Complete Streets

A. Background

Design professionals face an increasingly complex set of competing demands in development and delivery of street projects involving public rights-of-way. Designing a safe facility, completing construction, and installing various traffic control measures are only a part of a much larger picture. Street projects today also need to meet the objectives of regulatory, policy, and community requirements aimed at integrating the roadway into the existing natural and built environments. Among the many factors influencing the planning, design, and operation of today's streets are concerns about minimizing transportation costs; improving public health, creating and maintaining vibrant neighborhoods; accommodating the needs of the young, the physically challenged, as well as an aging population; and adopting greener and more sustainable lifestyles.

In the past, street design was focused on the need to move motor vehicles. The number and width of lanes was determined based on future projected traffic volumes or a set of standards based on the functional classification of the street. The functional classification and the adjacent land use also determined the general operating speed that was to be used for the design. Integration of facilities for pedestrians and bicyclists was not always a high priority. Some observers claim if you do not design for all modes of travel, then you preclude them.

Citizens within some cities are asking agencies to change the way they look at streets and the street function within each community. These agencies are looking to make their streets more "complete." Complete streets are designed and operated to enable safe access to all motorists, pedestrians, bicyclists, and transit users, regardless of age and ability. According to the National Complete Streets Coalition, there are in excess of 600 agencies that have adopted some form of a complete streets policy. Nineteen Iowa agencies, both small communities and larger cities, have adopted complete streets policies. Many other Iowa communities are looking into the concepts of complete streets. Complete streets also complement the principles of context sensitive design by ensuring that streets are sensitive to the needs of all users for the land use within the area. Proponents of complete streets note that by rethinking the design to include all users, the "balance of power" is altered by indicating that streets have many purposes and are not exclusively for motor vehicle traffic. The objectives of the complete streets philosophy are met by slowing vehicles down and providing better facilities for transit, pedestrians, and bicyclists. It is important to understand that safe and convenient walking and bicycling facilities may look different depending on the context. Appropriate facilities in a rural area will be different from facilities in a dense urban area.

There is no one size fits all design for complete streets. While the ultimate design goal for a complete street is a street that is safe and convenient for all users, every design should take into account a number of factors, some of which may be in conflict with each other. The factors include such elements as:

- Number and types of users - vehicles, trucks, transit buses, pedestrians, bicyclists
- Available right-of-way
- Existing improvements
- Land use
- Available budget
- Parking needs
- Community desires

In larger communities where the traffic volumes are heavy and land use density is greater, all of the above elements may be factors to consider. However, in smaller communities with lower traffic volumes and less dense developments, only a few may be important. The application of complete streets principles is most effective when neighborhoods are compact, complete, and connected to encourage walking and biking comfortable distances to everyday destinations such as work, schools, and retail shops. Past land use practices of large tracts for single use development are less effective in encouraging short walking or biking trips.

Complete streets are designed to respect the context of their location. For example, downtown locations may involve greater emphasis on pedestrians, bicyclists, and transit users than single family neighborhoods. Additionally context includes social and demographic factors that influences who is likely to use the street. For example, low income families and those without their own vehicle have the need for an interconnected pedestrian, bicycle, and transit network serving important destinations in the community.

The U.S. DOT adopted a policy statement regarding bicycle and pedestrian accommodations in March of 2010. It states:

> "The U.S. DOT policy is to incorporate safe and convenient walking and bicycling facilities into transportation projects. Every transportation agency has the responsibility to improve conditions and opportunities for walking and bicycling and to integrate walking and biking into their transportation systems. Because of the numerous individual and community benefits that walking and bicycling provide – including health, safety, environmental, transportation, and quality of life – transportation agencies are encouraged to go beyond minimum standards to provide safe and convenient facilities for these modes."

In addition to the U.S. DOT policy, members from the U.S. House of Representatives and the U.S. Senate have introduced a bill entitled “Safe Streets Act of 2014” that calls for all state DOTs and TMAs/MPOs to adopt a complete streets policy for all federally funded projects.

