RedVector®

Online Education for Design and Construction

Complete Streets - An Introduction to the Complete Streets Concept

- Identify how complete streets principles can be applied in the planning and development of transportation corridors and networks
- Incorporate complete streets principles into the routine decision making processes of transportation agencies to provide safety and access for all users

Complete Streets

Definition

A complete street can be defined as a transportation facility that is planned, designed, operated, and maintained to be safe and accessible for all road users. The road users being pedestrians, bicyclists, motorists, transit riders of all ages and physical abilities.

Complete Streets Approach

A Complete Streets approach to roadway design places all users on an equal footing, regardless of the mode of transportation. For example, walking, bicycling, motor vehicles, transit. And it embraces innovative designs, solutions, and technologies that promote safe, active, and healthy communities.

Over the years, through the efforts of policy advocacy groups, transportation officials, and many other stakeholders, Complete Streets policies, initiatives, and programs have been adopted nationwide at various levels of government.

As of December 2013, Complete Streets policies have been adopted by 27 states plus the Commonwealth of Puerto Rico and the District of Columbia. Fifty-one regional planning organizations, 48 counties, and 482 municipalities in 48 states have adopted Complete Streets policies as of December 2013.

Complete Streets Improvements

Components

In this section, we'll take a cursory look at some of the Complete Streets improvements. Complete Streets improvements may include: bicycle lanes, sidewalks, pedestrian crosswalks, bus lanes, pedestrian accessibility improvements, smart traffic signals and traffic cameras, road diets also known as road conversions, whereby existing roadway cross sections are modified, typically to reduce the number of lanes for vehicular traffic in order to provide for access of other modes of transportation such as bicyclists, pedestrians, buses, and so on and so forth.

roadway, the posted speed limit, the free-flow speed of the vehicles using the facility, the presence or otherwise of acceleration or deceleration lanes.

Median type - This characterizes whether we have a hard median or a striped median or if we have two-way left-turn lanes, commonly called suicide lanes, etc.

Terrain - This roadway variable describes whether the roadway environment is flat, rolling, undulating, etc. Exclusive left-turn lanes and exclusive right-turn lanes are also roadway variables used to determine level of service for the automobile.

The length of the roadway, the presence of exclusive left-turn storage lanes and the length of those storage lanes and several other roadway variables.

So the roadway variables are passed through a complex mathematical model that computes the capacity of the roadway and then relates it to the service volumes on the road and then assigns the level of service letter grade. Level of service provides a generalized and conceptual planning measure for assessing a user's satisfaction with the roadway environment.

Level of service can be determined for each and all the different modes of transportation. Each level of service mode has its required inputs and mathematical models. However, conventionally, at the federal and state levels, the level of service for automobiles has been the benchmark. This has obviously been good for automobile travel. However, it has resulted in the other modes of transportation -- such as bicycling, transit, and walking -- to not be considered on an equal footing in terms of measuring the success of transportation projects using level of service.

Engineering Design Practices

Another factor that has led to the current status quo of incomplete streets are the engineering design practices. After projects have been proposed, planned, and developed, it is ultimately up to the engineers to design and implement them. The engineering design process involves engineers designing the facilities to comply with clearly defined design requirements, industry standards, standard specifications, etc., that are stipulated in design manuals, regulatory guidelines, and other documents that have been compiled from years of experience, practice, and research.

So what we have are engineers performing various calculations and checking for compliance from tables and equations in design manuals and guidance documents that have been developed by their professional institutions. Therefore, engineers are not looking at what looks good or feels good for any specific mode of transportation. But they're rather looking at what fits and what meets the design standards.

As we previously discussed, the standards and guidelines are generally mode specific. In other words, they generally focus on one specific mode of transportation or the other, and we've seen that typically that mode is the automobile. Engineering design standards do allow for some

In this section, we shall take a look at some of the specific benefits of implementing Complete Streets. The first benefit we shall talk about is increased transportation choices. Complete Streets provides more choices in terms of mode of transportation for road users.

Complete Streets result in safer, welcoming, and friendlier streets for all road users.

Complete Streets result in an increased quality of life, neighborhood vitality, as well as livable communities.

Complete Streets has been demonstrated to contribute towards economic revitalization. Complete Streets provide a more attractive environment for new businesses. Studies have also shown that Complete Streets result in increases to property values.

Complete Streets have public health benefits. For example, by encouraging walking and bicycling, numerous health authorities have sited Complete Streets or recommended Complete Streets as one tool among many in tackling various healthcare crises in America. For example, the epidemic of childhood obesity.

Complete Streets results in improved aesthetics of the roadway environment.

Due to the fact that Complete Streets generally considers all modes of transportation, it has been demonstrated that Complete Streets results in improved traffic operations. This can also be linked back to the increase in transportation choices, resulting in more modes of transportation being utilized and therefore resulting in less congestion to any specific mode of transportation.

Complete Streets consider all road users on an equal footing. As a result, various features can be added during the project development and design to address various concerns that typically arise later in the life of a transportation facility. This therefore eliminates the need to implement retrofits. For example, in this photograph, an ADA improvement was implemented by retrofitting an existing sidewalk to cater to Americans with disabilities. By eliminating retrofits of this nature, complete streets projects will therefore result in lower costs over the life cycle of the facility.

Complete Streets can lead to increased transit ridership, which will result in less motor vehicle trips, less personal automobile trips, and, hence, less congestion on our roadways.

From an environmental point of view, Complete Streets results in less driving and therefore less carbon footprint and less climate change impacts. Complete Streets Programs.

