L E S S O N 3

Bicycle and Pedestrian Planning Overview

3.1 Purpose

Communities throughout the United States have begun to recognize both the potential for bicycle and pedestrian travel and the barriers that must be overcome. In order to address these issues, many communities have begun to develop master plans for bicycle and pedestrian mobility, often as part of the local Comprehensive Plan or Transportation Improvement Program, or through other regional planning efforts.

The renewed effort to plan for bicycle and pedestrian mobility was given a tremendous boost by the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, and was reaffirmed in 1998 by the Transportation Equity Act for the 21st Century (TEA-21). This new era of transportation legislation brought an array of planning requirements to States and Metropolitan Planning Organizations (MPOs). This lesson provides an overview of ISTEA and TEA-21 planning issues, and presents a variety of model master planning processes that can be used at various levels of government.

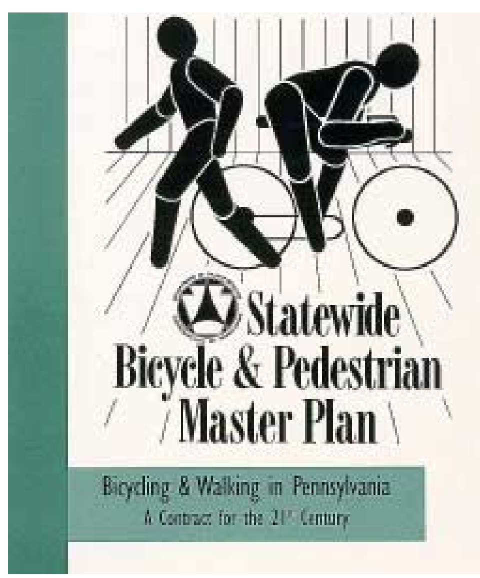
3.2 Federal Requirements for Planning

ISTEA requires preparation of non-motorized elements within State and metropolitan transportation plans.

In addition, each State and each MPO is required to incorporate appropriate provisions for bicycling and walking into the State Transportation Improvement Program (STIP) and Transportation Improvement Programs (TIP).

In addition, each State is required to establish a Bicycle and Pedestrian Coordinator position in its State department of transportation.

ISTEA offers substantial incentives for taking bicycling and walking seriously as alternative transportation modes. There is a wide variety of ISTEA funding programs with potential application to bicycling and walking.



State plans vary considerably in detail and planning approach.

Preparing Plans That Meet Federal Requirements
Information is available on Federal, State, and, in some areas, local levels to assist in preparation of bicycle and pedestrian transportation plans.

1. Technical guidance from FHWA/FTA.
The Federal Highway Administration and Federal Transit Administration have issued Technical Guidance for Bicycle and Pedestrian Planning at the State and MPO levels in order to meet Federal requirements.

Some communities combine the elements of on-road bikeways, trails, and sidewalks into a single plan.

- Any regionally significant bicycle or pedestrian project funded by or requiring an action by FHWA or FTA must be included in the Metropolitan Transportation Improvement Program (TIP).

- Bicycle and pedestrian elements of transportation plans should include:

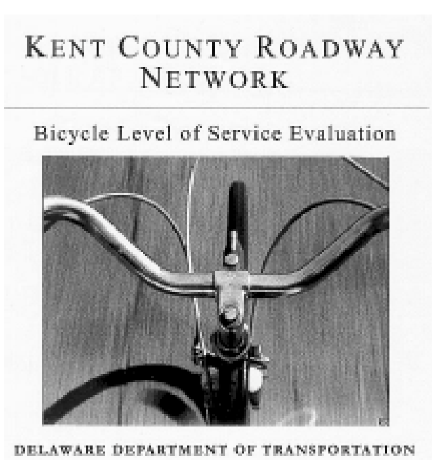
(1) Vision and goal statements and performance criteria.
(2) Assessment of current conditions and needs.
(3) Identification of activities required to meet the vision and goals.

In brief, the Technical Guide includes the following key points relevant to State and metropolitan area transportation planning for bicycles and pedestrians.

- Plan elements should include goals, policy statements, and specific programs and projects whenever possible.

- The Plan should identify financial resources necessary for implementation.

- Bicycle and pedestrian projects may be on- or off-road facilities. Off-road trails that serve valid transportation purposes as connections between origins and destinations are considered as eligible projects consistent with the planning process.



(4) Implementation of the bicycle and pedestrian elements in statewide and MPO transportation plans and transportation improvement programs.
(5) Evaluation of progress, using performance measures developed in (1).
(6) Public involvement as required by TEA-21 and the FHWA/FTA planning regulations.
(7) Transportation conformity requirements for air quality, where necessary.

2. State and metropolitan area planning guidelines.
State and MPO transportation planning guidelines vary considerably in terms of format, level of detail, and planning approach. In some States, the plans are prepared by staff and, in others, with primary input from consultants. Some States have developed detailed guidelines for preparation of bicycle and pedestrian plans and programs, while others provide little guidance in this area. Some have initiated a rigorous process of working with local and regional entities to make sure that the STIP is responsive to community needs, while others take a more hands-off approach.

