Chapter 4: Functional Classification Systems

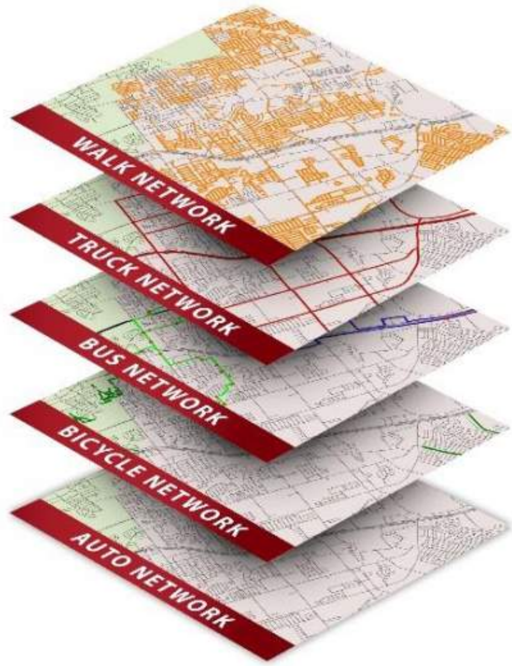
CHAPTER HIGHLIGHTS

- The Concept of Multimodal Functional Class and Facility Type
- The Auto Network
- The Bicycle Network
- The Bus Network
- The Truck Network
- The Walk Network

The Concept of Multimodal Functional Classes

The general concept of Functional Class was introduced in Chapter 2 to show the context of the hierarchy of different types of roads in the KTMPO region. That Chapter included a review of Thoroughfare Plans from KTMPO jurisdictions to show the street Functional Classes that were defined in their Plans, and showed that they were defined differently within each Plan. A set of accepted street Functional Classes were introduced that could be used consistently throughout the region, and which could be supported by the regional travel demand model in compliance with TxDOT standards.

With the general concept of Functional Class for streets having been introduced, this Chapter will expand the concept to cover the five discrete networks in the region which are layered together to form the regional multimodal network. Two additional transportation modes, the airport and railroad systems, interact with the networks as points of access rather than as travel links, and so the concept of Functional Class is not applicable to them.



For each discrete network layer, a mode-specific Functional Classification system is introduced. Where applicable, sub-classes of Facility Types are detailed to define additional features that may be applied to each Functional Class. Each Functional Class is described with its purpose, benefits, and applications.

Extending the concept of Functional Class and Facility Type to all transportation networks is proposed in order to bring the same level of precision to the analysis of all modes' needs. At the same time, transportation planners must recognize the relative shares of each mode and their respective contributions to mobility in the region. **Table 4-1** shows the national-level mode shares for commuting and for all trips, illustrating the significantly heavier use of the automobile over the other transportation modes of transit, bicycling, and walking. Recognizing this fact does not mean that the other modes are less important; rather it calls for transportation planning that preserves the mobility granted by the automobile while at the same time developing the mobility, sustainability, and livability that is promised by other transportation modes. It calls for the development and support of a balanced regional multimodal transportation system.

Table 4- 1: National-Level Mode Shares

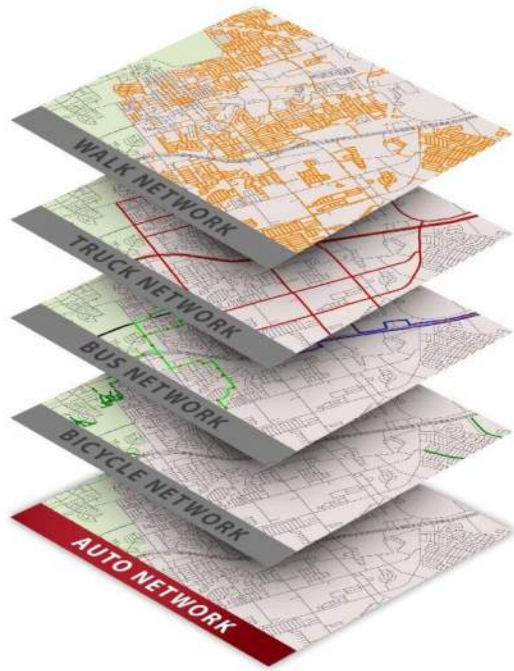
Mode of Travel	% of Commuters		% of All Trips Nationwide [3]
	Nationwide [1]	52 Large U.S. Cities [2]	
	2.8%	5.0%	10.4%
	0.6%	1.0%	1.0%
	5.0%	17.2%	2.2%
[4]	91.6%	76.7%	86.4%
All Modes	100%	100%	100%

Sources: (1) ACS 2011 (2) ACS 2009–2011 (3) NHTS 2009 **Notes**: The term "mode share" is used to describe the percentage of all trips or percentage of trips to work by each mode of transportation. (4) This includes trips by private car and "other" means that are not public transportation, bicycling, or walking—such as taxi, motorcycle, recreational vehicle, school bus, etc.

This community [was planned] when the car was king, and now we're recognizing the value of multiple modes and there are certain areas where we need to re-imagine, rethink, so they work for pedestrians.

- Eugene Howard
Project Manager
Denver Community Planning & Development Department

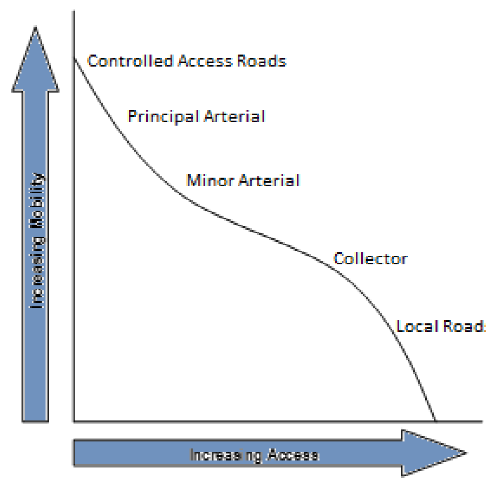
Auto Network Functional Classification



The functional classification of roadways with a comprehensive, systematic hierarchy of street type definitions considers the relationship between the type of trips served, the type of areas served, and characteristics of the streets themselves. The use of functional classification was mandated by the Federal-Aid Highway Act of 1973 to guide the provision of aid for transportation improvement projects, and this legislative requirement is still in effect today through provisions of the current FAST Act highway funding authorization. The Federal Highway Administration Functional Classification system is commonly accepted to define the functional and operational requirements for streets. These classifications are also used as the primary basis for geometric design criteria.

Purpose

The fundamental basis of street functional classification is the need to balance the two conflicting but complementary purposes of access and mobility. The Functional Classification system recognizes the hierarchy of purpose among streets that channel traffic flow from the highest level of access (local streets), to facilities collecting these flows (collector streets), then to facilities able to conveniently transport these larger flows over longer distances (arterials), and then even larger flows over even longer distances (controlled access roads), with the highest levels of mobility but least amount of access to adjacent land uses.