Complete Streets Programs

The primary objective of a Complete Streets program or policy is to implement routine agency processes that consider all users and all modes of transportation in all phases and levels of the development and management of transportation facilities.

each community is different. Some communities have a high proportion of seniors, whereas others have sophisticated high-tech transit systems that other communities do not have. So each community or agency formulating a Complete Streets Program must identify the specific users in that community. And these must be explicitly addressed in the plan. In other words, the specific direction, or vision for each of these user entities must be clearly and explicitly addressed in the Complete Streets policy of that community.

The next policy element is projects. Project types. A Complete Streets policy must explicitly stipulate what types of projects or improvements are applicable. In other words, what types of projects or improvements would trigger the consideration of Complete Streets improvements. Or it could be what types of projects are eligible for targeted funding if this community or agency has specific dedicated funding for Complete Streets. So for example, the policy could state that all new projects must consider Complete Streets. Or all upgrades to existing facilities must consider Complete Streets. Or all retrofit projects, or maintenance projects, or roadway rehabilitation projects must go back and look at possible opportunities for implementing Complete Streets concepts. Some communities and some agencies require Complete Streets improvements to be considered if for example there is a road widening or if turn lanes are to be added to an existing roadway. So the community or agency formulating the Complete Streets policy must explicitly stipulate what types of projects or improvements require the consideration of Complete Streets elements.

It may also be stipulated that publicly funded projects or private development projects on a large scale for example must consider Complete Streets. The policy may also stipulate what phases of the project in which Complete Streets must be considered. For example, should Complete Streets be considered during the planning phase? Or should Complete Streets considerations be required during the engineering design phase and beyond? Or should the consideration of Complete Streets elements be initiated at the right of way acquisition phase? Some agencies may prefer to have Complete Streets considerations required from the project development review and permitting phase, and so on and so forth. So the specific phases of the project at which Complete Streets elements will be required to be considered must be explicitly stipulated in the Complete Streets policy.

The next policy element we shall discuss is the exceptions. In other words, under what circumstances would a community or agency exempt the requirement that Complete Streets elements be considered. So programs and policies must have clear rules and processes for providing, or at least considering, exceptions to the Complete Streets requirements. For example, a scientific study may be required to demonstrate a lack of future need for the Complete Streets elements and this study may need to be reviewed by staff and approved by, say, the board of county commissioners if this were a Complete Streets policy for an agency at the local government level.

Network and connectivity. An overarching goal of Complete Streets programs or a Complete Streets policy is to incrementally and ultimately create a connected network of Complete Streets facilities. This must be made clear in the Complete Streets policy. The Complete Streets policy must provide specific details of such a future goal and the specific facilities of that community or

of service or some multimodal parameter or metric that shall be used to measure the performance or success of the Complete Streets Program over some time horizon.

Other performance measures could include the miles of on-street bicycle routes created, say, annually. Or the linear feet of pedestrian accommodations that are added annually. One may also measure the changes in the number of people using the various modes of transportation. What we call mode shift. In other words, as a result of the implementation of the Complete Streets program or policy or specific Complete Streets improvements, how have the public's choices on the modes of transportation shifted or changed as a result of the presence of these multiple and increased transportation choices?

Implementation. The implementation of a Complete Streets policy must be done through a special working committee, task force, or commission. There are a number of key areas that must be considered for successful implementation of a Complete Streets policy. The first is restructuring of the agency's procedures such that all road users and all modes of transportation are taken into consideration on every transportation project. Another key area is that the agency or community must develop new design policies, procedures, and guidelines that specifically address the goals of Complete Streets. Another area is that the agency must offer training and professional development opportunities for transportation professionals. These would include workshops, symposia, charrettes, etc. And at these events, community leaders as well as other stakeholders' participation should be strongly encouraged and actively sought after to enrich the knowledge and experience transferred to the transportation professionals who will actually be implementing these programs. And finally, it is important to establish relevant performance measures with reporting and feedback processes that collect data and monitor the progress of the program. Complete Streets programs performance measurements should be established to a specific calendar or timetable or routine such that these performance measures data are collected accordingly for timely analysis to enable all stakeholders to see and assess how well or otherwise the Complete Streets policy is working.

Policy Reviews

Minnesota

Policy reviews. In this section, we shall review some Complete Streets policies that have been adopted by various levels of government and various types of transportation agencies across the country. We shall review the Complete Streets policy that was enacted by a state legislature. We shall review a Complete Streets policy that was directed by the state Department of Transportation of a large state. We shall look at the Complete Streets policy that was established by directive of a state Department of Transportation. We shall review a Complete Streets policy adopted by a county government. We shall review a Complete Streets policy adopted by a regional city. And we shall review a Complete Streets policy adopted by a small rural city.

Under the implementation plan, bicycle, pedestrian, and transit travel will be facilitated by creating Complete Streets beginning early in system planning and continuing through project delivery and maintenance as well as operations. The plan seeks to develop a network of Complete Streets through collaboration among all functional units of the agency and by establishing effective partnerships with all stakeholders.

The implementation plan consists of seven categories; namely, the highest focus areas, review and updates of guidance, manuals, and handbooks, drafting policy and plans, funding and project selection procedures to raise awareness of the Complete Streets program, to provide training and to fund and conduct research to further Complete Streets.

A steering committee consisting of division chiefs, directors, and district directors was established to implement the policy. The steering committee is supported by a technical advisory committee that consists of staff experts.

The steering committee conducts an annual assessment of overall progress of the implementation by considering the following: Identifying gaps in or the need for legislative solutions to implement Complete Streets, to explore new revenue sources and changes in existing funding programs that may achieve Complete Streets, to review existing committees to ensure Complete Streets representation.

The steering committee shall evaluate improvements to project initiation documents to meet Complete Streets policy. The steering committee shall also evaluate training needs and develop a training plan for Complete Streets implementation to ensure statewide consistency. The steering committee is also tasked to facilitate coordination between pedestrian infrastructure initiatives and also to develop complete streets implementation information.