3. Preparing regional plans.
The ISTEA planning process has the potential to be a major stimulus to intermodal cooperation and work among diverse local entities and disciplines. Working together to set priorities and select projects on a metropolitan basis can help bring communi ties within the region closer together as common

objectives are defined and mutually agreeable selection criteria are established.

Regional planning process issues. Issues that typically arise during the regional planning process include:

- Interpreting the meaning of an "eligible" project under the various ISTEA programs.
- Providing guidelines for preparation of regional plans so information is formatted for ease of incorporation into State-level planning.

Recommended Action Plan for State and Local Governments

Action Item 1:
Organize a bicyclist/pedestrian program

Action Item 2:
Plan and construct needed facilities

Action Item 3:
Promote bicycling and walking

Action Item 4:
Educate bicyclists, pedestrians, and the public

Action Item 5:
Enforce laws and regulations

Many entities need to organize their roles and objectives as part of the local planning effort.

- Dealing with implementation and funding realities — Who coordinates implementation of a multi-jurisdictional plan? What about Traffic Management Organizations (TMOs)? How can applications and funding commitments be met?
- Conflicting standards and philosophies among the regional entities–each county or town may have somewhat different ideas about bicycle and pedestrian transportation and a different set of facility and street standards.
- Reconciling potential conflicts between local and regional perspectives.
- Keeping a broad perspective on plans and programs rather than concentrating only on facility project selection. (Drake, *Pedestrian and Bicyclist Safety and Accommodation Participant Workbook*)

3.3 Preparing Local Pedestrian Plans

Cities and town with good bicycle and pedestrian plans can have a far greater impact on the regional and State-level planning processes. It is advantageous for the local entity to format its plan to meet State and regional guidelines so it can easily be folded into STIP, TIP, and specific bicycle/pedestrian plans.

It is beneficial if neighboring communities can work together to coordinate recommendations and create linkages. Implementation of local programs and facility construction can have far greater use if they extend beyond the city limits to adjoining communities.

In order to do well in the "ISTEA Derby," the local entity must demonstrate a commitment to providing matching funds and meeting required deadlines, and should come equipped with specifics of projects, cost-estimates, and other information— to add to the regional planning process. The city that does its homework has the best chance of securing the funds.

1. Pedestrian planning strategy.
Planning for pedestrians should begin with a thorough understanding of existing local conditions. Therefore, it is advisable to start a pedestrian program by developing a project checklist to help identify possible problems, existing environmental constraints, and/or program features.

Next, proceed to implement improvements through the use of interactive and responsive programs. For the most part, such programs can be managed as part of an agency's routine function.

For example, if the project checklist suggests installing accessible curb ramps at intersections, find

Many communities are making traffic calming a top priority.

out what curb-cut standard (if any) the street department currently uses. If a poor or sub-optimal design is being used, there are several steps that can be followed to improve safety for pedestrians. These include:

- Changing the curb-cut standard (or design guidelines) for new construction.

- Having the street department use the new standard whenever they replace or modify a current installation.

- Budgeting a reasonable amount of money for annual curb-cut installation, based on public requests and a quick prioritization of the street system (e.g., streets near schools, social service offices, popular transit stops, and senior centers).

2. Project priorities.
One approach in setting priorities for pedestrian improvements is to identify what would encourage people to walk more often and then orient efforts toward improving conditions for pedestrians in this direction. During the development of the bicycle and pedestrian plan for Louisiana, citizens were asked what could be done to make it easier to get around by foot. The responses were ranked as follows:

1.	More sidewalks	61.93%
2.	More off-road trails	57.80%
3.	Destinations close to home and work	33.94%
4.	Education for motorists	30.28%
5.	Enforcement of bicyclist/motor vehicle laws	28.44%
6.	More benches, water fountains, etc.	28.44%
7.	More crosswalks	27.06%
8.	Slower traffic on local roads	21.56%
9.	Better transit service	15.14%

Another approach that can help determine where to start is to see what America's most progressive "pedestrian-friendly" communities are doing. Pedestrian activities in these communities typically include:

- Providing a community-wide walkway network that is continuous and safe.
- Providing curb ramps at intersections.
- Installing curb bulbs.
- Calming neighborhood streets.
- Rewriting work-zone policies.
- Reconfiguring arterials.

Some projects are modest in scope, while others can be major undertakings.

While each of these projects and programs may be part of a larger comprehensive planning effort, each can be implemented singly. Also, implementation can be accomplished in phases and in sequences that best reflect local realities.

For example, if it would be easy to install key pedestrian signals, but far more difficult to retrofit sidewalks on a bridge across a major river, the former should be done immediately and the latter as funding and political support materialize.