Unavoidably, as the provision for access to adjacent land uses increases with connecting street intersections, curb cuts, and provisions for turning movements, the level of mobility that a facility provides must decrease. The balance that a facility demonstrates between serving access and mobility is a substantial part of defining a facility's Functional Classification.

Recognizing this balance between access and mobility in a street's purpose is important to consider when planning for the balance between the street's accommodation of auto traffic and ensuring the safe and comfortable use of the street for users of all ages and abilities, using all appropriate transportation modes. This second balancing is a critical part of updating the previous Regional Thoroughfare Plan into a Regional Multimodal Plan.

Benefits

From a practical perspective, identification of the functional role of roadways is a useful tool for communities to plan for their transportation system. The Functional Classification system directly supports the Metropolitan Transportation Plan (MTP) project selection process by establishing a consistent relationship among all streets. This in turn is the basis for establishing a consistent system of street speeds and capacities that is linked to street attributes. For the purposes of project evaluation, any project for a change in a street's Functional Class (Minor Arterial to Major Arterial), Facility Type (undivided to divided), number of lanes (2 lanes to 4 lanes), or associated Area Type (rural to suburban) has a consistent and realistic effect on the street's speed and capacity attributes for itself and in relation to all other streets in the network. This allows each street project to be properly evaluated using the travel demand model, supporting a consistent and objective evaluation of projects.

Applications

The derived regional street Functional Classification system that has been developed with reference to the FHWA system and to the systems defined in the individual Thoroughfare Plans from KTMPO member jurisdictions is incorporated into the regional travel demand model network. The regional street Functional Classification system defines facilities as:

Controlled Access Functional Class roads include Interstate Highways, Freeways, and Expressways. Interstate Highways are high speed, divided highways with no direct access to adjacent land uses. All interchanges are grade-separated. Freeways and Expressways have a lesser amount of control over access, and may have a limited number of at-grade intersections controlled by traffic signals. The primary function of Controlled Access roads is to serve mobility, so they tend to serve longer-distance trips.

Major Arterial Functional Class roads are higher speed, higher volume facilities which provide regional mobility, but are balanced with a greater degree of access. They often serve significant regional activity centers, and provide major access points with at-grade intersections. While access is important, the principal function of this Functional Class is to provide mobility.

The ***Minor Arterial Functional Class*** augments and feeds the major arterial system and distributes traffic flows to smaller regions. This Functional Class places more emphasis on providing access.

The ***Collector Streets Functional Class*** is the lowest level Functional Class that is considered to have regional significance and to be routinely included in the travel demand model. They function to gather and concentrate the traffic from local streets, and funnel it onto the higher Functional Class System in the street network. For Collector Streets, providing access is by far the most important concern. Low speed and low capacity reflect the lesser importance given to mobility.

Frontage Roads and ***Ramps*** are secondary street Functional Classes associated with detail coded Controlled Access Arterials. They provide the linkage to connect Controlled Access Arterials to the network.

Local Streets Functional Class is typically not included in a regional travel demand model, as the modeled network is designed to include only streets which have regional significance. However, provisions have been made to include local streets if they provide necessary connectivity for the network.

There are currently no ***Toll Roads*** or managed lanes (High-Occupancy/Toll, or ***HOT*** lanes) in the KTMPO region, and no toll roads or managed lane projects are included in the adopted 2040 KTMPO modeled street network. The standard TxDOT Functional Class System has been updated to define this Functional Class, so it can be added to the KTMPO regional network if needed for the analysis of projects.

TxTag

Several tolled Facility Types have been defined to distinguish between radial and circumferential facilities, and to support the definition of truck-only facilities. Facility types for HOT lanes distinguish between the travel lanes and HOT ramps that provide connections to the non-tolled main lanes.

Facility Types

The standard TxDOT definition street attributes defines three Facility Types for roads. To support the concept of livability in the transportation planning process, two additional street Facility Types have been defined in this Plan. In general, Facility Types are optional attributes within the street cross section which may be applied to a street regardless of its Functional Class.

The **Divided Facility Type** applies to Major Arterials, Minor Arterials, and Collectors that have a median that physically separates the travel lanes by direction. Periodic median crossings are provided to accommodate turning movements.

In most instances of divided streets in the KTMPO region, the median is formed by a grassy or landscaped buffer strip. Divided streets may also be defined by a raised curb with paving, as shown in this illustration.

The **Continuous Left Turn Lane Facility Type** also applies to Major Arterials, Minor Arterials, and Collectors. The purpose of the continuous left turn lane is to provide opportunities for vehicles to pull out of the travel lane as they wait for oncoming traffic to clear before making their turn, so they are most commonly applied to higher Functional Class roads with higher speeds and higher volumes of traffic.

The **Undivided Facility Type** is common throughout the system, and has no physical barrier between the travel lanes by direction. While this allows unlimited turning movements, vehicles queueing for a turn can block the travel lanes. Undivided streets are more common on lower Functional Class roads with lower speeds and lower volumes of traffic.

Complete Streets are an additional **Facility Type** defined for this Regional Multimodal Plan. The concepts of Complete Streets and Context Sensitive Solutions have been endorsed by FHWA and TxDOT, which promote their development and provide guidance and design standards. The goal of Complete Streets is to design street attributes so that they consider the needs of all appropriate users and transportation modes. This does not imply that all modes must be present on all streets, but that accommodations are made as appropriate. Complete Streets design features were introduced in Chapter 3, and include treatments such as narrower travel lanes, median islands, curb extensions, parklets, bike lanes, and crosswalk treatments. Streetscape treatments such as landscaping and shade trees may also be considered as Complete Streets features.

The **Green Street Facility Type** is also newly defined in this Plan. A Green Street integrates stormwater management into the street design, often using natural water diffusion and infiltration techniques rather than simply channeling water to drains. While Green Streets may be seen as an environmentally-friendly approach to water management, the natural processes which are used are often more efficient and more cost-effective than traditional engineering approaches. Green Streets treatments include pervious pavement, rain gardens, bioswales, and retention basins.

Bicycle Network Functional Classification

While the use of a Functional Classification system for streets is mandated by Federal regulations, there are no regulatory requirements to establish a system for other modes, including the bicycle mode. This bicycle Functional Classification system is therefore offered as a tool to define a hierarchy of bicycle facilities which can be implemented as appropriate.

A balanced bicycle network defines infrastructure to provide safe, convenient, and comfortable access to the street network. This does not conflict with the right of bicycles to use any street in the network. Bicycles are legally defined as vehicles and have the same rights to the road and obligations to obey traffic laws as other vehicles. Bicycles are prohibited only from controlled access facilities such as Interstates, Freeways, and Expressways. For all other streets, including Frontage Roads, every street is a bicycle street, regardless of its bikeway designation or infrastructure.

Purpose

While the basis for a Functional Classification system for the auto network is primarily that of balancing the purposes of access and mobility, in contrast, the basis for a bicycle Functional Classification system can be seen primarily as addressing safety. Bicyclists operate a vehicle and are legitimate road users, but they are slower and less visible than motor vehicles. Bicyclists are also more vulnerable in a crash than motorists.