The steering committee's report must identify policy updates in the various divisions of the agency. The report must also look at funding eligibility rules and project selection guidelines that incorporate Complete Streets. The report is also to present policy initiatives to raise awareness to other levels of government and other stakeholders.

The plan enumerates training for key divisions and positions within the agency.

The report concludes with relevant research and case studies relevant to the further pursuance of Complete Streets in the state of California.

Massachusetts

The Massachusetts Department of Transportation issued the Healthy Transportation Policy Directive in 2013. The goal of this directive is that all MassDOT, Massachusetts Department of Transportation, projects must be designed and implemented such that all customers have access to safe and comfortable healthy transportation options.

The policy defines healthy transportation modes as walking, bicycling, and transit. The implementation element of the directive focuses on two areas: Project reviews and the project

The MassDOT directive states specific reference documents that shall be used for design guidance as well as other guides that may emerge or evolve in the future from the transportation institutions such as AASHTO; the Manual on Uniform Traffic Control Devices, MUTCD; the United States Department of Transportation, USDOT; and others.

So in summary, the MassDOT directive requires a number of steps in the review of design projects to ensure that all modes of transportation are considered equally, and then the directive has a project design process element that discusses factors related to Complete Streets that are required to be considered in the design of all MassDOT facilities.

Nashville TN

The metropolitan government of Nashville in Davidson County, Tennessee, issued Executive Order No. 40. Under this executive order, the metropolitan government supports the use of Complete Streets to develop a transportation system that is safe and convenient for all users regardless of age, ability, or mode of transportation.

The executive order defines Complete Streets as public ways that include some combination of appropriate facilities as determined by the surrounding context that accommodate all modes of transportation including private vehicles, mass transit, walking, and bicycling.

The policy requires that in the design, planning, construction, reconstruction, rehabilitation, or maintenance of the metropolitan government facilities a, full consideration is given to the accommodation of the transportation needs of all users and b, all current public way plans, guides, regulations, and drawings be reviewed for compliance with this executive order.

The policy requires full consideration be given to the accommodation of the transportation needs of all users regardless of age or ability including those traveling by private vehicle, mass transit, on foot, and on bicycles. The policy requires a review of all current public way plans, guides, regulations, and standard drawings to comply with the executive order.

Exclusions or exceptions to the policy may be justified under the following conditions. Specific Complete Streets principles may be prohibited by law; for example, bicycle or pedestrian facility along an interstate highway. This is expressly prohibited by federal law and would, therefore, receive an exception under the Nashville and Davidson County Complete Streets policy. Another condition for granting an exception is that the cost of complying with this policy on a particular project would substantially exceed the public value to be realized.

An exception may be granted if a lack of population or physical character or context of the immediate environment surrounding the public way area indicates an absence of current or future need for Complete Streets improvements. An exception may be granted if compliance with this policy would substantially impair unique characteristics of great public value; for example, historical buildings.

The manual provides detailed planning as well as engineering design guidance for each mode of transportation.

Every City department is required to follow the Manual.

All builders and developers are required to obtain and comply with the Manual.

All permitting agencies that have authority within the City are to comply with the Complete Streets Manual.

The Fort Lauderdale Complete Streets Manual recommends objective as well as subjective performance measures to evaluate the program. Objective measures include:

- Multimodal level-of-service
- Traffic counts
- Travel speeds
- Crash data

Subjective data or subjective measures focuses on the attitudes and beliefs of the transportation users, e.g.:

- Purpose of trip
- Choice of travel mode
- Perceived deficiencies of the system
- Choice of route
- Modal split

Desired improvements, barriers to transportation and level of satisfaction of the transportation user.

The Fort Lauderdale policy lays out an implementation plan that addresses departmental responsibilities in implementing the policy, project prioritization procedures, training for staff and elected officials, coordination of efforts, and funding.

Breckinridge MN

Breckenridge, Minnesota is a city and seat of Wilkin County, Minnesota. As of the 2010 census, the population of Breckenridge is 3,386 residents. Resolution No. 12092-42/2011 was signed by Mayor in April 2011. The resolution established a complete streets policy for the community.

The policy defines the goal of complete streets as improving the access and mobility for all users of streets in the community by improving safety through reducing conflict and encouraging non-motorized transportation and transit, which will enhance the promotion of active living as a

Conclusions

Summary and Implications

In this course, we presented an introduction to the complete streets concept. An overview of the status quo that has necessitated the complete streets concepts was discussed in detail.

Examples of complete streets improvements and their potential benefits were presented.

The elements of a comprehensive complete streets policy/program were presented.

Examples of complete streets policies adopted by a variety of transportation agencies were discussed.

The spectrum of policies included legislation at the state level for a large state, through policy adopted by small rural local governments.

Thank you for your choosing us for your training needs. Thank you for joining us today to discuss the fundamental principles of complete streets.

Thank you very much for your attention.

Author Biography

Kwabena Ofosu Ph.D., P.E., PTOE

Kwabena Ofosu currently serves as the Traffic Engineer in the Public Works Department, City of Palm Bay, Florida. He is also an Adjunct Professor in the Division of Engineering, Computer Programming and Technology, Valencia College in Orlando, Florida, where he teaches undergraduate courses in Statistics and Probability for Engineers, Engineering Mechanics, and computer applications for engineers.

He earned his Bachelor's degree with Honors in Civil Engineering from the University of Science and Technology, in Ghana. He earned his Master's degree and PhD, both in Civil Engineering from Florida State University in Tallahassee, Florida.

His research areas include bridge engineering, transportation asset management, and artificial intelligence.

RedVector®

Online Education for Design and Construction

Complete Streets: An Introduction to the Design of Complete Streets

Introduction

Course Description

Hello. My name is Dr. Kwabena Ofosu.