B. Design Guidance

There are a myriad of ways to address the development of complete streets in terms of a planning function, but there are not specific complete streets design elements identified for engineers to use to develop construction or reconstruction projects. The concept of complete streets goes beyond safety, tying in issues of health, livability, economic development, sustainability, and aesthetics.

Applying flexibility in street design to address the complete streets philosophy requires an understanding of each street’s functional basis. It also requires understanding how adding, altering, or eliminating any design element will impact different users. For instance, large radii may make it easier for trucks to navigate the street, but they create wider streets for pedestrians to cross. Designers of complete streets should understand the relationship between each criterion and its impact on the safety and mobility of all users.

Various manuals are available to provide design guidance including:

- AASHTO’s A Policy on Geometric Design of Highways and Streets (the Green Book)
- The Manual on Uniform Traffic Control Devices (MUTCD)
- The Highway Capacity Manual (HCM)
- AASHTO Guide for the Development of Bicycle Facilities
- ITE Traffic Engineering Manual
- NFPA Fire Code
- Local design ordinances
- The Access Board’s PROWAG

Some elements within these manuals are specific standards and some are guidelines with ranges of acceptable values. The MUTCD has been adopted as law; therefore the standards within it need to be met. In addition, there may be different standards for facilities that are under the Iowa DOT's jurisdiction than those for local control. If federal or state funding is being used to assist in a project's financing, the standards may be different yet. Local jurisdictions utilize the above manuals for design as a means of protection from lawsuits. Thus from a liability standpoint, it is very important that the design guidance meet the standards or fall within the range of acceptable guidelines provided by the above manuals.

As always, functional classification, traffic volumes, and level of service are factors to consider in any street design, and may be the highest priority for certain facilities. Through stakeholder input, it is important to identify the core issues, develop a spectrum of alternatives, and reach a design decision considering the needs of all of the users. The project development process may determine vehicular level of service is not the critical element and improved service for the other travel modes for pedestrians, bicyclists, and transit users is equal or more important.

C. Design Elements

If a complete streets design is contemplated, many elements must be determined during the design process. Traditionally designers have focused on those related to motor vehicles. With a complete streets design, other elements are also addressed. Each of those elements will be discussed and design guidance presented.

1. **Land Use:** The type of adjacent land use provides insight into several factors. For instance, in industrial areas, the expectation is that truck volumes will be higher. Also in commercial/retail areas, there is an expectation that pedestrians, transit, and bicyclists will have a greater impact. In residential land use areas, the street and right-of-way should accommodate pedestrians of all ages and abilities, and shared use of the street by motorists and bicyclists should be expected.

   Land use will influence speed, curb radii, lane width, on-street parking, transit stops, sidewalks, and bicycle facilities.

2. **Functional Classification:** Most jurisdictions classify their streets as a means of identifying how they serve traffic. Streets are generally classified as arterial, collector, or local facilities. Complete streets projects must take into consideration each street classification because it helps determine how the street and network needs to be treated to handle traffic volumes and other conflicts that may arise if design changes are made.

   Street classifications and the functions of each type are explained in detail in Section 5B-1. It is important to note that all jurisdictions, regardless of size have at least one street in each category. That means that in a larger community an arterial street may carry 20,000 vehicles per day, but in a smaller city the volume on their arterial street might be 2,000 vehicles per day. Similar differences exist in the collector classifications. Generally arterial streets are designated because their primary purpose is to move traffic. Collectors serve the traffic mobility function, but also provide access to adjacent property. Local streets are primarily there to serve adjacent property and should not have through traffic. Designs appropriate for low density residential areas are not likely to fit in the downtown commercial areas due to the likelihood of more pedestrians, bicyclists, trucks, and buses.

3. **Speed:** Because of the differences from community to community in functional classifications, a better criteria to use for design is speed. There are two types of speed to consider in design. The first is operating speed and the other is design speed. Operating speed is typically the posted speed limit and the design speed is often set at 5 miles per hour greater as a factor of safety. It is

also permissible to set the design speed and the posted speed the same. The design speed determines various geometric requirements for safe operations at that speed. These include stopping sight distance, passing sight distance, intersection sight distance, and horizontal and vertical curve elements. These standards are from the AASHTO Green Book and are outlined in Tables 5C-1.01 and 5C-1.02 and for liability reasons should be met at all times, especially for new streets. If it is not possible for any design element to meet the geometric standards on existing streets, warning signs and other safety treatments must be used.