If the zoning ordinance is currently being revised, adding pedestrian considerations like mixed-use zoning or reduced commercial frontage requirements might be considered. Thus, it is both possible and desirable to pick and choose those projects and programs from the list that have local appeal and are doable. Such an approach makes it possible to get things going almost immediately and to start making a real difference in the community, often at minimal expense.

Of course, some projects are expensive. For instance, if there is a need for a grade-separated pedestrian crossing of a freeway, such a project can easily cost upwards of $300,000 to $500,000. Planning for such an expenditure can take several years and may involve grant applications or implementation through the Transportation Improvement Program (TIP) process and the use of any one of several categories of Federal funds. Meanwhile, many small, but important, changes can be made as the community works its way toward pedestrian-friendliness.

Pedestrian signals that are consistent in their design and actuation are important.

Many local programs have found that small initial successes build momentum, allowing more ambitious work to follow. In one western community, for instance, installation of several "test" traffic circles on residential streets — a project that took several days of work and less than $5000 to accomplish–helped build support for an on-going program installing such circles all over town.

3. Program/Project list.
The list below briefly describes pedestrian programs or projects in categories that relate to the time-honored "Four E's"–engineering, education, encouragement, and enforcement. While not every conceivable pedestrian program or project is included, the following checklist contains the most important.

a. Engineering.

Walkways:
Typical concerns: Sidewalks are often broken, missing, or not continuous.

Possible Solutions: Require sidewalk installation or replacement as a condition of development.

Intersections:
Typical concerns: 14 percent of fatal crashes in urban areas occur in the central business district (CBD). Two-thirds of CBD injuries occur at intersections.

Possible solutions: Create guidelines for intersection design to make pedestrians as visible as possible and their actions as predictable as possible.

Crosswalks:
Typical concerns: Pedestrians "dart out" or cross vehicular roadways at random locations.

Possible solutions: Create a program to install crosswalks, bulbouts (flared curbs), and refuge islands to encourage pedestrians to cross streets and roads at predictable, as well as convenient, locations. Bulbouts and refuge islands also reduce exposure time for pedestrians at crossings and increase green time for vehicles.

Curb ramps:
Typical concerns: Wheelchair users can't cross street or must use a nearby driveway.

Possible solutions: Create an annual curb ramp program to install ramps where requested.

Creative intersection design can greatly increase motorists' awareness of pedestrian safety.

Curb bulbs and curb radii:
Typical concerns: Wide streets are more difficult to cross than narrow ones and expose pedestrians to traffic dangers for a longer period of time.

Possible solutions: Use curb bulbs to narrow streets at important crossings and include the specifications in standard designs.

Signal timing and push buttons:
Typical concerns: Pedestrian signals are often inconsistent in their timing and actuation methods.

Possible solutions: Follow a consistent policy of push-button installation and signal timing whenever traffic signals are installed or modified.

Pedestrian half-signals:
Typical concerns: Where residential streets meet arterial streets at unsignalized intersections, pedestrians may have great difficulty crossing.

Possible solutions: Install pedestrian half-signals near schools, hospitals, social service offices, and senior citizen centers.

Signing and marking:
Typical concerns: When pedestrian signing and marking is used in the wrong location, in the wrong manner, or for the wrong purpose, it can lead to a false sense of security for pedestrians.

Possible solutions: Evaluate high-risk locations and install consistent pedestrian crossing controls.

Pedestrian amenities:
Typical concerns: Streetscape is devoid of amenities and street furniture that facilitate and encourage walking.

Possible solutions: Develop and install a system of amenities and street furniture, taking care not to limit sight distance or restrict the width of normal pedestrian paths.

Reconfiguring arterial streets:
Typical concerns: High arterial street speeds are often associated with high risks of pedestrian fatalities.

Possible solutions: Change the channelization to provide median refuges and slow traffic down.

Bridges:
Typical concerns: Without adequate sidewalks, pedestrians may have to walk in the roadway or avoid a walking trip all together.

Possible solutions: Make sure sidewalks are included in all major renovation projects.

Traffic calming:
Typical concerns: Too often, through traffic diverts to residential streets in order to avoid arterial street congestion.

Possible solutions: Install a set number of traffic circles per year in response to neighborhood requests.

Maintenance:
Typical concerns: Badly maintained sidewalks or those cluttered with portable signs and newspaper stands can lead to pedestrian injuries.

Possible solutions: Enact clear and fair laws governing the use of sidewalks for private purposes. Establish and implement an ongoing maintenance program. Remove all hazards. If a hazard cannot be removed, erect barriers or clear warning signs.

b. Education.

Public awareness campaigns:
Typical concerns: Safety and acceptance of walking as a legitimate travel mode are serious concerns for pedestrians.

Possible solutions: Construct public awareness and education campaigns that target safety problems and change attitudes for the better.

c. Encouragement.

Trip-length reduction:
Typical concerns: Even with adequate sidewalks and crosswalks, if destinations are out of reach, few people will walk for utilitarian purposes.