This course presents an introduction to the elements of the design of Complete Streets. The Complete Streets concept shall be introduced followed by a discussion of the factors that are taking into consideration in the design of Complete Streets improvements. The design of specific Complete Streets elements is then presented in detail.

Course Overview

An overview of this course is as follows. We'll start with some basic definitions. Then we'll have an introduction to the design of Complete Streets. We'll review the Complete Streets' principles. We'll then look at the engineering design considerations for Complete Streets. We'll then discuss Complete Streets design treatments.

Learning Objectives

At the end of this course, you'll be able to:

- Define Complete Streets and describe the relevance, benefits, and importance;
- Describe the numerous factors that must be taken into consideration before the design and implementation of a Complete Streets project;
- Identify specific elements that are incorporated into the design of a Complete Streets facility;
- Identify the treatments that address specific components of a Complete Streets facility; and you'll be able to
- Describe the process of implementing Complete Streets projects upon completion of design.

Complete Streets

Definition

A Complete Street can be defined as a transportation facility that is planned, designed, operated, and maintained to be safe and accessible for all users, the users being pedestrians, bicyclists, motorists, transit riders of all ages and abilities.

Another reason why we have incomplete streets is that the engineering design practices involve engineers designing the facilities to comply with clearly defined design requirements, industry standards, standard specifications, etc. as stipulated in design manuals, regulatory guidelines, etc. that have been compiled from years of practice and research.

Therefore, engineers are generally not looking at what looks good or what feels good in the design process, but they're rather looking at what fits and what complies with the guidelines. Design guidance must, therefore, be updated to take Complete Streets elements into consideration.

So in summary, the status quo has been dominated by the delivery of mode-specific transportation projects that are designed in accordance with standard practices that achieve stipulated level of service goals. The status quo, therefore, has lacked approaches and policies that consider all transportation users and modes of transportation in a holistic manner.

The Complete Streets Trend

So what is causing the current trend towards Complete Streets? Automobile travel continues to decline across the United States. Vehicle miles of travel per capita reached a peak in the 2005-2006 period, and has since steadily declined. We also have demographic shifts in the United States. Americans are generally living longer but driving less.

Studies show that the millennial generation is much less inclined to drive than their forbearers. Americans are increasingly asking for more transportation choices. Transportation agencies are, therefore, being pushed to address the new transportation reality.

Benefits of Complete Streets

So what are some of the benefits of Complete Streets? Increased transportation choices; safer, more welcoming, and friendlier streets for all users; increased quality of life; neighborhood vitality, and livable communities. There's also the benefit of economic revitalization such that Complete Streets have made some areas more attractive to new businesses, resulting in increased property values, improved neighborhood aesthetics, improved traffic operations, increased transit ridership resulting in less cars on the road, and, hence, less congestion.

Design of Complete Streets

Engineering Design Considerations

We shall now discuss the engineering design considerations for Complete Streets. Complete Streets improvements are unique to each project and roadway environment. So a Complete Streets solution at one location may not be remotely relevant at another location. Several

This report presents a synthesis of traffic calming experiences to date in the United States and Canada. It contains information on traffic calming in residential areas and in areas where high speed, rural highways transition into rural communities.

Americans with Disabilities Act

Another design reference is the Americans with Disabilities Act. Americans with Disabilities Act, commonly called ADA, is administered by the United States Department of Justice.

The ADA standards for engineering design are required, and they are required to ensure access to the built environment for Americans with Disabilities Act. The ADA standards apply nationwide in addition to any state or local laws, and they apply to new facilities as well as alterations to existing facilities.

State and Government Design Guidelines

At the state level, state departments of transportation typically have design guidance documents that go above and beyond the minimum standards that are set at the federal level. For example, Florida has the Florida Department of Transportation plans preparation manual, which establishes the design criteria on the state highway system.

In addition, Florida has the Florida Green Book, which provides the minimum design standards for all public roads and streets that are not part of the state highway system. These would typically be roads and streets owned and maintained by cities, towns, and other local government entities.

Local governments may have additional design guidance through, for example, a city public works department manual or a county's Complete Streets handbook and so on.

Agencies, particularly larger ones, may develop or adopt guidelines of their own that address their unique situations and roadways in addition to the nationally recognized guidelines. For Complete Streets purposes, these guidelines and standards must incorporate multi-modal considerations.

Classifications

Roadway Functional Classification

The next factor we shall discuss that must be taken into consideration in the design of complete streets improvements is the roadway functional classification.

In Florida, the functional classification designation may be re-evaluated following the decennial census. Redesignation of functional classification of a roadway may be necessitated by changes in, for example, jurisdictional boundaries, traffic conditions, travel patterns, trip purposes, property use, and new large developments among other factors.

Functional Classification

It is pertinent to note that functional classification is used for determining the federal aid funding eligibility of a facility. For example, the surface transportation program may fund all functional classifications of roadways except rural minor collectors and rural local streets. Other funding programs have other functional classification eligibility requirements.

Typologies

Complete Street Typologies

The next factor that must be taken into consideration in the design of Complete Streets improvements is the Complete Streets typology. Complete Streets typologies go above and beyond functional classification to provide a more detailed and comprehensive description of a streets function. In addition to the functional classification elements, typologies also characterize the types of uses of a facility as well as the nature of the abutting land uses and relevant environmental factors.

In the design of Complete Streets facilities, typologies are used to identify specific design treatments that are relevant and appropriate for a given street. There are many typology systems.

The city of Fort Lauderdale, Florida, for example, uses the following typologies for Complete Streets - boulevard, avenue, street, and special street.

Typology - Boulevard

A boulevard is a walkable, divided street design for high vehicle capacity and moderate speed. A boulevard typically traverses a central business district of a city. Boulevards typically serve as routes for the movement of goods and people, emergency response, and evacuation.