It has been past practice to set the design speed at the highest level that will meet the safety and mobility needs of motor vehicles using the street. One of the principles of complete streets provides for slowing vehicles down to improve safety for all users, especially pedestrians and bicyclists. In general, the maximum speed chosen for design should reflect the network needs and the adjacent land use. The speed limit should not be artificially set low to accomplish complete streets objectives if the roadway environment does not create the driver expectation that they should slow down.

The maximum speed for arterial streets should be 45 miles per hour (mph), but only in rural sections or situations where access control is established and free flowing traffic is the normal situation. A maximum of 35 mph is more typical for most arterial streets in urban developed areas.

Collector streets serve both a mobility and property access function and thus the maximum speed is generally 30 mph. In some cases, 35 mph could be used but only when property access is very limited.

Local streets should be designed at 25 mph since their primary function is for property access.

4. **Design Vehicle:** The selection of the design vehicle is an important element in complete streets design. Lane width and curb radii are directly influenced by the design vehicle. It is not always practical to select the largest vehicle that may occasionally use a street as the design vehicle. In contrast, selection of a smaller vehicle if a street is regularly used by larger vehicles can invite serious operational and safety problems for all types of users.

   When selecting a design vehicle, the designer should consider the largest vehicle that will frequently use the street and must be accommodated without encroaching into opposing traffic lanes during turns. It is generally acceptable to have encroachment during turns into multiple same-direction lanes on the receiving street but not opposing lanes. The choice of a design vehicle is particularly important in intersection design where pedestrians, bicyclists, and vehicles routinely share the same space.

   All street designs must meet the minimum standards for fire departments and other emergency vehicle access and must consider the needs of garbage trucks and street cleaning equipment.

5. **Lane Width:** The AASHTO Green Book provides for lane widths from 9 to 12 feet wide. Narrower lanes force drivers to operate their vehicles closer to each other than they would normally desire. The drivers then slow down and potentially stagger themselves so they are not as close. The actual lane widths for any given street are subject to professional engineering judgment as well as applicable design standards and design criteria. The width of traffic lanes sends a specific message about the type of vehicles expected on the street, as well as indicating how fast drivers should travel. With painted lane lines being 4 to 6 inches wide, the actual "feel" to the driver will be about 1 foot narrower than the design lane width. Wider lanes are generally expected on arterial and collector streets due to truck traffic and higher operating speeds. Snow plowing and removal practices must also be considered as lane width decisions are being made,

especially for the curb lane. Narrower curb lane widths may necessitate different handling of snow because no space is available to plow the snow and it may require loading and removing on a more frequent basis.

It is preferred that arterial streets with 3 to 5% trucks or buses or operating speeds of 35 mph or greater have lanes that are 12 feet wide. That is especially important on the outside lane of multi-lane facilities. It is acceptable to have 11 foot wide lanes on arterial streets when speeds are 30 mph or less, but the entire street context, such as the presence of on-street parking, bicycle lanes, buffer areas, turn lanes, and volume of trucks and buses, needs to be considered before lane widths are chosen.

Collector streets can have 11 foot wide lanes if the number of trucks and buses is low. Collector street speeds should not exceed 35 mph.

Local commercial and industrial streets should be no narrower than 11 feet due to the larger volume of trucks expected with that land use. Local streets can have lane widths down to 10 foot wide in residential areas. For low volume local residential streets, two free flowing lanes are generally not required. This creates a yield situation when two vehicles meet.

The designer should recognize that there is an impact to the capacity of a street as the lanes are narrowed. According to the Highway Capacity Manual, capacity is lowered by 3% if lane widths are narrowed from 12 feet to 11 feet and 7% if lanes are narrowed to 10 feet.