Possible solutions: Encourage mixed-use development through incentives such as increased density or additional height.

Walking-route maps:
Typical concerns: Knowing how to reach nearby destinations on foot is a major step to encouraging walking.

Possible solutions: Develop an interest in a series of neighborhood and regional walking maps.

Walking events:
Typical concerns: Just getting started is often the biggest barrier to increased pedestrian activity.

Possible solutions: Facilitate the organization and promotion of special walking events to celebrate foot travel and encourage novices to give walking a try.

Group B (basic) bicyclists value designated bike facilities such as bike lanes.

d. Enforcement.

Construction zones:
Typical concerns: Work sites often “take over” pedestrian space, forcing people to walk in the street or through construction debris.

Possible solutions: Require clear consistent work zone controls as part of the building permit process.

Land use development requirements:
Typical concerns: Having to cross large parking lots to reach a nearby store negates the value of curbside sidewalks; it can be unsafe and a discouragement for walkers.

Possible solutions: Require safe pedestrian access to new and renovated buildings.

Enforcement:
Typical concerns: Motorists often ignore pedestrians in crosswalks and pedestrians often ignore crosswalks.

Possible solutions: Enforce pedestrian-related traffic laws, focusing first on key crash locations.

3.4 Local Bicycle Planning

Transportation planning is a process for making decisions about the development of transportation facilities. This includes providing accurate information about the effects that proposed transportation projects will have on the community and projected users. Bicycle planning is no exception. However, because much of the information necessary to reach sound decisions about providing for safe, efficient bicycle use is already available as a by-product of the normal operation of the road system, the bicycle planning process is a specific application of the overall transportation planning process.

This is especially true in the case of Group A bicyclists–the more experienced and proficient bicyclists that comprise about 5 percent of bicycle users in the United States. These bicyclists are able to operate on the roadway in most traffic conditions and favor the directness and right-of-way preference given to roads with a high functional classification. The planning process used to develop or improve roadways for motorists is equally valid for this type of bicyclist.

There are, however, some important design features to be taken into account to best accommodate Group A bicyclists, and for this reason, planners and engineers should refer to the American Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities* (1999) during the planning process for streets and highways. Group A riders should be anticipated and provided for on all roadways where bicycles are not excluded by statute or regulation, regardless of functional classification.

2. Inventory the existing bicycle facility and roadway system.
3. Identify desired bicycle travel lines and corridors.
4. Evaluate and select specific route alternatives.
5. Select appropriate design treatments.
6. Evaluate the finished plan against the established performance criteria.

The situation is very different for Group B/C bicyclists (bicyclists of average skill and experience, and children). While these bicyclists value many of the same roadway features as Group A bicyclists (i.e., accessibility and directness), they also value other characteristics such as designated bicycle facilities and lower traffic volumes.

Group B/C bicyclists typically prefer to ride on neighborhood streets and/or designated bicycle facilities. The location of these facilities is best determined through a planning process that seeks to determine where designated facilities are needed and the type of bicycle facilities that should be provided to accommodate and encourage Group B/C bicyclists.

Developing a Bicycle Network Plan
The following discussion details a planning process intended to identify a network of routes where special bicycle facility treatments should be employed to meet the needs of Group B/C bicyclists.

Many model planning processes could be used to select routes and design facility treatments to accommodate Group B/C bicyclists. Chapter 1 of the AASHTO Guide contains several suggestions for establishing a bicycle planning program. The following process is but one example It consists of six steps:

1. Establish performance criteria for the bicycle network.

Establish Performance Criteria for the Bicycle Network
Performance criteria define the important qualitative and quantitative variables to be considered in determining the desirability and effectiveness of a bicycle facility network. These can include:

- **Accessibility:**This is measured by the distance a bicycle facility is from a specified trip origin or destination, the ease by which this distance can be traveled by bicycle, and the extent to which all likely origins and destinations are served. Some communities (e.g., Arlington, VA) have adopted a criterion of having a bicycle facility within 1 mile (1.61 km) of every residence. More importantly, no residential area or high-priority destination (school, shopping center, business center, or park) should be denied reasonable access by bicycle.

- **Directness**: Studies have shown that most bicyclists will not use even the best bicycle facility if it greatly increases the travel distance or trip time over that provided by less desirable alternatives. Therefore, even for Group B/C bicyclists, routes should still be reasonably direct. The ratio of directness to comfort/ perceived safety involved in this trade-off will vary depending on the characteristics of the bicycle facility (how desirable is it?), its more direct alternatives (how unpleasant are they?), and the typical user's needs (in a hurry?, business or pleasure trip?).

- **Continuity:** The proposed network should have as few missing links as possible. If gaps exist, they should not include traffic environments that are unpleasant or threatening to Group B/C riders, such as high-volume or high-speed motor vehicle traffic with narrow outside lanes.