Boulevards generally have vehicle and pedestrian access management techniques. They may have large landscaped mediums, and they may have exclusive bus lanes and frontage roads.

Boulevards may be subdivided into the following: city center boulevard, commercial boulevard, and residential boulevard.

shops, smaller offices, and multi-family residential. On-street parking is typically provided to support the vitality of the businesses along the commercial avenues.

Residential avenues.

Residential avenues are of a smaller scale than commercial avenues. Traffic is generally slower, and the routes are generally controlled by traffic signals where they intersect with other facilities of similar status. They may serve as alternate routes, and they connect neighborhoods. Abutting land uses include heavy residential and some neighborhood commercial uses.

Typology - Street

Streets. The street typology includes local, walkable, multi-modal facilities with traffic speeds not exceeding 25 miles per hour. The purpose of streets is to serve local pedestrian and vehicle traffic and to provide access to abutting properties. To facilitate pedestrian traffic, streets should include raised curbs, small corner radii, wide sidewalks, and ornamental plantings.

Streets may be subdivided into city center streets, commercial streets, and residential streets.

City center streets are located with the central business district. The abutting land use is high-rise structures with mixed uses, particularly commercial uses at the street level.

City center streets typically have the highest need for multi-modal options such as bicycle lanes, speed restrictions, high emphasis crosswalks, and enhanced pedestrian features.

On-street parking should be provided to support the street-level commercial activity along city center streets. Commercial streets.

Commercial streets are of less density than city center streets and serve commercial districts. Abutting development is of lower density, low- to mid-rise structures with larger setbacks. Land uses typically include restaurants, shops, small offices, etc.

On-street parking facilitates commercial activity on these streets.

Residential streets. Residential streets are solely for the purpose of providing access to properties. For example, homes in low-density residential neighborhoods. Exclusive bicycle lanes are not typical. Sidewalks are generally provided on both sides of the street, however. Vehicular traffic volumes are light and speeds are low.

Typology - Special Streets

Special streets are a special typology for roads that have very different or unique land use and multi-modal use than any other street typology, and, therefore, they warrant a special typology designation unto themselves. For example, the city of Fort Lauderdale, Florida has a typology beach thoroughfare.

The next factor that should be taken into consideration in the design of Complete Streets improvements of the design vehicle.

Design Vehicle

The design vehicle used for geometric design of the street should be consistent with the predominate intended users of the facility. Also, all Complete Streets designs must meet minimum standards for fire trucks, emergency vehicles, sanitation vehicles, snow plows, as well as refuse collection and street sweeping.

Intersections

Intersections must be taken into consideration in the design of Complete Streets facilities. Intersections are points or nodes on the street network where the highest chance of conflict between road users occurs. These conflicts include the users of the same mode of transportation as well as intermodal conflicts. Consideration must be given to implement design elements that control vehicle speed and minimize the number of conflict points.

Examples of such design elements include using the smallest possible turning radii, raised intersections, crosswalks, street lighting, textured pavement, and roundabouts. Speed mitigating design elements should be considered wherever possible and appropriate to enhance the safety of all road users.

On-Street Parking

On-street parking. On-street parking is an important consideration in the design of Complete Streets as it offers many benefits and opportunities for Complete Streets. For example, on-street parking is needed to support businesses located along the Complete Streets corridor. On-street parking has an inherent speed mitigation effect.

On-street parking, however, must be managed appropriately as it may potentially yield negative impacts. For example, it may restrict the field of view and maybe a factor in conflicts involving vehicles and pedestrians or bicycles performing crossing maneuvers.

There is also always the potential of bicyclists being hit by opening vehicle doors, a hazard referred to as dooring. Dooring may be minimized by providing adequate buffer areas between the parking and the bicycle accommodations

On-street parking must be properly priced such that its usage is attractive. Otherwise, the benefits of on-street parking will not materialize. Another benefit of on-street parking is that it may be incorporated into innovative and green storm water systems. For example, the use of pervious pavers and infiltration zones that are built as part of the parking areas.

Schools and parks. Access to schools and parks by all transportation modes should be provided. Therefore, the network of bicycle and pedestrian facilities that connect residents to parks and schools should be a priority.

Public Transportation

Public transportation. Complete Streets take into consideration all users and all modes of transportation. In addition, they must facility intermodal access and connections in order to address the needs of the many different users. To be effective, Complete Streets projects must consider the presence of transit vehicles, the locations of transit stops as well as locations where transit passengers must cross a roadway to access transit services.

Consideration must be given to sidewalks and sidewalk connections to transit stops. These improvements must be designed such that they are safe, reliable, convenient, and comfortable for the transit riders to use. Effective incorporation of transit into road projects can potentially lead to increased use of transit, increased intermodal travel, and encourage the public to consider alternative modes of transportation such as transit.

Land Use and Context

The next factor to be discussed that should be taken into consideration in the design of Complete Streets improvements is land use and context.

Street designs must consider the context of adjacent land uses. For example, designs for pedestrians in the residential environment will not fit or even work in a commercial setting and vice versa. In all cases, streets must be safe and accessible to all transportation users.