6. **Curb Radii:** The curb radius of intersection corners impacts turning vehicles and pedestrian crossing distances. Larger radii allow larger vehicles, such as trucks and buses, to make turns without encroaching on opposing travel lanes or the sidewalk, but increase the crossing distance for pedestrians and allows smaller vehicles to turn at faster speeds. Shorter curb radii slow turning traffic and create shorter crossing distances, but make it difficult for larger vehicles to safely navigate the intersection. The curb radii that is chosen by the designer should reflect the number of pedestrians, the number of right turns by larger vehicles, length of the pedestrian crossing, and the width of intersecting streets.

   The curb radii must meet the AASHTO Green Book turning templates for the design vehicle selected. The curb radii may be modified if parking lanes and or bicycle lanes are present. It is acceptable to have encroachment into same-direction lanes on the receiving street. It is not acceptable to design a curb radius that calls for turning vehicles to encroach upon the opposing traffic lanes. The minimum curb radii in all cases should be 15 feet.

7. **Curb Extensions or Bump-outs:** Curb extensions or bump-outs are expansion of the curb line into the adjacent street. They are traditionally found at intersections where on-street parking exists, but may be located mid-block. Bump-outs narrow the street both physically and visually, slow turning vehicles, shorten pedestrian crossing distances, make pedestrians more visible to drivers, and provide space for street furniture. Use of curb extensions does not preclude the necessity to meet the turning radii needs of the selected design vehicle.

8. **Bicycle Facilities:** Bicycle facilities provide opportunities for a range of users and are a fundamental element of complete streets design. In Iowa, bicycles are legally considered a vehicle and thus have legal rights to use any street facility unless specifically prohibited. They also have legal responsibilities to obey all traffic regulations as a vehicle. Bicycle facilities generally are one of the following three types:
   a. **Shared Use Paths:** Separate travel ways for non-motorized uses. Bicycles, pedestrians, skaters, and others use these paths for commuting and recreation. Generally used by less experienced bicyclists.

b. **Shared Lanes:** These are lanes shared by vehicles and bicycles without sufficient width or demand for separate bicycle lanes. They may be marked or unmarked. Low speed, low volume residential streets generally will not have pavement markings. For higher speed or higher volume facilities, sharrow pavement markings and signage are used to remind drivers of the presence of bicyclists in the travel lane. Placing the sharrow markings between vehicle wheel tracks increases the life of the marking. These types of shares lanes are used more for commuting than recreation.

c. **Bicycle Lanes:** Dedicated bicycle lanes are used to separate higher speed vehicles from bicyclists to improve safety. Conflicts in shared lanes generally becomes problematic when vehicular volumes exceed 3,000 vehicles per day and operating speeds are 30 mph or greater. Use of bicycle lanes will influence the capacity of the roadway unless widening is possible. The mobility and potential safety benefits of the bicycle lanes need to be evaluated against the capacity impacts. There are generally three types of bicycle lanes:
   1) **Conventional:** Located between the travel lanes and the curb, road edge, or parking lane and generally flow in the same direction as motor vehicles. They are the most common bicycle facility in the United States.
   2) **Buffered:** Conventional bicycle lanes coupled with a designated buffer space separating the bicycle lane from adjacent motor vehicle lanes and/or a parking lane.
   3) **Separated:** An exclusive facility for bicyclists that is physically separated from motor vehicle or parking lanes by a vertical element. Separated bicycle lanes are also called cycle tracks or protected bicycle lanes.

Design information for each bicycle facility type is detailed in Sections 12B-1 through 12B-3. Bicycle parking facilities at destination points will assist in encouraging bicycle usage.

Snow and ice control activities impact vehicular lanes and bicycle lanes differently. Generally, plows will leave some snow on the pavement. Vehicles are able to travel through this material but bicyclists may have more difficulty. In addition, the material may refreeze and make bicycle use more treacherous.