Conversely, when bicycles interact with pedestrians, it is the bicycle that is the higher speed and higher mass object, and the pedestrians who are the more vulnerable users. Bicycles travel 15 to 20 mph faster than pedestrians, so mixing bicycle and pedestrian traffic is inappropriate in most cases. Therefore, within the regional multimodal network, the purpose of bicycle infrastructure is managing the interactions of the bicycle network with all other modal networks, not just the automobile.

Benefits

The best evidence of the quality and fitness of a region's bicycle infrastructure is its volume of users. The highest-volume examples are in Europe, where significant bicycle facilities, denser development patterns, high gas prices, and a cycling culture combine to give the bicycle mode shares which are commonly in the 20% to 40% range. The average bicycle mode share for U. S. cities is 1.0%. American cities with high bicycle mode shares reported in the American Community Survey include Portland, Oregon with a 7.0% share, and only four other cities with mode shares of 4.0% or higher.

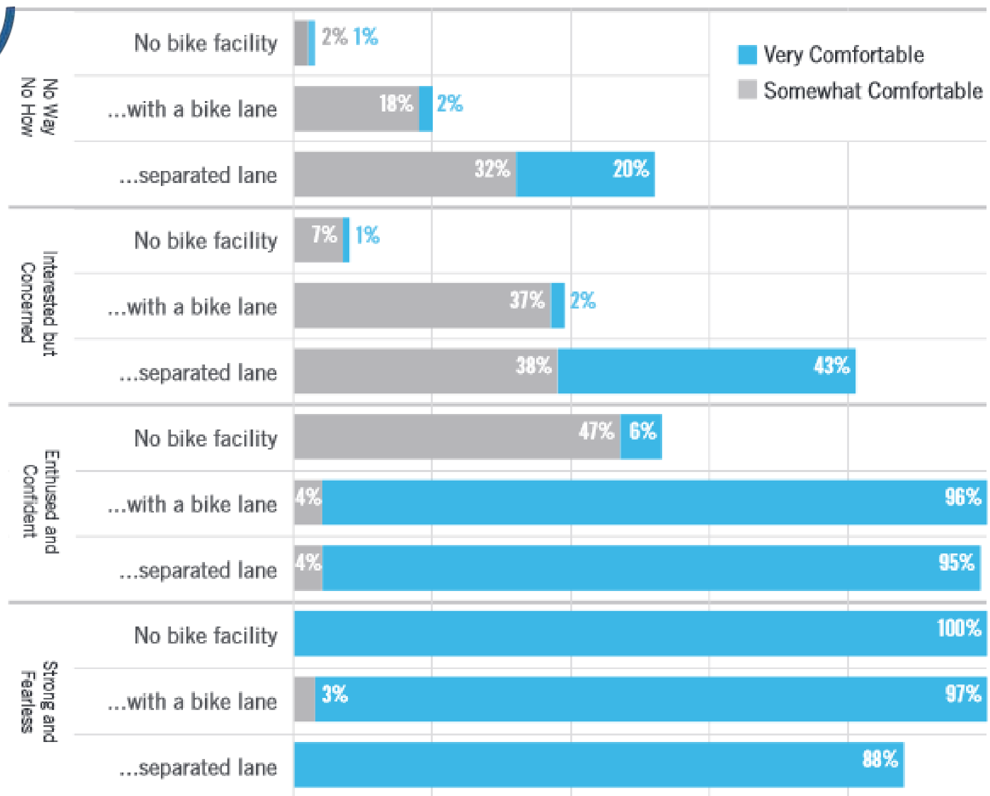
The data for Texas cities shows even smaller bicycle mode shares. Only four Texas cities are in the top fifty as reported by the Census Journey-to-Work data: Austin, ranked # 19 with a 1.3% mode share; Corpus Christi, ranked #43 with 0.5%; Houston, with a 0.5% mode share and a #44 ranking; and Plano, ranked #50 with an 0.4% share. The overall bicycle mode share for Texas is 0.6%. The bicycle mode share for the KTMPO region is reported in the Census data as rounded to 0.0%.

The low volumes of bicycle ridership in U. S. cities as compared to European cities validates a common saying among advocates that bicycling in the United States is geared towards **"the young, the fit, and the brave…and not too many of them"**. It also illustrates the challenge of bringing the existing bicycle network in the KTMPO region into balance.

The bicycling environment in Portland, Oregon illustrates the need for bicycle infrastructure. Portland is known for its extensive bicycle infrastructure and has the highest bicycle mode share of any U. S. city, yet a 2013 survey revealed that fully 80% of residents were "very concerned" or "extremely concerned" about the safety of cycling in their city. Commenting on the survey, Portland Bicycle Planning Coordinator Roger Geller estimated that about 60 percent of people in Portland would like to bike more, but are **afraid to ride**.

As shown in **Figure 4-1**, the survey classified respondents into four groups based on their confidence in riding, ranging from "No Way No How" to "Interested but Concerned", "Enthused and Confident" and "Strong and Fearless". The survey showed that bike infrastructure, particularly a separated (protected) bike lane, had a significant impact on the perception of safety.

Figure 4-1: Portland, Oregon Survey on Safety and Bike Infrastructure

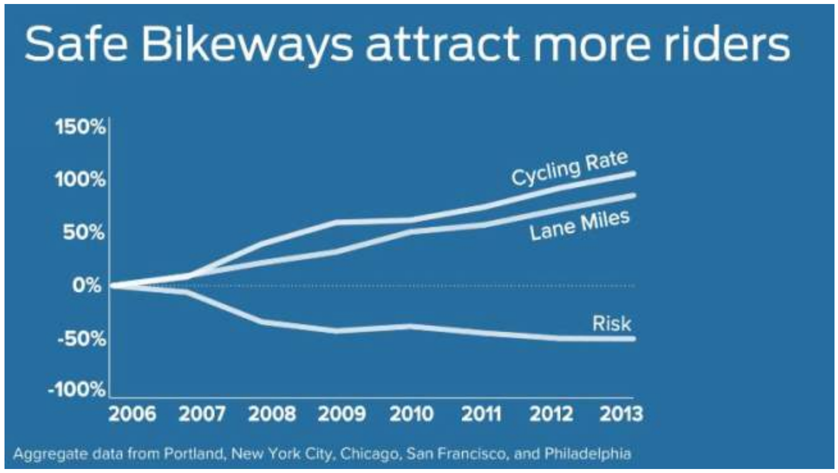


Source: https://peopleforbikes.org/blog/selling-biking-perceived-safety-the-barrier-that-still-matters/

One benefit of balancing the bicycle network is that developing a network of safe bicycling infrastructure has been shown to increase ridership, which in turn increases the visibility of bicyclists and improves safety. **Figure 4-2** uses data from five U. S. cities which have been active in building protected bike lanes. The chart shows a clear correlation: as more bike lanes are built, people feel more safety in riding, and ridership increases. The inverse is also true: if bicycle infrastructure is not built, then people will continue to be **afraid to ride**, bicycle safety and fatalities will continue to be an issue, and bicycle ridership will continue at very low levels.