- **Route Attractiveness:** This can encompass such factors as separation from motor traffic, visual aesthetics, and the real or perceived threat to personal safety along the facility.
- **Low Conflict**: The route should present few conflicts between bicyclists and motor vehicle operators.
- **Cost:** This would include the cost to both establish and maintain the system.
- **Ease of Implementation:** The ease or difficulty in implementing proposed changes depends on available space and existing traffic operations and patterns.

Inventory Existing System

Both the existing roadway system and any existing bicycle facilities should be inventoried and evaluated. The condition, location, and level of use of existing bicycle facilities should be recorded to determine if they warrant incorporation into the proposed new network or if they should be removed. If existing bicycle facilities are to be used as the nucleus of a new or expanded network, the inventory should note which improvements to the existing portions of the network may be required to bring the entire new network up to uniform design and operations standards.

A simple inventory of the roadway system could be based on a map of the annual average daily traffic (AADT) counts on each road segment within a community or region. A more complex inventory could include factors such as the number of traffic lanes, the width of the outside lane, the posted speed limit or actual average operating speed, the pavement condition, and certain geometric and other factors (e.g., the frequency of commercial driveways, grades, and railroad crossings).

Identify Bicycle Travel Corridors

Predicting bicycle travel corridors for a community is not the same as identifying the routes that bicyclists currently use. Instead, travel corridors can be thought of as "desirable lines" connecting neighborhoods that generate bicycling trips with other zones that attract a significant number of bicycling trips.

For motor vehicle traffic, most peak morning trips are made between residential neighborhoods and employment centers. In the evening peak hours, the opposite is true. In the evening or on weekends, the pattern of trip generation is much more dispersed as people travel to shopping centers, parks, and the homes of friends or relatives.

Estimating these trip flows for an entire city can be a complex, time-consuming effort requiring significant amounts of raw data and sophisticated computer models. Fortunately, transportation planning for bicycles is much simpler. Unlike traditional transportation planning that attempts to predict travel demands between future zones on as-yet unbuilt streets and highways, bicycle planning attempts to provide for bicycle use based on existing land uses, assuming that the present impediments to bicycle use are removed. These desire lines are, in fact, well represented by the traffic flow on the existing system of streets and highways.

The underlying assumption is that people on bikes want to go to the same places as do people in cars (within the constraints imposed by distance), and the existing system of streets and highways reflects the existing travel demands of the community. Furthermore, most adults have a mental map of their community based on their experience as motor vehicle operators. Thus, they tend to orient themselves by the location of major streets and highways.

Again, it is important to note that the resulting map may not be a representation of where bicyclists are now, but is instead a reflection of where bicyclists wish to go. The actual travel patterns of Group B/C bicyclists are heavily influenced by their perception of the bicycling environment they face. Uncomfortable or threatening bicycling conditions will cause these bicyclists to alter route choice from their most preferred alignment, choose a different travel mode, or not make the trip at all. Thus, the task of the transportation planner for bicycling is to ask, "Where are the bicyclists now?" and "Where would they be if they could go where they preferred?"

Although this use of existing traffic flows is a useful overall predictor of bicyclists' desire lines, a few special situations may require adjustments to the corridor map:

- Schools (especially colleges and universities) and military bases can generate a disproportionately large share of bicycle trips. This is especially true for campuses where motor vehicle parking is limited.

- Parks, beaches, libraries, greenways, rivers and lakesides, scenic roads, and other recreational facilities attract a proportionately higher percentage of bicycle trips.

Evaluate and Select Specific Route Alternatives
The corridor identification procedure identifies desire lines for bicycle travel between various locations. The next step is to select specific routes within these corridors that can be designed or adapted to accommodate Group B/C bicyclists and provide access to and from these locations. The aim is to identify the routes that best meet the performance criteria established in the first step of this planning process.

Typically, this step and the selection of appropriate design treatments are highly interactive processes. The practicality of adapting a particular route to accommodate Group B/C bicyclists may vary widely depending upon the type of design treatment selected. For example, a less direct route may become the best option if comparatively few inexpensive and easily implemented design improvements are required.

Therefore, steps 4 and 5 should be approached as an iterative loop in which both route selection and design treatment are considered together to achieve a network that is highly advantageous to the user, is affordable, has few negative impacts on neighbors and other non-users, and can be readily implemented.

In summary, the selection of a specific route alternative is a function of several factors, including:

- The degree to which a specific route meets the needs of the anticipated users as opposed to other route options.

- The possible cost and extent of construction required to implement the proposed bicycle facility treatment.

- The comparative ease of implementing the proposed design treatment. For example, one option may entail the often unpopular decision to alter or eliminate on-street parking while another does not.

- The opportunity to implement the proposed design treatment in conjunction with a planned highway construction or reconstruction project.

A more inclusive list of factors to be considered in the selection of a specific route is presented in the AASHTO Guide.