9. **On-Street Parking:** On-street parking can be an important element for complete street design by calming traffic, providing a buffer for pedestrians if the sidewalk is at the back of curb, in addition to benefiting adjacent retail or residential properties. The width of parallel parking stalls can vary from 7 to 10 feet. Streets with higher traffic volumes and higher speeds should have wider parking spaces or a combination of parking space and buffer zone. Narrower parking spaces can be used if a 3 feet buffer zone is painted between the parking stall and a bicycle or traffic lane. The buffer zone will minimize exposure of doors opening into bicyclists, as well as facilitate faster access into and out of the parking space. Placement of parking stalls near intersections or mid-block crossings is critical so as to not impede sight lines of pedestrians entering crosswalks. Snow plowing could impact the availability of on-street parking intermittently. Requirements for ADA accessible on-street parking numbers and stall design must be adhered to. Information on those requirements can be found in Section 12A-2.

10. **Sidewalks:** Sidewalks are the one element of a complete street that is likely to provide a facility for all ages and abilities. Often sidewalks are the only way for young and older people alike to move throughout the community. Sidewalk connectivity is critical to encourage users. Sidewalks should be provided on both sides of all streets unless specific alternatives exist or safety is of concern. All sidewalks are required to meet ADA guidelines or be a part of a transition plan to be upgraded. Sections 12A-1 and 12A-2 identify the specific ADA requirements for sidewalks.

Sidewalks that are set back from the curb are safer than if the sidewalk is located at the back of curb. Street furniture and landscaping can add character and improve safety for sidewalks that are located at the back of curb. Providing seating areas within the sidewalk area can further enhance the urban environment and encourage pedestrian activity.

11. **Turn Lanes:** Turn lanes located at intersections provide opportunities for vehicles to exit the through lanes and improve capacity of the street. Two Way Left Turn Lanes (TWLTL) provide the opportunity to access midblock driveways without causing backups in the through lanes. Turn lanes also allow faster speeds in the through lanes so a trade-off with safety exists especially at intersections.

    Width of turn lanes should reflect the character of the traffic. Dedicated left and right turn lane widths should match the width of the lanes on the street. Local streets should not provide separate turn lanes. TWLTL should be a minimum of 12 feet wide because of the presence of through traffic on each side.

12. **Medians:** Medians provide for access management, pedestrian refuge, and additional space for landscaping, lighting, and utilities. Use of medians and the functions provided are dependent upon the width of available right-of-way and the other types of facilities that are included. The minimum width for pedestrian refuge is 6 feet. The minimum width of a median for access control and adjacent to left turn lanes is 4 feet. The minimum width for landscaped medians is 10 feet. Greater widths provide more opportunities for more extensive landscaping.

13. **Transit:** Bus service within the state is limited to the larger metropolitan areas. Currently there are a number of fixed route systems in the state. Smaller communities do not have fixed route service due to lack of demand. Children, elderly, and low-income people are the primary users of a fixed route transit system. In addition to system reliability, use of transit systems as a viable commuting option is directly dependent on the frequency of service and the destinations within the fixed route. To have a successful transit system, stops must be within walking or biking distance of residential areas to attract riders and it must have major retail, employment, and civic centers along its route system.

    Transit stops should be located on the far side of intersections to help reduce delays, minimize conflicts between buses and right turning vehicles, and encourage pedestrians to cross behind the bus where they are more visible to traffic. Far side stops also allow buses to take advantage of gaps in vehicular traffic.

    Bus turn out lanes are also best located on the far side of intersections. These turn outs free up the through lanes adjacent to the bus stop. Transit bulb outs are more pedestrian friendly than turnouts because they provide better visibility of the transit riders, as well as potentially providing space for bus shelters without creating congestion along the sidewalk. With buses stopping in the through lane, bulb-outs also provide traffic calming for the curb lane.

14. **Traffic Signals:** Traffic signals are not usually considered an element of complete streets, but they have many components with direct implications for complete streets. The timing, phasing, and coordination of traffic signals impacts all modes. Well-planned signal cycles reduce delay and unnecessary stops at intersections, thus improving traffic flow without street widening. Traffic signal timing can be designed to control vehicle operating speed along the street and to provide differing levels of protection for crossing pedestrians.

    The flashing don’t walk pedestrian phase should be set using a 3.5 feet per second walking speed and the full pedestrian crossing time (walk/flashing don’t walk) set using 3.0 feet per second. Some agencies representing the elderly are indicating that the overall walking speed should be 2.7

feet per second to cover a larger portion of the elderly population. ADA accessible pedestrian signal elements, such as audible signal indications, should be included in all new pedestrian signal installations and any installations being upgraded. See Section 13D-1, F for more information on accessible pedestrian signals.