If you always do what you always did, you'll always get what you always got

Figure 4-2: Safety and Bicycle Use



Bicycle infrastructure can also be seen as an educational and visibility tool. Although it is historically, logically, and legally inaccurate, some motorists have the attitude that bicycles do not have a right to the road. Developing highly visible bicycle infrastructure provides riders with protection from these motorists and reminds them of the fact of bicyclists' rights.

One of the challenges that we often have in communities is that there can be a perspective that roads are for cars, and cyclists are interfering with the use of cars. This mindset can lead to aggressive driving and potentially endanger lives.

- Derek Bouchard-Hall
CEO, USA Cycling

Figure 4-3: Ridership and Safety

Others accept the rights of bicycles as vehicles, but feel that bike lanes are not necessary because bicycles can share the lane with cars, trucks, and buses. Safety data and ridership data show the error of this attitude, as shown in **Figure 4-3**. This data from the International Transport Forum shows a strong correlation between higher volumes of ridership and lower rates of fatalities. The Netherlands logged the highest amount of travel by bicycle and the lowest fatalities rate. In contrast, the United States showed a much lower travel volume of travel and a much higher rate of fatalities. Bicycle infrastructure clearly plays a role in establishing safety and ridership volumes.

Dr. John Snow is regarded as one of the founding fathers of modern epidemiology. As London suffered a series of cholera outbreaks during the mid-19th century, Snow theorized that cholera was spread through contaminated water. During the September 1854 cholera outbreak, he mapped known cholera deaths around thirteen public water wells and noted a strong correlation for one particular location. He had the pump handle removed and the outbreak quickly subsided.

Noah Budnick, Deputy Director of the Transportation Alternatives advocacy group, uses this historic example to promote bicycle infrastructure as a safety measure. "…then they built infrastructure, and people stopped dying", says Budnick. "If you build infrastructure like protected bike lanes, then people stop dying."

Applications

The bicycle Functional Classification system as proposed in this Plan is based on promoting visibility, safety, convenience, and building ridership volumes. Each of the bicycle Functional Classes, ranging from **Protected Bike Lanes** to **Shared Roadways**, therefore has multiple roles in developing a balanced regional multimodal network.

The ***Protected Bike Lane Functional Class*** is defined as conventional bicycle lanes paired with a designated buffer space and some type of barrier that physically separates the bicycle lane from the adjacent travel lane or parking lane. The protected bike lane is designed to heighten safety and, perhaps even more importantly, to promote the perception of safety among bicyclists in order to appeal to a wider cross-section of potential riders.

Facility Types for Protected Bike Lanes

The advocacy group *People for Bikes* has developed a guide of different treatments for a protected bike lane, which may be inferred as defining different Facility Types. The guide is based on information developed for the 2014 Austin Bicycle Plan. Summarizing the treatments found in this Plan, six general Facility Types for Protected Bike Lanes are proposed:

Curbs Facility Type can be cast-in-place or prefabricated to provide a visible physical barrier that is mountable for emergency vehicles, but which discourages routine encroachment from autos.

A curb-protected bike lane may have issues accommodating street cleaning equipment, so debris may accumulate in the lane.

Flexible Bollards Facility Type have a higher profile and so are more visible to motorists. They also have the advantage of being readily recognized as lane barriers.

Debris in the bike lane is still an issue, but the bollards do not interfere with stormwater drainage in any way.

Several varieties of **Low Bumps Facility Type** are available. Low Bumps have the advantage of defining the lane while still being mountable for emergency vehicles and street sweepers, so they perform well for debris sweeping and stormwater drainage. However, this can also be a disadvantage if motorists disrespect the laws and park in the bike lane.

The **Parking Stops Facility Type** is readily available and recognizable for defining the edges of lanes. Drainage is unimpeded, and the spacing between parking stops can be adjusted to allow access to the bike lanes or turning requirements at intersections.

In this example from Boulder, Colorado, the parking stops are augmented with flexible bollards and a painted buffer to further define the bike lane.

The **Parking Facility Type** can provide a solid physical barrier. As shown in this illustration from Austin, a second form of physical barrier is sometimes provided to prevent the cars from encroaching on the bike lane. In this example, Flexible Bollards were installed. Opening car doors can also present an issue for bikes in the lane.

This installation also shows the use of colored green pavement to define the bike lane.

The **Planters or Jersey Barriers Facility Type** provides a permanent and highly visible insurmountable barrier to protect the bike lane. They also provide space for landscaping to make the entire street more attractive, although this imposes a maintenance cost.

Jersey Barriers can also be used, which have the advantage of being a readily-recognized form of traffic control. Jersey Barriers may also be painted or have cast-in decorative treatments.

The **Rigid Bollards Facility Type** has all the advantages of flexible bollards, while at the same time having the advantages of a permanent and insurmountable barrier.

Installation costs for Rigid Bollards are higher than for other Facility Types. They are more susceptible to damage than linear treatments such as Jersey Barriers, but can be replaced more readily.

In practice, multiple Facility Types for Protected Bike Lanes can be implemented on the same facility when they are appropriate to reinforce the message of the protected lanes, heighten visibility of the lanes, or direct motorists and bicyclists at the entrances to the lanes. In this example, planting and a wider buffer help define the entrance to a protected bike lane.

As a special instance of a Protected Bike Lane, a ***Cycle Track Functional Class*** is an on-road facility with bicycle traffic in two directions. It is located on one side of the road. As shown in the illustration, applications can be placed on one-way streets, so the Cycle Track allows two-way movement within the street grid.

A cycle track may be at the same level as the street, as shown here, or may be raised to the level of the sidewalk to deter encroachment from autos wherever the track does not have a barrier.

Facility Types for a Cycle Track would be the same as for the Protected Bike Lane. With two directions of bicycle traffic and two delineated lanes, separation from pedestrian traffic is important as well. Treatments of the Cycle Track at intersections are more complex and require careful consideration of auto turning movements conflicting with both directions of bicycle traffic.

A ***Conventional Bike Lane Functional Class*** is defined as a portion of the roadway that has been designated for bicyclists by pavement markings. Bike lanes are intended to enable bicyclists to ride without conflicts with other traffic. As an upgrade in protection over shared wide travel lanes, Conventional Bike Lanes provide a greater space for bicycles without making the bike lane appear so wide that it might be mistaken for a travel lane or a parking lane.

Conventional bike lanes are a common Functional Class of facility in use in the US, and most jurisdictions are familiar with their design and application as described in the MUTCD and AASHTO Guide for the Development of Bicycle Facilities. Safety and volume data show that Conventional Bike Lanes have largely been unsuccessful in making bike trips on high-speed, high-volume streets comfortable for most bicyclists. They can be more effective in lower-speed, lower-volume situations.