Select Appropriate Design Treatments
Guidelines for selecting an appropriate design treatment are presented in lesson 3 of this manual. In overview, the principal variables affecting the applicability of a design treatment are:

- **The design bicyclist.** Is the proposed route projected to be used primarily by Group A bicyclists, or is it intended to also serve as part of a network of routes for Group B/C bicyclists?

- **The type of roadway project involved on the selected route.** Is the roadway scheduled for construction or reconstruction, or will the incorporation of design improvements be retrofitted into existing geometrics or right-of-way widths?

- **Traffic operations factors.** The most significant traffic operations factors for determining the appropriateness of various design treatments are:
  - Traffic volume.
  - Average motor vehicle operating speeds.
  - Traffic mix.
  - On-street parking.
  - Sight distance.
  - Number of intersections and entrances.

Evaluate the Finished Network Plan Using the Established Performance Criteria
Will the proposed network meet the criteria established at the start of the planning process? If it does not meet most of these criteria, or inadequately

meets a few critical goals, either the proposal will require further work, or the performance criteria must be modified. In the latter case, the planning process as a whole should be reviewed to determine if previously discarded routes should be reconsidered. There may now be more preferred options in light of the newly modified criteria.

This reality check is important. Many well-considered proposals fail when it is determined that the finished product no longer meets its established objectives. (Drake, *Pedestrian and Bicyclist Safety and Accommodation Participant Workbook*, 1996).

Several factors will determine the final design treatment used; two of the foremost are cost and controversy.

3.5 Using Analytical Tools in the Planning Process

Bicycle planners have traditionally relied on anecdotal evidence to prove that bicycle facilities are needed within specific roadway corridors. In the case of a typical urban arterial with heavy traffic and relatively high speeds, planners rightfully argue that demand is not accurately reflected by the number of bicyclists currently riding within the road right-of-way. They maintain that due to impedances, there exists a pent up, or latent, travel demand within the corridor.

However, when challenged to quantify this latent demand, many planners are at a loss as to how to respond. Some bicycle planners attempt to employ the "desire lines" technique–a vintage 1930's planning tool that has become obsolete with today's environment of linked urban tripmaking patterns and expectations of sophisticated travel demand models. Other planners have relied on the "if you build, it they will come" philosophy of response - one that requires a leap of faith that many policymakers aren't ready to take except in rare circumstances.

Today's trend toward quantitative analysis puts more pressure than ever on transportation planners to justify public expenditures "by the numbers." Increasingly, competition among projects for priority within metropolitan area Transportation Improvement Programs requires a numerical basis to demonstrate that all projects can reach measurable objectives. Furthermore, in the case of the increasingly popular method of providing facilities by development exactions, local governments have been issued a "wake-up call" by the U.S. Supreme Court through its 1994 *Dolan vs. Tigard* decision. That decision has underscored the need for local governments to clearly demonstrate, or quantify, how a proposed bicycle facility will offset traffic caused by new land developments. Clearly, in today's transportation planning environment, bicycle planners must use analytical methods in order to do their jobs successfully.

While millions of dollars and decades of research have gone into travel demand models for motor vehicles and transit, bicycle travel demand models are virtually non-existent. However, a recently developed analytical tool, the Latent Demand Score (LDS) Model, can help planners to quantitatively evaluate bicycle travel demand on a systemwide basis. The LDS Model measures the relative amount of bicycle travel that would occur on a road segment if there were no bicycle travel impedances. It employs a simplified, probabilistic gravity model technique to quantify the proximity and magnitude of bicycle trip attractors and/or generators. Applied on a segment-by-segment basis and in conjunction with a bicycle Level of Service (LOS) analysis, the LDS model can provide a clear, reasonable, and relatively

Streets and roadways can be analyzed to determine the relative level of service they provide to bicyclists.

low-cost method of determining which roads are the best candidates for bicycle facility improvements. And until significant federal funding for the development and calibration of a bicycle travel demand forecasting model is mad available, the LDS Model will be the model of choice for cutting-edge bicycle transportation planners. The following sections outline the LDS Model technique.

Technical Review: The Latent Demand Score (LDS) Model

The LDS Model was developed to provide transportation planners with 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 upon their proximity, frequency, and magnitude of adjacent bicycle trip generators and/or attractors. The LDS Model uses many parameters similar to those in the highway model. The steps of the LDS Model are:

1. Establish trip-making thresholds for the bicycle trip attractors and generators for the four trip purposes: home-based work, home-based shopping, home-based recreational/social, and home-based school trips. The attractors/ generators include: home-based work markets, home-based markets per census block group, commercial employment per traffic analysis zone, public parks (stratified in to minor, staffed, and major), and elementary and middle schools' student population (within their transportation exclusion zone).

2. Geocode and/or map the attractors/ generators and record (in the database), for each segment, the number of indicators, stratifying according to proximity using Geographic Information System (GIS) 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 stratification, the number of indicators by their distance impedance.
   c. Sum, for each trip purpose, its value for the segment.

