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Achieving Safety and Mobility through Traffic Control

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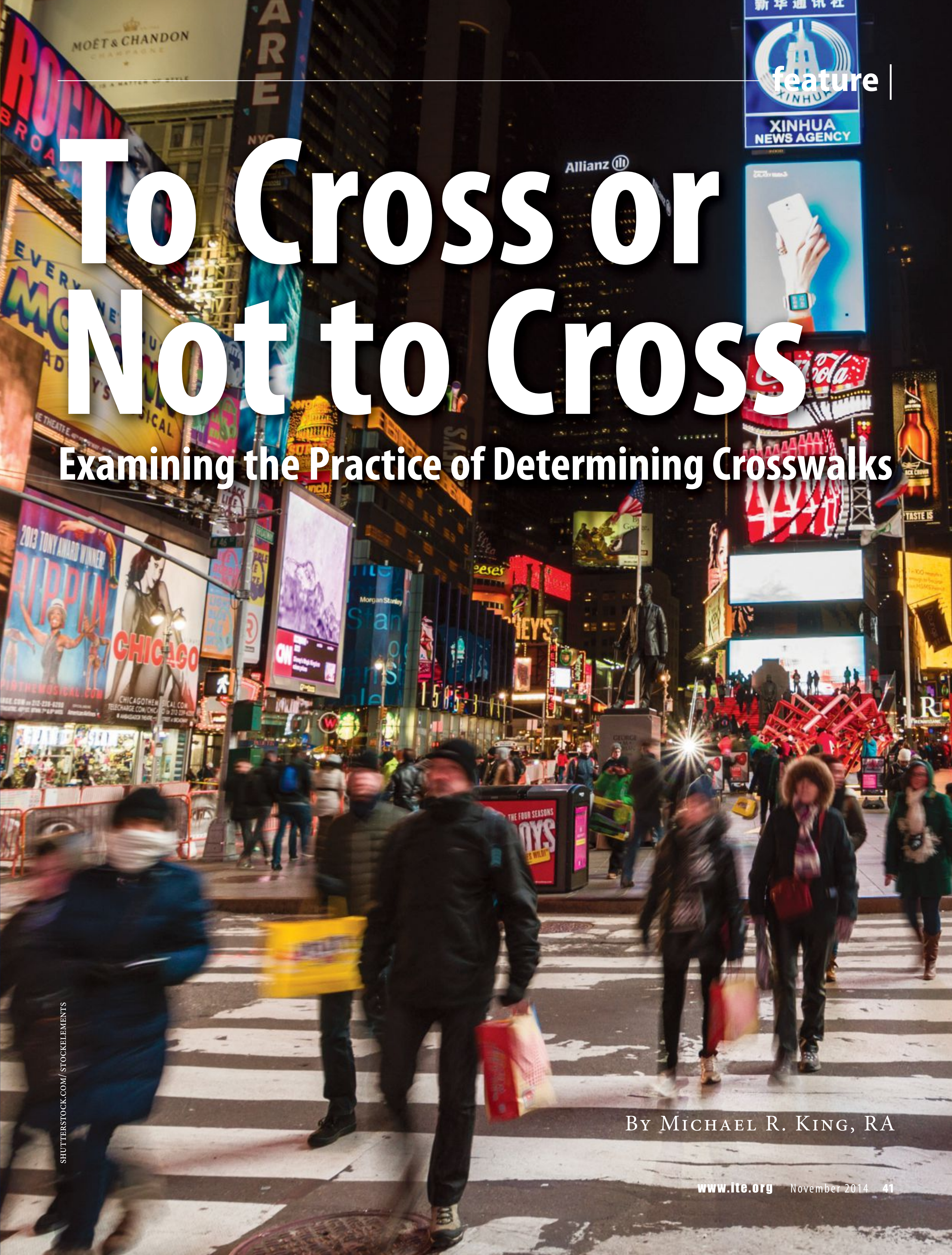
To Cross or Not to Cross