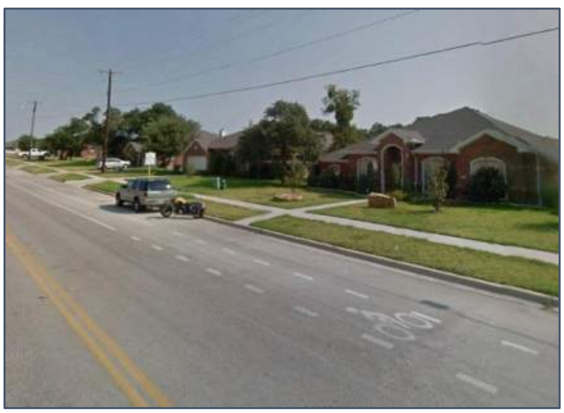
Since a Conventional Bike Lane has no physical barrier that restricts motorized traffic or parking, in practice encroachment on bike lanes by traffic, parked vehicles, and curbside trash containers has been common. Protected Bike Lanes were developed in part to address this issue.

Facility Types for Conventional Bike Lanes

The Conventional Bike Lane Functional Class is marked with painted lines rather than with physical barriers. Three Facility Types can be defined: Outboard, Inboard, and Buffered.

The **Outboard Facility Type** is illustrated by this bike lane in Temple. It is also known as a Curbside Facility Type, with the wide travel lane marked with a consistent white stripe against the curb. Bike lane symbols are provided at intersections to guide motorists and alert them of the definition of the lane.

In this application, there is no designated parking strip to conflict with the bike lane.



Killeen provides an example of an **Inboard Facility Type** for a Conventional Bike Lane, where the bike lane is defined inboard of a parking lane. This Facility Type recognizes the need to park along the curb while still providing a bike lane. It also addresses a common issue of debris in a bike lane by placing it more into the street.

The **Buffered Facility Type** separates an Outboard or Curbside Bike Lane from traffic with a painted buffer, but unlike the Protected Bike Lane, it does not have physical barrier. Styles of the painted buffer can vary, with the MUTCD providing guidance on buffer widths and on the use of stripes and chevrons to define the buffer.

Bicycle Boulevard Functional Class

Bicycle boulevards are streets with low motorized traffic volumes and speeds, designed to give priority to bicycles over motorized vehicles. The goal of the Bicycle Boulevard is to divert bicycle trips to alternate routes, avoiding high-speed and high-volume arterial streets and intersections. Bicycle Boulevards use signs, pavement markings, and speed and volume management measures which are typically consistent with Complete Streets treatments to discourage through trips by motorized vehicles and create safe, convenient bicycle crossings of busy arterial streets.

Bicycle boulevards have the potential to play a key role in a low-stress bikeway network, as they can complement and provide strategic connections between dedicated bicycle lane treatments, multi-use trails, and off-street paths. They can make cost-effective use of existing roadways and connections with a series of relatively minor treatments that substantially improve bicycling conditions on local streets. Many local streets offer the basic components of a safe bicycling environment. These streets can be enhanced using a range of design treatments to create bicycle boulevards. Many of the treatments not only benefit people on bicycles, but also help create and maintain quiet streets that benefit residents and improve safety for all road users.

Bicycle boulevards should be kept in good condition, with a smooth riding surface. Many cities have maintenance schedules for resurfacing and rehabilitating road surfaces that give priority to higher-volume streets. Local streets are typically the lowest priority for repaving, but bicycle boulevards should have a higher priority for repaving or spot improvements than other local streets.

The goal of the Bicycle Boulevard is to divert bicycle trips to alternate routes, so good wayfinding signs and markings are critical to clearly establish and publicize the routes

Shared Roadway Functional Class

A shared roadway is a street in which bicyclists ride in the same travel lanes as other traffic. There are no specific dimensions for shared roadways. On narrow travel lanes, motorists have to cross over into the adjacent travel lane to pass a cyclist. Shared roadways work well and are common on low-volume, low-speed neighborhood residential streets, rural roads, and even low-volume highways.

On streets where bike lanes would be more appropriate but with insufficient width for bike lanes, wide curb lanes may be provided. This may occur on retrofit projects where there are physical constraints and all other options, such as narrowing travel lanes, have been pursued. Wide curb lanes are not particularly attractive to most cyclists; they simply allow a passenger vehicle to pass cyclists within a travel lane, if cyclists are riding far enough to the right.

Shared-lane marking stencils, commonly called “sharrows”, may be used as an additional treatment for shared roadways. The stencils can make motorists aware of bicycles potentially in the travel lane, and they show bicyclists the correct direction of travel.

Among other benefits, shared lane markings and signs reinforce the legitimacy of bicycle traffic on the street, recommend proper bicyclist positioning, and may be configured to offer directional and wayfinding guidance. The shared lane marking is a pavement marking or a sign with a variety of uses to support a complete bikeway network; it should not be considered as equivalent bike lanes, cycle tracks, or other separation treatments.

Off-Street Multi-Use Trail Functional Class

An off-street trail provides the greatest amount of separation and protection from traffic. Off-street trails are often multi-use, intended to serve bicycle and pedestrian trips. Multi-use trails must be wide enough to accommodate safe interactions between bicycles and pedestrians.

Depending on their width, alignment, connections to the street network, and connections to other bicycle facilities, off-street multi-use trails can accommodate recreational use, but have the potential to accommodate bicycles as a practical mode of transportation serving regional destinations.

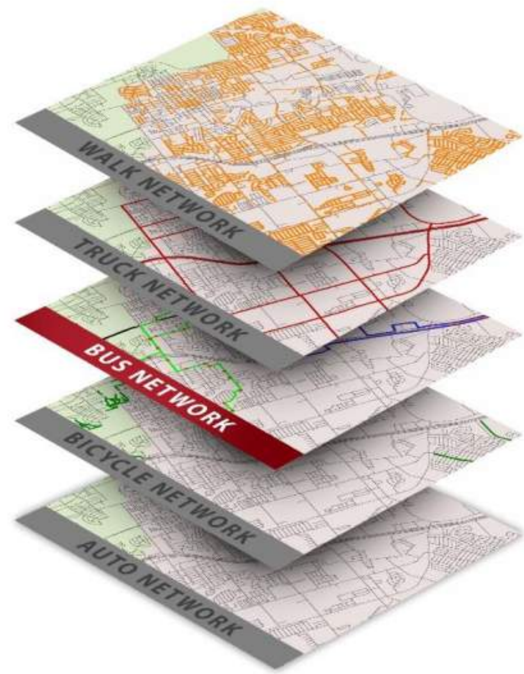
Facility Types for Multi-Use Trails

The **Hard Paved Facility Type** features a hard and smooth surface to provide a path free of impediments and to accommodate high-end road bikes and strollers. Concrete or asphalt are common surfaces. Brick or other paver types are not recommended for bicycle facilities because of their effects on the quality of the ride.