4. Normalize the Demand Indicator Values (DIV) to reflect their relative trip generation (ADTs) by:
   a. Estimating the average independent variable of each attractor/generator.
   b. Calculating the average trip generation of each attractor/generator using the *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 by summing the DIVs.

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.

Case Study: Application of the LDS Model in Birmingham, Alabama

In Birmingham, Alabama the LDS Model was used as one component of a comprehensive Bicycle, Pedestrian and Greenway Plan for a large two-county region. The plan was funded with Congestion Mitigation and Air Quality (CMAQ) funds and serves as part of the MPO's Long Range Transportation Plan. The project was conducted by the Birmingham Regional Planning Commission (BRPC).

One important task for this project was to prioritize facility development. The planning process included a Route Planning Charette for local planners, engineers, citizens and elected officials that resulted in a "ultimate needs list" of on-road and off-road corridors for bicycle and pedestrian facility development. The needs list, which included more than 900 different corridor segments, was further refined through a needs assessment, as defined in the steps below:

Step 1: Assess the Current Level of Service

During the first step, a bicycle level of service (BLOS) analysis was computed for the on-road route system identified in the Route Planning Charettee. The BLOS model, based upon the Interaction Hazard Score of IHS Model (*Landis, Transportation Research Record 1438*) quantified the bicyclists' perception of hazard level of interacting with motor vehicles. The resulting BLOS score was scaled into categories A, B, C, D, E, or F, with "A" representing the best conditions and "F" representing the worst conditions.

Step 2: Estimate Latent Demand

The LDS Model, as described above, was used to measure potential bicycle travel activity for each on-road and off-road segment. For the Birmingham Area plan, latent demand was estimated for four trip types:

- Home-based work.
- Home-based shopping.
- Home-based recreational/social.
- Home-based school trips.

An impedance variable was added to the model to account for the effect of grade on travel demand, because steep hills are commonplace throughout the region. In addition, the LDS Model's distance impedances were stratified to account for the different average trip distances in rural versus suburban and urban areas.

Step 3: Compute Analytical-Based Priority

By combing the results of the BLOS and LDS Models, an analytical score was produced for each segment of the proposed route system. A road segment with poor bicycling conditions, but a high latent demand ranked higher on the priority list than a road with a similar level of demand, but relatively good conditions for bicycling. Off-road future segments were ranked only with the latent demand.

Step 4: Measure Public Priority

During two public meetings held in January 1996, participants were asked to identify the routes that they felt should have the top priority. The attendees were given five votes each (more than 150 citizens participated in this process). The results were tallied and public priorities for the route system were established

$$LDS = \sum_{n=1}^{4} TTS_n \times \frac{\sum_{n=1}^{4}(GA_n \times \overline{TG_n})}{(GA_n \times \overline{TG_n})} \times \left[\overline{TG_n} \sum_{d=1}^{I} P_{nd} \times ga_n\right]$$

n	=	bicycle trip purpose (e.g., work, personal/business, recreation, school)
TTS	=	trip purpose share of all bicycle trips
GA	=	number of generators or attractors per trip purpose
TG	=	average trip generation of attractor or generator
P	=	effect of travel distance on trip interchange, expressed as a probability
ga	=	number of generators or attractors within specified travel distance range
d	=	travel distance range from generator or attractor

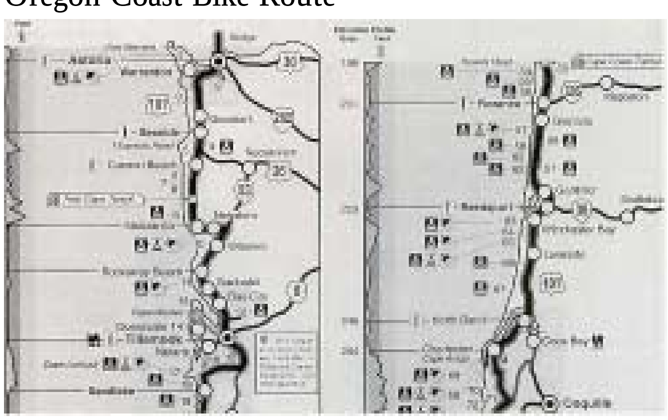
Form of Latent Demand Score Model equation.

Step 5: Compute Final Needs Ranking
The final needs ranking for the proposed route system was computed as a combination of the analytical score and public priority. The results of the final needs ranking were divided into three Needs Levels: A, B, and C, and stratified by jurisdiction.

Step 6: Designation of the Short-Term and Long-Term Route Plans
The Long-Range Route Plan is composed primarily of routes that were scored as Level A on the final needs assessment. Level B and Level C routes are included on this plan as needed to form necessary regional connections. The Short-Range Plan includes routes that are deemed critical for immediate improvement and/or areas already planned for improvement (thus making bicycle/pedestrian facility development less expensive).