Examining the Practice of Determining Crosswalks

By Michael R. King, RA



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How, when, and where does one “cross” the “street”? Current practice holds that streets are to be crossed only at crosswalks, typically located at intersections. And yet, people cross the street at a number of locations, in a variety of ways, and at multiple times. This article expands on the thinking in the National Association of City Transportation Officials’ *Urban Street Design Guide* about crossings and crosswalks. It seeks to understand the myriad factors which can be used to locate crossing points. It posits that a nuanced methodology is required for the profession to realize an egalitarian system of circulation for drivers and pedestrians alike.

Existing Guidance

Existing literature contains limited information detailing where crossing points should be. What information there is typically subjugates the walking to the driving network, either overtly or not.

The *Manual on Uniform Traffic Control Devices* (MUTCD) obliquely mentions a crossing spacing of 90 meters (300 feet [ft.]); however, it is not clear if the dimension stems from signal or crossing spacing:

> “The Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal or STOP sign controlling the street that pedestrians desire to cross is less than 300 ft., unless the proposed traffic control signal will not restrict the progressive movement of traffic.”[1]

The 90 meters (300 ft.) “is believed to be based on the distance a pedestrian will walk in order to cross the major street.”[2] As noted below, many existing intersections in highly walkable areas are spaced closer than 300 ft., calling this guidance into question.

The above quote from the MUTCD implies that accommodating people walking shall not come at the expense of people driving. As per the letter of the guidance, if 1,000 people an hour were crossing the street but 150 ft. from a nearby signal, they would not be afforded an additional signal, unless that signal was synchronized with the other. It is instructive to flip the guidance to preference people walking: The Vehicle Volume signal warrant shall not be applied...unless the proposed traffic control signal will not restrict the progressive movement of people walking.

The AASHTO *Green Book* has a slight conniption on the subject:

> “Many pedestrians consider themselves outside the law in traffic matters, and in many cases, pedestrian regulations are not fully enforced. This makes it difficult to design a facility for efficient pedestrian movements.”[3]

The key to designing a facility for efficient pedestrian movement is to understand and accommodate pedestrians. If it appears that pedestrians are violating laws more than other road users, then this is likely a result of infrastructure that is inconvenient and unaccommodating for pedestrians.

Crossing Spacing

A fairly exhaustive review found very little original, or even substantiated, recommendations with regards to the spacing of pedestrian crossings. Design guides proffer a large range of distances, from 45 meters (150 ft.) in highly pedestrian districts to 180 meters (600 ft.). While many guides seem to coalesce around 90 meters (300 ft.), it appears that they are merely repeating each other.

Figure 1. Recommended Crossing Spacing Listed in Various Sources [values rounded for convenience]

Source	**Crossing Spacing**	
	meters	feet
Portland Pedestrian Design Guide – on main streets[4]	45–90	150–300
Portland Pedestrian Design Guide – on city walkways[5]	45–120	150–400
AASHTO Pedestrian Guide[6]	60–90	200–300
ITE & CNU Designing Walkable Urban Thoroughfares[7]	60–90	200–300
Sacramento Pedestrian Safety Guidelines – on major arterials[8]	90	300
MUTCD[9]	90	300
NJDOT Flexible Design of New Jersey Main Streets[10]	90	300
Improving Pedestrian Safety at Unsignalized Crossings[11]	90	300
Abu Dhabi Urban Street Design Manual - unpublished research	110	350
San Diego Street Design Manual[12]	180	600

Block Size

Block size can be a proxy for crossing interval, on the presumption that there will be a crossing at each intersection. In researching for this article, we uncovered guidance on block length ranging from 60 to 240 meters (200 to 800 ft.). For reference, blocks in highly walkable cities such as New York City, NY, USA, Portland, OR, USA, and Savannah, GA, USA are generally 60 meters (200 ft.) long on the short side.