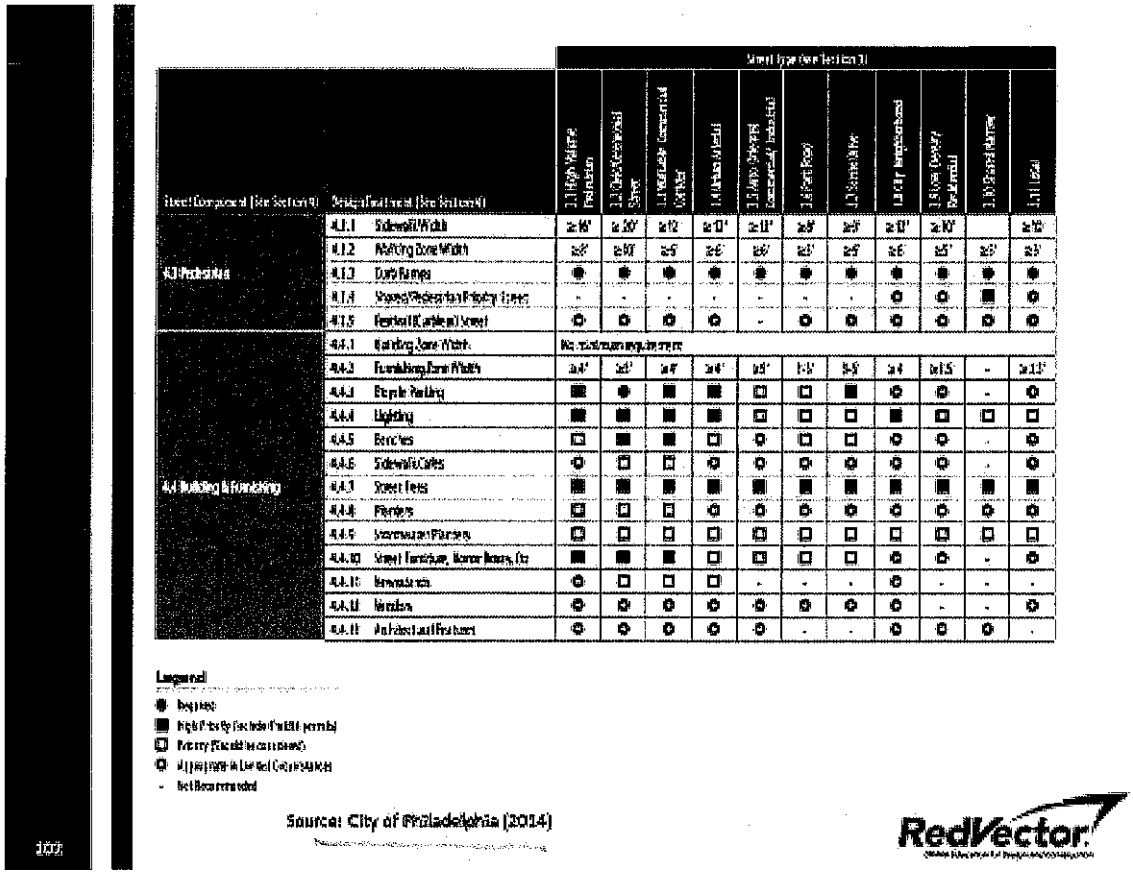
Environment

Environment is an important factor for consideration in the design of Complete Streets improvements. Roadways should be designed to enhance the aesthetics and environmental quality. Environmental goals include improving storm water control, reducing air pollution, reducing carbon footprint, improving water quality, and many others. These can be achieved by applying elements such as landscaping, street trees, natural drainage systems, pervious pavements, and many others.

Design Components

Components and Treatments

For example, the pedestrian component, the building and furnishing component, and so on. So for each component, a number of applicable design treatments are listed. The street typologies are ranked in a hierarchy, and the design treatments are assigned to the typologies based on the hierarchy as to whether they are required, whether they are high priority, whether they are appropriate in limited circumstances, and so on.



Source: City of Philadelphia (2014)

So, for example, for the pedestrian component, curb ramps are required on urban arterials. The walking zone width to address the pedestrian component on an urban arterial must be at least six feet whereas it may be at least five feet on a local street.

Other examples we can see from the component treatment matrix developed by the city of Philadelphia, Pennsylvania include the bicycle component where, for example, the treatment buffered bike lane priority for a walkable connected corridor street typology whereas it is a priority for an urban arterial.

The Pedestrian Component

So in this section, we shall take a general view of what the various components consist of and also discuss very broadly some of the applicable treatments for these components.

The pedestrian component involves the clear area between the curb and the adjacent frontage where pedestrians travel.

Pedestrian Component Design Objectives

The design objectives for the pedestrian components are:

- To provide sidewalks that provide safe access for all users.
- To provide sidewalks that are designed and maintained to create an attractive and welcoming environment for pedestrians.
- To use pedestrian volumes and the significance of a street based on its typology to inform design decisions.
- To minimize vehicle intrusions into the pedestrian component via driveways, and
- To provide direct pedestrian routes between destinations and frequent crossing opportunities wherever feasible.

Pedestrian Component Sidewalks

The sidewalk treatment should always be provided on both sides of the street wherever possible. For design purposes, the sidewalk can be divided into four contiguous zones.

Frontage Zone

This is the transition area between the property line and the building elements that encroach into the sidewalk such as the awnings, stairways, store front, displays, and other building elements.

Pedestrian Zone

This is the clear area of the sidewalk on which the pedestrians travel.

Furnishing Zone

This is the portion of the sidewalk used for street furniture, trees, and landscaping, transit stops, lights, fire hydrants, etc.

Alternative use of parking.

Parking spaces may be temporarily converted to other uses that enhance the walking experience. For example, planters or restaurant seating. This option may be applied in high-volume pedestrian streets, but may not be considered on streets with a restricted peak-hour on-street parking.

This strategy is useful on streets with narrow sidewalks or where there is inadequate space for planters or seating. This strategy helps calm traffic, and it must be applied in conjunction with safety improvements, for example, curbs and bollards. They must be used such that they have no impact on the drainage and bicycle lanes.

Vegetated swales.

These are longitudinal depressions for conveyance of runoff. In vegetated swales, the water infiltrates into the soil and is taken up by the plants. Vegetated swales enable sediments and pollutants to settle out of the runoff, hence, improving storm water quality.