The **Soft Paved or Unpaved Facility Type** is paved with materials which can reduce costs or provide a more recreational user experience. This Facility Type is generally more amenable for recreational use. Gravel, decomposed granite, and dirt are typical soft paving materials.

The **Dual Track Facility Type** is designed to provide a greater separation of bicycle flows and pedestrian flows. Examples of implementation of Dual Track facilities are typically off-road because of the greater right-of-way required. The buffer between the bicycle and the pedestrian tracks may be a grassy strip, as shown in the example, or it may be a painted line. Sturdy barriers such as those used to separate bicycle flows from auto traffic are generally not necessary in this context.

Bus Network Functional Classification



As with other non-auto transportation modes, there are no regulatory requirements to establish a Functional Classification system for the bus network. This bus network Functional Classification system is therefore offered as a tool to define a hierarchy of bus stop facilities.

Purpose

The concept of Functional Classification for the bus network does not relate to routes or operations, but to the transit system infrastructure of bus stops. A consideration of passenger amenities is the primary driver in this Plan's definition of bus stop Functional Class. The definition of Facility Types considers other aspects of bus stop infrastructure related to the context of the stops. Context considerations for Facility Types include bus pull-outs or on-street placements, pedestrian access and ADA compliance, and stormwater treatments.

Bus stops operated by The HOP in the KTMPO region are internally classified as being located on the Near Side, Far Side, or Mid-Block relative to the closest intersection. This distinction is important, but it is primarily an operational issue rather than an infrastructure issue relating to a bus stop Functional Classification system, and so is not addressed in this Plan.

Benefits

Collating the various attributes of the passenger amenities and bus stop context into a defined Functional Classification system is intended to assist transportation planners in defining the inventories, needs, and gaps in the balanced multimodal network, and to develop and evaluate projects to address those gaps.

Increased ridership is an added benefit of a balanced bus network with improved passenger amenities at bus stops. *TCRP Synthesis 117: Better On-Street Bus Stops* cited data that supports the logical conclusion that transit ridership increases with bus stop improvements. However, most increases were found to occur at high-ridership stops; little or no increases were seen when amenities were improved at low-ridership stops. This finding indicates that the overriding requirement of the bus system is that it must provide safe, convenient, and practical trips. Transit coverage area, route orientation, service hours, and connectivity to desired destinations were shown to be more important than stop infrastructure in the Mineta Transportation Institute report *Investigating the Determining Factors for Transit Travel Demand by Bus Mode*. Convenient and comfortable access to the system is not a benefit if the system does not provide the desired services.

Applications

Each of the bus Functional Classes, ranging from **Station** to **Basic Bus Stop** is defined to support the development of a balanced regional multimodal network.

The selection of amenities at individual bus stops is generally driven by the volume of ridership. Stops with higher volumes generally support a higher level of amenities.

The ***Station Functional Class*** has the highest level of amenities. Stations are enclosed, weather-controlled facilities with waiting areas, seats, manned stations for tickets and information, and restrooms. Many stations also feature advanced amenities such as vending machines and wireless internet.

Intercity bus routes schedule rest stops and breaks for meals at commercial sites such as gas stations and fast food restaurants. Although not officially listed as stations, for the purposes of the Functional Classification system these facilities exhibit a high level of amenities, and so can reasonably be classed as Stations.

A consideration to be made for some stations, particularly intercity bus and AMTRAK, is that they are privately owned and operated. Some partner with The HOP to allow joint access to their stations and stops, but the stations remain private. Planning for stations must accommodate this fact.

The ***Shelter Functional Class*** in the KTMPO region includes two distinct styles of shelters. The Handi-Hut, as shown, is green metal with a peaked roof. The Brasco bus shelter has a black frame with flatter plexiglass. Both styles are open-fronted and have integral benches.

TCRP Synthesis 117: Better On-Street Bus Stops reports that the most common request for an amenity at a bus stop is a shelter, and nationally, transit agencies overwhelmingly rate shelters as the amenity most valued by their riders.

The ***Bench Functional Class*** uses a bench and typically includes a paved area, but does not have a shelter. Additional amenities such as informational signs and trash cans may also be present.

Bus stops with benches typically also have a hard surface paved landing pad to accommodate waiting. In this illustration, the bench is set back from the curb far enough to allow space for wheelchair users and the deployment of bus ramps.

The ***Basic Bus Stop Functional Class*** is typically used for the lowest-ridership locations. This Functional Class typically has a sign identifying the location as a bus stop. The sign may or may not include schedule information. Other amenities such as trash cans and paved places to wait are typically not provided with this Functional Class.

Facility Types for Bus Stops

In general, Facility Types are attributes which may be applied to any bus stop regardless of its Functional Class. Four Facility Types have been defined in this Plan.

The **ADA Access Facility Type** refers to the ease of pedestrian access to bus stops and to their compliance with the Americans with Disabilities Act (ADA). ADA details specific design parameters to ensure that users are able to access facilities regardless of their disabilities, which include mobility or vision impairments.

The illustrations shows an example of an access accommodation at a bus stop. The illustration shows an ADA-compliant stop with a loading platform connected to the sidewalk, and the bench is set back far enough to allow maneuvering a wheelchair and deployment of a bus ramp.

Cities throughout the country are incorporating rain gardens and planters in their streetscapes, either as Complete Streets projects or as Green Roads projects addressing stormwater runoff. The improved streetscapes can enhance the attractiveness of bus stops, but the design of streetscapes can impact the ADA compliance of bus stops by blocking access.

The **Bulb-Out Facility Type** is designed with two considerations in mind, both based on the needs of transit in high-volume areas. In practice, a bus bulb-out often is placed within a parking lane, rather than taking space out of the travel lane.

The first consideration is that a bus pulling out of the travel lane for a stop may have difficulty pulling back into traffic on a congested road. Breaks in traffic of sufficient size to allow a bus to safely enter can be infrequent, and can therefore impact the busses' on-time performance. A bus bulb-out addresses this by keeping the bus in the travel lane for the stop. This treatment gives the bus priority over other traffic, as the bus blocks the travel lane during its stop.

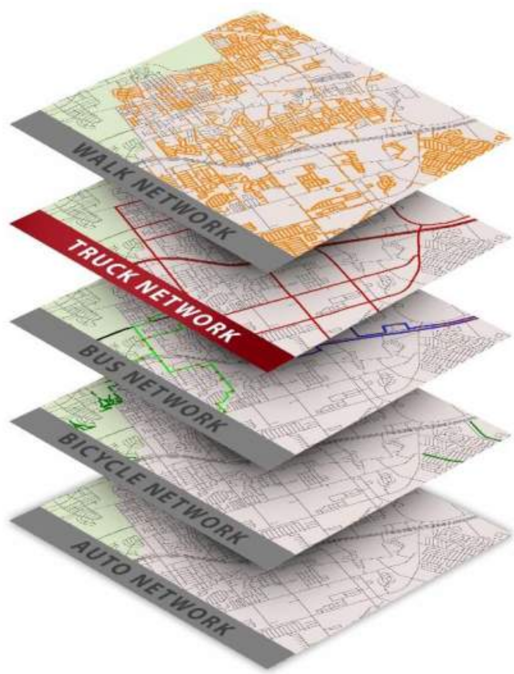
The second consideration in a bus bulb-out is pedestrian mobility. In high-volume areas, sidewalks are often crowded as well, and a bus stop can take up room on the sidewalk that is needed for walking. The bus bulb-out provides additional space on the sidewalk, and separates the waiting area from the walking area.