15. **Summary:** The table below summarizes some of the critical design elements that should be examined if a complete streets project is implemented. Other geometric elements can be found in Table 5C-1.02. Some of the lane width values shown in the table below differ from the acceptable values from Section 5C-1 because the expectation is that the complete street environment includes the potential for on-street parking and/or bicycle lanes. Adjustments in the values may be necessary to accommodate large volumes of trucks or buses. Contact the Jurisdictional Engineer if design exceptions are being considered.

Table 5M-1.01: Preferred Design Elements for Complete Streets

Classification	**Local**				**Collector**						**Arterial**					
Posted Speed (mph)	25		30		25		30		35 and Up		25		30		35 and Up	
Land use[1]	*Res.*	*C/I*	*Res.*	*C/I*	*Res.*	*C/I*	*Res.*	*C/I*	*Res.*	*C/I*	*Res.*	*C/I*	*Res.*	*C/I*	*Res.*	*C/I*
Travel lane width (ft)[2]	10[3]	11	10	11	11	11	11	11	11	12	11	11	11	12	12	12
Turn lane width (ft)	--	--	--	--	11	11	11	11	11	12	11	11	11	12	12	12
Two-way left-turn lanes width (ft)	--	--	--	--	12	12	12	12	12	12	12	12	12	12	12	12
Curb Offset (ft)[4]	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2	2
Parallel parking width (no buffer) (ft)[5]	8	8	8	8	8	9	8	9	9	9	10	10	10	10	10	10
Curb radii (ft)[6]	15	15	15	15	15	25	15	25	25	30	15	25	15	25	25	30
Bicycle lane width (ft)[7]	--	--	--	--	5	5	5	5	5	5	5	5	5	5	5	5

[1] Res. = Residential, C/I = Commercial/Industrial
[2] Minimum sharrow lane width is 13 feet.
[3] For low volume residential streets, two free flowing lanes are not required. They can operate as yield streets if parking is allowed on both sides and vehicles are parked across from each other.
[4] Curb offset, less the width of the curb, may be used in the parallel parking lane width.
[5] For arterial or high speed collectors, the parallel parking stall width may be reduced if a minimum 3 feet wide buffer strip is included.
[6] Curb radii may be adjusted based on design vehicle, presence of bicycle lanes or parking lanes, and the number of receiving lanes. Encroachment of turning vehicles into opposing lanes is not allowed.
[7] If paving is integral without a longitudinal gutter joint, the curb offset, less the width of the curb, may be used as part of a bicycle lane.

D. Traffic Calming

Traffic calming is different from but related to complete streets philosophies. Through design measures, traffic calming aims to slow traffic down to a desired speed. By slowing vehicular traffic, biking and pedestrian activities are made safer.

It is absolutely critical that traffic calming measures recognize the need to maintain access for emergency vehicles. Unless the situation is unusual, realizing slower speeds involves a series of traffic calming measures. However, too many measures along a street is likely to divert vehicles to adjacent streets and just move the problem or frustrate drivers to the point of complaining to the level necessary for removal of the traffic calming measures. Because of the anticipation that traffic will be just displaced to adjacent streets, it is very important to study a larger area than a single street when evaluating traffic calming measures.

Many design elements will accomplish traffic calming. These include the following.

- Reduction in lane widths:
  - Short medians
  - Bulb outs
  - Lane striping
- Lateral shifts
  - Chicanes
- Raised/tabled intersections
- Raised/tabled cross walks
- Speed humps or speed cushions
- Traffic circles
- Radar speed signs

Choosing the design elements to use for a particular area will depend on the neighborhood context and the specific concern to be addressed. Prior to evaluating alternative measures, stakeholders must be educated so they can have meaningful involvement. The evaluation needs to involve all stakeholders in the definition of the problem. If possible, all stakeholders, including drivers, pedestrians, bicyclists, and area property owners, would achieve some level of agreement on the traffic calming plan prior to implementation.

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