Storm water planters.

This treatment consists of specialized planters installed in medians and in the sidewalk area. The planters manage runoff by providing storage and infiltration. They may be applied on all street typologies. Storm water planters are designed with four concrete curb sides with inlets.

The planter is lined with filter fabric, gravel, and soil. They are installed such that they maintain the minimum clear walking width and do not present a tripping hazard. At transit stops, they must be checked so that they do not present wheelchair accessibility impacts.

Storm water tree trench.

This treatment consists of a storm water system where the trees are connected to a subsurface infiltration structure. The system consists of a trench dug along the sidewalk and lined with filter fabric, gravel, and soil. Storm water runoff flows through special inlets into the chamber where it is stored.

The water infiltrates through the bottom of the chamber while some is consumed by the trees. On the surface, the trees appear as normal tree grates. This option may be considered wherever applicable on all street types.

Intersection and Crossing Components

The intersection and crossing component addresses design treatments that influence safety, function, and quality of intersections and street crossings for all users and modes of transportation.

The design objectives for the intersection and crossing component are:

Curb ramps.

ADA requires that wheelchair ramps with detectible warning strips should be installed wherever a sidewalk crosses a curb. Existing ramps should be upgraded on any project to meet current ADA guidelines. Curb ramps are appropriate on all street types, and may be required for new developments, reconstruction, or upgrades of a street. Corner radii at intersections.

Larger curb radii allow larger vehicles, such as buses and trucks, to make right turns without encroaching on adjacent travel lanes or the sidewalk, but they do increase the crossing distance for pedestrians. Shorter curb radii slow turning traffic and creating shorter crossing distances, but they can make it difficult for larger vehicles to navigate the intersection.

Bulb Outs and chokers.

Bulb Outs are an expansion of the curb line into the adjacent roadway either at a corner or at a mid-block location. Two bulb-outs located on either side of a street create what is called a choker. Bulb-outs narrow the roadway both physically and visually. They shorten crossing distance and reduce potential conflicts between vehicles and pedestrians.

Bulb-outs have been shown to discourage illegal parking within the crosswalk, provide a location for street furniture as well as discourage trucks from turning onto local access streets.

Signal timing.

Signal timing at intersections impacts all users and all modes of transportation. Optimal signal timing will reduce delays and unnecessary stops and, hence, improve traffic and increase roadway capacity.

Pedestrian signal crossings at intersections.

Pedestrian signal indications notify pedestrians when to cross by providing walk, flashing don't walk, and don't walk indications. Pedestrian countdown displays inform pedestrians of the remaining time they have to cross the street. Pedestrian signals should be used at all crossings more than 26 feet wide.

Signals should be prioritized based on pedestrian volumes, crossing length, pedestrian crash experience, road safety, road safety audits, and proximity to schools and senior facilities. Audible pedestrian signals should be used where appropriate. In fact, in some jurisdictions they are required by law.

Pedestrian walk signals should be built into the signal cycle when there are regular high volumes of pedestrians. Leading pedestrian intervals can be used to give pedestrians a head start to cross the street before traffic moves. All way pedestrian phasing should be used in limited instances where there are high enough volumes and significant conflicts with turning vehicles.

In this section we shall discuss treatments that address the vehicle component of a complete street. The vehicle component involves the portion of the public right of way that is intended primarily for use by motor vehicles.

The design objectives for the vehicle components are

- To design sidewalks that maintain an attractive pedestrian environment and provide safety and access for all users.
- To use the street typology, the pedestrian volumes and the importance of a facility in a network to inform design decisions.
- To minimize vehicle intrusions into the pedestrian zone via the driveways and to provide direct access for pedestrians as well is frequent crossing opportunities.

Speed Humps

The first treatment we shall discuss for the vehicle component are speed humps. Speed humps are an effective way of reducing vehicle speeds they are most effective when used in combination with other traffic calming measures. Their use however, may be restricted on transit routes, freight routes and emergency and evacuation routes.

Speed humps are typically 3 to 4 inches in height and 12 to 13 feet wide, they must be installed with warning signs and pavement markings. Speed hump spacing is based on operating speed in order for the desired speed reductions to be realized.

Raised Table Intersections

Raised table intersections is another treatment that is applicable to the vehicle component of a complete street. A raised table intersection is where the entire intersection is raised and generally given a different pavement treatment. As drivers negotiate the elevated intersection they slow down hence, traffic calming by speed reduction.

Raised intersection tables are typically 3 to 4 inches above the original road surface.

Raised table intersections must be installed with adequate warning signs and pavement markings.

Refuge Islands

Refuge islands reduce the crossing distance for pedestrians, they enable pedestrians to cross traffic moving in one direction at a time. Traffic islands may provide drivers with a sense of constriction thus causing them to reduce speed.

with posted speed limits below 35 miles per hour should have lane widths at the lower end of the range.

Two-way local streets pavement should be between 18 and 20 feet wide if the pavement is such that a narrow width forces of vehicles to slow down before passing each other or one vehicle has to yield for the other this is called a yield street. The pavement width of yield streets should be between 14 and 18 feet.

Local roads and residential neighborhoods should be as narrow as possible with yield street operation unless the need for free flow traffic can be justified. The selected width of any road is subject to professional engineering judgment and applicable design standards and design criteria.

On-street parking – On-street parking produces a conception of restriction to the motorist and causes them to reduce speed. On-street parking also provides a buffer from traffic for pedestrians thus making streets more comfortable for pedestrians and bicyclists. The desired parking space dimensions are 8 feet wide by 20 feet long.

Parking spaces may be parallel to the travel way or angled. On wide streets in commercial areas for example back in angled parking may be used eight and a half feet wide parking spaces. For parallel parking at least one half feet must be left between the curb and any roadside objects such as trees and signs to allow for opening and closing of car doors.