With the **In-Street Facility Type**, the bus stops directly in the travel lane to load passengers. This design is well suited to locations where traffic volumes are relatively low and the stopped bus blocking one lane is acceptable, or, as in the illustration, on multi-lane streets where traffic can change lanes to bypass the stopped bus. Since the bus stays in the travel lane, this design avoids issues with the bus merging back into traffic.

In contrast to the Bulb-Out and In-Street Facility Types, the **Pullout Facility Type** gives priority to keeping traffic moving by displacing the bus out of the travel lane for loading.

A Pullout can be appropriate in many locations where traffic volumes are low or Level of Service (LOS) is relatively high. Potential issues with a bus Pullout are shown in the illustration, and include the difficulty of the bus pulling back into traffic, narrowing of the sidewalk, and conflicts with bicycle facilities.

Truck Network Functional Classification



The definition of Functional Classes for trucks is intended to inform the street design process of the needs and impacts of trucks. As with other non-auto transportation modes, there are no regulatory requirements to establish a Functional Classification system for the truck network. This Functional Classification system is therefore offered as a tool to define a hierarchy of street facilities as used by trucks.

The definition of a truck is important when considering the different impacts of the different types of truck. While the FHWA and TxDOT use a very detailed classification system based on the number of axles and trailer combinations, for planning purposes the three types defined in the FHWA *Quick Response Freight Manual* (QRFM) are adequate.

The three truck types in the QRFM system are:

- Heavy trucks such as 18-wheeled tractor-trailers and single unit trucks with four or more axles.
- Medium trucks are typically 6-tire single-unit box trucks.
- Light trucks are two axle, 4-tire commercial vehicles, including standard pickup trucks.

Purpose

The purpose of a Functional Classification system for trucks is to provide a basis for planning which highlights the different needs and impacts that trucks have on the regional multimodal network. The concept of Functional Classification for trucks as proposed in this Plan is to define streets according to the differences in the desirability of the presence of trucks.

Benefits

The identification of the desirability of trucks on any particular street is the primary benefit to be developed from this Functional Classification system. This supports transportation planners in defining the needs and gaps in the regional multimodal network, and to develop and evaluate projects to address them.

Applications

The truck Functional Classification system defines facilities as:

The ***Truck Priority Functional Class*** designates preferred truck routes documented in plans or policies. In all cases for this Functional Class, the routes are defined as a preference, and no regulations mandate that trucks use the routes. Both Federal and Texas State plans have designated certain routes as preferred truck routes. Planning networks which define preferred truck routes include:

- National Highway System (NHS), which includes the Interstate Highway system. The NHS includes only 4% of the total mileage of road in the nation, but carries 75% of all heavy truck traffic.
- National Highway Freight Network (NHFN), defined in the FAST Act highway authorization bill.
- Primary Highway Freight System, a component of the NHFN focusing on roads.
- Strategic Highway Network (STRAHNET), a component of the NHS focusing on access for military installations.
- Texas Highway Freight Network, defined in the Texas Freight Mobility Plan.

The ***Truck Restricted Functional Class*** is defined as facilities where some trucks are denied access, but others are allowed. The restrictions are typically based on truck heights, widths, or weights. In the cases of height and weight, the restrictions are often points such as bridges or overpasses where larger trucks do not have enough clearance to pass. Truck weight restrictions may apply to entire roads where the road structure is not adequate to bear the weight, but may also apply to points such as bridges.

A truck's weight is distributed according to the number and the spacing of axles, so the configuration as well as the weight is one of the issues to consider. Therefore, some weight-restricted roads or bridges specify different weight limits based on the configuration of the truck.

The ***Truck Hazardous Material Functional Class*** is a hybrid of the Truck Priority and the Truck Restricted Functional Classes. This designation is more than a preference, as there is a legal mandate for trucks carrying non-radioactive hazardous materials loads to travel only on the designated routes. Likewise, all other routes are restricted for these trucks, and the restrictions are legally defined. Radioactive hazardous materials form a special class, and the routes for those loads are "preferred routes".

The ***Truck Prohibited Functional Class*** refers to streets or bridges where all medium and heavy trucks are legally prohibited, regardless of their dimensions or weights. Prohibitions typically apply to residential streets, although exceptions may be made for trucks making deliveries. Trucks are also often prohibited from High Occupancy Vehicle (HOV) and High Occupancy or Toll Managed Lanes (HOT).

Walk Network Functional Classification

As with the other non-auto transportation modes, there is no regulatory requirement to establish a Functional Classification system for the walk mode. This walk network Functional Classification system is therefore offered as a tool to define a hierarchy of facilities which can be implemented as appropriate when the walk network interacts with the other modal networks.

Purpose

The bicycle and the pedestrian modes are often grouped together in transportation planning under the label of "active transportation". This is appropriate in many contexts, including the definition of the primary purpose of the walk network Functional Class System: to promote the safety of the user. Pedestrians are the most vulnerable of all road users, and the mix of pedestrians can include children, children in strollers, the elderly, wheelchair users, and others with limited mobility. Defining pedestrian infrastructure is therefore not only a matter of balancing the regional multimodal network; it is a vital element in planning for the safety of the network.

Benefits

The definition of a Functional Classification system for the walk network is intended to support planning for a balanced regional multimodal network. By describing the attributes of walk Functional Classes, a more precise and more accurate inventory of facilities can be developed. This is a critical tool in defining network attributes, needs, and gaps, and in developing projects to address any needs and gaps which are identified in the network.

Applications

As the "active transportation" modes of bicycles and pedestrians share many attributes, they also appropriately share some but not all infrastructure. Bicycles and pedestrians have different speeds, different trip lengths, and different mixes of users. Therefore, while some of the infrastructure and Functional Classes are common between the two transportation modes, there are also some differences.

Off-Street Multi-Use Trail Functional Class

An off-street trail provides the greatest amount of separation and protection from traffic. Off-street trails are often multi-use, intended to serve bicycle and pedestrian trips. Multi-use trails must be wide enough to accommodate safe interactions between bicycles and pedestrians.

Facility Types for Multi-Use Trails

The **Hard Paved Facility Type** features a hard and smooth surface to provide a path free of impediments and to accommodate high-end road bikes and strollers. Concrete or asphalt are common surfaces.

The **Soft Paved or Unpaved Facility Type** is paved with materials which can reduce costs or provide a more recreational user experience. This Facility Type is generally more amenable for recreational use. Gravel, decomposed granite, and dirt are typical soft paving materials.