As a regional plan, funding and construction for routes identified on the Short- and Long-Range Plans will require partnerships between local governments and the Birmingham Regional Planning Commission. This MPO is committed to allocating a portion of the region's Surface Transportation Funds (above and beyond Enhancement Funds) for bicycle and pedestrian facility construction and programs. While each route on the route plan is eligible for funding, a high level of competition among local governments is expected in the years to come.

Oregon Coast Bike Route



Oregon Coast Bike Route map provides a clear and easily read map for all users.

Conclusion
Together, the Latent Demand Score and Bicycle Level of Service Models are effective bicycle system planning and roadway facilities prioritization tools that:

- Are adaptable to a variety of software.
- Use data available in virtually all metropolitan areas.
- Use objectively collected field data.
- Can be easily updated.
- Can be used for "fingertip" policy testing of traffic calming or other alternatives.
- Generate easily understood results.

Numerous metropolitan areas throughout the United States are using these models to successfully develop their bikeway network in today's challenging planning environment. (*Pro-Bike/Pro-Walk 1996 Conference Proceedings, Article #70,* "Using the Latent Demand Score Model to Estimate Use")

3.6 Mapping

Consistency in bicycle maps enables users to readily understand symbols and colors when they visit a new area. A system of unified codes and symbols is also useful to planners, designers, and engineers.

There are four basic types of bicycle maps:

- Urban bicycle facility maps.
- County, State, or regional bicycling guides.
- Bicycling tour guides.
- City or county planning maps.

The first three types are used mainly by bicycle riders; the fourth is used by a wide variety of interested parties.

Urban Bicycle Map
Used primarily by local utilitarian bicyclists, newcomers, and visitors, this type of map is intended to help cyclists choose routes they feel comfortable bicycling on, and to encourage first-time riders to make certain trips by bicycle.

All streets should be shown. A simple color code indicates the presence and type of bicycle facilities. It also warns bicyclists of roads they should use with caution. The accompanying text should provide information on the proper use of bikeways, traffic laws, and safety tips.

Other useful information includes enlargements of difficult intersections, steep hills, weather data, parking facilities, bike shops, important destinations, and landmarks, etc. However, too much detail creates a cluttered effect; simplicity makes it easier to find needed information.

CODE:

Blue	Bike Lanes
Purple	Multi-Use Paths
Red	Caution Areas
Black	Local Streets (shared roadways)

Bicycle Guide
The intended audience is recreational and touring riders interested in medium- to long-distance trips. The major concerns when choosing a route are traffic volume and roadway conditions. Color coding indicates bicycle level of service; a solid line indicates the presence of shoulders wide enough for bicycle travel.

The map should include State highways and county roads. The level of detail is less than that on an urban map. Other information to be included are distances, grades, weather data (especially prevailing wind directions), and camping facilities. Text should be used for information on local history, landmarks, viewpoints, etc.

Description of loop tours is useful to riders planning day trips. Local bicyclists should ride the loops in order to assess conditions. A written description of the route listing landmarks and turns is helpful.

Since bicycle trips often cross jurisdictional boundaries, counties are encouraged to coordinate regional maps, covering a natural geographical area within easy reach of several population centers.

Shoulders:
Black lines indicate shoulders 1.2 meters (4 feet) or wider on both sides of the roadway.

Grades:

1 Chevron	2-4% grade
2 Chevrons	4-6% grade
3 Chevrons	Greater than 6% grade

Bicycling Tour Guide
The intended audience is bicyclists on an extended tour. The format can be fold-out maps, strip maps, or brochures. Various agencies can cooperate to produce maps for long-distance bicycle tours that traverse several jurisdictions.

If a loop or one-way tour is best when bicycled in one direction only, this should be emphasized in the text (for example, it is best to ride the Oregon Coast Bike Route from north to south, to take advantage of prevailing winds).

Points of interest are important, as are distances, grades, campgrounds, availability of water, and details about different areas. A written description of the route listing landmarks and turns is useful, as well as an elevation profile.

Other Useful Tips
Good maps are clear and simple, as too many symbols and details create confusion. Only needed information should be included:

- For urban maps, all city streets should be shown, as well as schools, public agencies, and other common destinations. But not every street needs to be coded for bicycling purposes: most residential streets and minor collectors function well as shared roadways and should be left open on the map.

- For bicycling guides, too much topographical detail obscures the information that is really useful.

- For tour guides, inclusion of all roadways in the vicinity creates a confusing, web-like effect. Only the roads on the tour need to be included, along with roads that connect the route to other localities (for riders who wish to join or leave the route at intermediate points). Insets of urban areas are useful.

It is usually better to create a new map. If available graphics capabilities don't allow this, existing maps can be used by adding and deleting information.

Other important considerations are:

- Symbols and text should be oriented in a direction consistent with the way a map is going to be held (if possible, north at the top).

- Descriptive text should be placed as close as possible to the relevant map segment (especially important for tour guides). (*Oregon Bicycle and Pedestrian Plan*)

3.7 References

AASHTO, *Guide for the Development of Bicycle Facilities*, 1999.

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