Pervious pavement parking - Innovative storm water management may be designed to use impermeable pavers in the parking area, this will reduce the amount of runoff without any loss of parking. Pavers and other permeable pavement treatments help calm traffic as they provide the sense of a narrower street.

Target speed - The target speed is the desired speed at which vehicles should operate on that facility from a complete street's point of view. Complete streets design should start with a selection of a target speed, the target speed is to be achieved using a combination of measures and treatments such as curb extensions, medians, narrower lanes, on street parking, etc.

The target speed should be selected based on the street typology and the context. The existing or projected operating speed should not be used as the basis of the target speed. The design speed used for establishing the geometry of the road should be no greater than five miles per hour above the target speed.

The Bicycle Component

Bicycle Component Design Objectives

The bicycle component. In this section we should look at treatments that address the bicycle component of a complete street. Bicycle component addresses the portion of the public right-of-way that accommodates bicycle travel.

This consists of bicycle racks it is commonly provided within the right-of-way along the sidewalk but may also be provided on the shoulder or in a lot.

Short-term public parking should be provided proactively and not just in response to requests by citizens and businesses.

Long-term public parking for bicycles.

This is applicable when bicyclists must store their bicycles away from home for extended periods of time. They are applicable at major transit hubs as well as large employment centers. Preferably these facilities should be located indoors to protect the bicycles from theft and inclement weather, for example like in a parking garage.

Short-term and long-term private parking for bicycles.

These are bicycle parking facilities provided by private businesses and institutions, these facilities should be encouraged and considered during the development review process. Private institutions should provide both short-term and long-term facilities.

Buffered bicycle lanes.

A buffered bicycle lane is a conventional bicycle lane with a dedicated buffer space separating it from the adjacent vehicular travel lane. Buffered bicycle lanes are used to create a larger space for bicyclists without potentially causing the bicycle lane to look like a vehicular travel lane for a parking lane. Buffer lanes may be considered on streets with high traffic volumes, high truck traffic, or high speeds, the buffer should be 2 to 3 feet wide.

Raised bicycle lanes.

Raised bicycle lanes are dedicated bicycle lanes that are separated by grade from the vehicular travel lanes. The bicycle lane should be two to four inches above the vehicular Lane, the race bicycle lane and the vehicular travel lane are separated by a curb that is traversable by bicycles.

Bicycle route signage.

Signs can be used on any type of roadway to increase awareness of bicyclists, on the class II and class III Routes bike lane or bike routes signs are typically used. On other roads signs with, share the roadway can improve motorist's awareness of the presence of bicyclists.

Signage can be used to provide information to bicyclists to enhance their and operations and safety. Guidance on signage can be found in the manual on uniform traffic control the devices, the MUTCD.

Colored pavement.

Green colored pavement should be used to identify bicycle lanes, other colors may be used in context to the districts in which they are applied. Retro reflective and skid resistant colored paint increases the visibility of bicyclists and reemphasizes the multimodal character of the

passengers with disabilities. Transit stops should maintain a clear area for disabled access from the bus shelter to a waiting transit vehicle. All transit stops must meet all ADA requirements.

Location of transit stops - Transit stops should be located on the far side of intersections wherever possible. Intersections are generally more convenient for passengers intercepting other transit connections, accessing crosswalks and connecting to pedestrian routes. For signalized intersections the far side location is also generally recommended.

Far side placement of stops helps reduce transit delays, encourages pedestrians to cross behind the vehicle where they are more visible to traffic and minimizes conflicts between buses and right turn vehicles. Far side location of stops enables transit vehicles to take advantage of gaps in the traffic flow.

Location selection should be conducted on a case-by-case basis.

Bus shelters - Ideally passenger shelter should be located at occasional and predictable intervals along a transit route and particularly at stops with the passenger traffic. At stops with passenger activity throughout the day he shelters recommended. Green shelters should be incorporated whenever possible. Large developments such as large retail, office complexes and institutional buildings should be encouraged to provide bus shelters concurrent with the construction of their project.

The next treatment for the transit component that we shall look at is bus stop signage, transit stop signs direct riders where to wait and board a transit vehicle. The sign should clearly identify the transit operator, the route numbers and the bus schedule. Maps showing transit routes servicing the stop should be provided. Flag signs should be located towards the front of the bus stop.

Bulb outs and turnouts - Bus turnout should be used where there is adequate opportunity for buses to easily reenter the traffic stream, for example on the far side of the traffic signal.

Bus bulb outs are more pedestrian friendly than turnouts and provide better visibility of transit riders waiting at stops. Bulb outs are an effective traffic calming strategy for traffic adjacent to the curb.

Bicycle racks - Bicycle racks should be included in transit stops, bicycle racks may be part of the shelter or separate but supporting the adjacent stop.

Sidewalks - At transit stops sidewalks should extend to the curb so that riders may access the sidewalk directly from the bus doors. It is desirable to provide a stop area of at least the distance from the front bus door to the rear bus door. The sidewalk capacity should be increased where there are higher volumes of pedestrians and high transit use where the sidewalk has insufficient width curb extensions may be installed to increase its capacity.

Mid-block cross walks - Where the stops are located at mid-block on a long block, a mid-block crossing should be considered. The crosswalk should be placed behind the bus stop and

pedestrian component of the complete street, the intersection component, the vehicle component, the bicycle component, the transit component.

For each component we looked at the specific treatments that are relevant to that component. In addition we discussed detailed specific design guidance for the treatments and how they are applied to address their specific complete street component.

This concludes the course entitled, An Introduction to the Design of Complete Streets. Thank you very much for choosing us for your training needs, my name is Kwabena Ofosu. Thank you very much for your attention.