward.*

William R. Stein, *Pedestrian and Bicycle Modeling in North America's Urban Areas: A Survey of Emerging Methodologies and MPO Practices.*

Scott E. Davis, Ellis King, and Douglas Robertson, "Predicting Pedestrian Crosswalk Volumes," *Transportation Research Record 1168.*

James M. Ercolano, Douglas M. Spring, and Jeffery S. Olson, *Sketch Plan Method to Evaluate Peak-Hour Pedestrian Traffic for Central Business Districts and Suburban Corridors.*

Edward Weiner and Frederick Ducca, *Upgrading Travel Demand Forecasting Capabilities.*