The **Dual Track Facility Type** is designed to provide a greater separation of bicycle flows and pedestrian flows. Examples of implementation of Dual Track facilities are typically off-road because of the greater right-of-way required. The buffer between the bicycle and the pedestrian tracks may be a grassy strip, it may be a painted line, or the separation may be unmarked, as in this illustration. Sturdy barriers such as those used to separate bicycle flows from auto traffic are generally not necessary in this context.

The ***Sidewalk Functional Class*** is the most common type of pedestrian infrastructure, and is unique in that it is the only facility in the balanced multimodal network that is intended solely for a single mode of transportation. This is an instance where the grouping of bicycle and pedestrian modes into the "active transportation" category is not appropriate for shared infrastructure.

The illustration shows some of the best practices in sidewalk design as well as some common limitations. The curb cut for ADA compliance is generous, well-marked, and has a bordering tactile surface for traction and to alert the visually impaired. The sidewalk is set well back from the driveway cut, allowing cars to complete their turns so that they are oriented at 90^0 when they meet the sidewalk, allowing better visibility of pedestrians and giving more space to stop out of the flow of traffic on the street. The sidewalk width of three to four feet is generous for pedestrians in this suburban context, but is not sufficient for pedestrians and bicyclists to share the same space. For this reason, sidewalks are not intended for bicycles. Many jurisdictions prohibit adult riders from sidewalks, allowing only children on smaller bikes.

Facility Types for Sidewalks

Three Facility Types are suggested for Sidewalks to distinguish their design and attributes within the context of their environment.

The **Conventional Sidewalk Facility Type** is common in both urban and suburban settings. These types of sidewalks are generally three to four feet wide, which is adequate for their purposes and for their existing volumes of traffic.

An issue with conventional sidewalks is that their relatively narrow width may not be sufficient in special circumstances. The illustration shows a conventional sidewalk on the Adams Ave. bridge crossing over the railroad tracks in Temple. Because the necessary side rails on the bridge line one edge of the sidewalk, the width seems inadequate to protect pedestrians from traffic in the travel lanes.

Other instances where conventional sidewalks may be too narrow to function adequately include cases where barriers lie within the sidewalk, such as telephone poles, fire hydrants, curb cuts, and street furniture.

The **Landscaped Sidewalk Facility Type** is often wider than the Conventional Sidewalk, and can be as wide as twelve feet. This Facility Type often features decorative pavement or trim, landscaping, street trees, and pedestrian-scaled lighting.

While a Landscaped Sidewalk addresses contextual issues to build a pleasant and "walkable" pedestrian environment, its primary purpose still focuses on walking rather than on urban development.

In a further development of the Landscaped Sidewalk, the **Urbanized Sidewalk Facility Type** is intended to stimulate an active street environment. Urbanized Sidewalks are divided into zones for storefronts, walking, street furniture, landscaping, and buffer areas. Total sidewalk width may be greater than twelve feet. Urbanized Sidewalks may include “parklets” or “pocket parks”, which convert one or two curbside parking spots into street furniture areas. Urbanized Sidewalks with their specialized zones are a part of the movement for Context-Sensitive Solutions, which has been endorsed by TxDOT.

Desire Lines are not infrastructure like the other Functional Classes, but they rather are facilities that define the need for infrastructure. They are defined as a Functional Class to recognize a unique feature of the walk network, where pedestrians create their own infrastructure. Where sidewalks are missing but a demand exists, pedestrians will wear a path into the ground that reveals their desire for travel in the area. Desire Lines can be found where there are short gaps in the sidewalk network, but also in places where there are no sidewalks at all. They may be located alongside a road as shown in the illustration, or may be “short cuts” across vacant fields.

Transportation planners should be aware of Desire Lines as the public’s demonstrations of their needs for walk network infrastructure.

Another unique aspect of the walk network is that movements crossing the street are as important as movements along designated pedestrian routes. The ***Crosswalk Functional Class*** is proposed so that transportation planners can define infrastructure to evaluate and to promote safety as pedestrians interact with vehicles when they cross streets.

Texas state law specifically outlines the responsibilities of vehicles and of pedestrians in marked and in unmarked crosswalks. Essentially, every intersection is a crosswalk, and pedestrians have the right-of-way over vehicles in every instance. In this respect, the Texas Transportation Code does not distinguish between marked and unmarked crosswalks.

Vehicles have the right-of-way over pedestrians when they are crossing the street anywhere other than at intersections (mid-block crossings).

Facility Types for Crosswalks

The **Complete Streets Crosswalk Facility Type** is defined to accommodate the various types of Complete Streets treatments as they apply to street crossings. The illustration shows a raised crosswalk that lifts the street surface up to the same level as the sidewalk as a way to emphasize the presence of pedestrians and to capture motorists' attention. Other Complete Streets treatments relative to crosswalks include median refuge islands, sidewalk bulb outs, and traffic calming.

The **Creative Crosswalk Facility Type** references an international movement to augment the standard markings of crosswalks with innovative designs or colors in order to highlight the crossing and to better capture motorists' attention. Common approaches to Creative Crosswalks have included artistic designs, painted patterns to simulate brick or paving stones, actual brick or paving stones laid in designs and with enough texture to draw attention to the crossing, or a combination of all treatments.

Creative Crosswalks may be considered as related to decorative treatments for intersections or streets that help define specific areas or neighborhoods. In all cases, one of the purposes of the treatments is to improve safety by emphasizing the presence of the crosswalk.

The MUTCD has recognized Creative Crosswalks, but recommends restrictions on the colors and patterns to be used so as not to cause confusion. From a practical standpoint, painted treatments will wear down and need maintenance, so designs which can be applied with templates are recommended rather than freehand artwork.

The MUTCD also stipulates that the Creative Crosswalk is not permitted to give information, as that would make it a traffic control device, which is governed by a different set of regulations.

The **Marked Crosswalk Facility Type** marks the crossing with MUCTD-mandated white bars or white bars within a set of parallel bars.

In this illustration from Killeen, the various legs of the intersection are marked separately. The crosswalk is placed mid-way through the dedicated right turn lane to heighten the visibility of the pedestrian. The curb cuts in the pedestrian refuge island serve as the anchor for the crosswalks going in each direction across the streets of the intersection.

The **Unmarked Crosswalk Facility Type** is assumed at every unmarked crossing of every intersection by Texas state law. In this illustration, the crosswalks are marked on three legs of the intersection. The dashed green lines show the Unmarked Crosswalk.

Summary

A Functional Classification system is required for the auto network by Federal legislation. Functional Classes and their associated Facility Types are useful in defining the inventory of streets by their types to support a more precise analysis of modal needs and gaps.

Although it not required, extending the concept of Functional Class and Facility Type to the bicycle, bus, truck, and walk networks is proposed in order to bring the same level of precision to the analysis of these modes' needs. This augmentation of the transportation process is intended to address each mode's unique needs and to support the development of a more balanced regional multimodal network.