Figure 2. Recommended Block Length Sizes Listed in Various Sources [values rounded for convenience]

Source	**Block Length**	
	meters	feet
United Kingdom Manual for Streets[13]	60	200
ITE & CNU Designing Walkable Urban Thoroughfares[14]	60–90	200–300
Western Australia Street Layout, Design, and Traffic Management Guidelines[15]	70–240	230–800
Neighborhood Design and Walking Trips in Ten U.S. Metropolitan Area[16]	90–180	300–600
ITE Design and Safety of Pedestrian Facilities[17]	90–180	300–600

Signal Spacing

The number of traffic signals along a stretch of road can determine the number of crossing opportunities for pedestrians. While not specifically related to pedestrians and crossings, signal spacing is relevant because many corridors are designed and operated accordingly. This has ramifications for not only pedestrian crossings, but also street network, land use, and economic development. The table below presents a sample based on a 90-second cycle for consistency, which ranges from 497 to 751 meters (1,630–2,465 ft.).

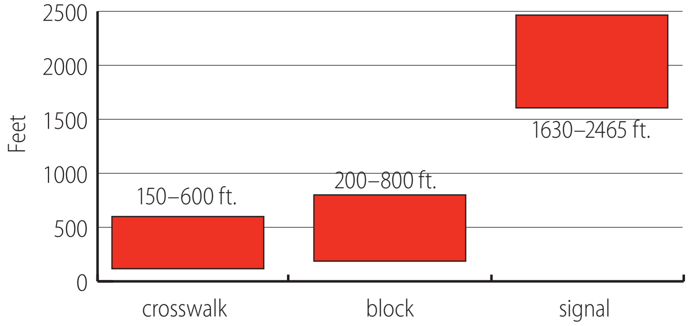
Figure 3. Recommended Traffic Signal Spacing Listed in Various Sources

Source	**Speed**		**Signal Spacing**	
	km/h	mph	meters	feet
Access Management Manual - 90 second cycle[18]	40	25	497	1630
	48	30	604	1980
	56	35	704	2310
Development of a Traffic Signal Operations Handbook[19] formula is $C = 2L/1.47v$; C = cycle length (90 seconds); L = segment length, ft; and v = progression speed, mph	40	25	501	1643
	50	31	626	2054
	60	37	751	2465

Guidance Compared

The chart below compares the guidance listed previously for crossing (crosswalk) spacing, block size, and traffic signal spacing. Clearly, recommendations for signal spacing intervals are higher than those of pedestrian crossings and block sizes. Conflicts arise when streets are organized according to traffic signal spacing guidelines, and designated pedestrian crossings are restricted to these signals.

Figure 4. Comparison of the Three Main Measures of Crossing Spacing



The following diagrams illustrate the evolution from a walking-based (200 ft.) to a driving-based (1/4 mile) grid pattern. The grid on the left has crossing points at every point along the main street. It maintains circulation for pedestrians, transit, cyclists, and motorists. In the center the main street has become an arterial with traffic signals at ¼ mile intervals. This creates street typology based on auto traffic principles (local, collector, arterial). Circulation is limited between the two halves to facilitate motorized traffic flow. To ensure there is no intermediate crossing, the grid has been removed along the main street. The land adjacent to the arterial becomes a non-revenue producing void. On the right, the grid has been further eroded for access management reasons along the collector streets and more land has become non-revenue producing. Circulation is further curtailed.

These diagrams demonstrate how moving from a pedestrian-oriented to an auto-oriented grid results in the loss of circulation, access, and revenue-producing land. In order to ensure the purity of the arterial and collector network, adjacent land must be rendered inaccessible and circulation limited.

Figure 5. From a Walking to a Driving Grid

Towards Better Guidance

Apart from the traditional guidance previously discussed, the location of pedestrian crossing points is primarily informed by desire lines, which are predicated on urban design, the walking network, and the street grid.

Desire Lines

As stated in the AASHTO *Green Book*, "Pedestrians tend to walk in a path representing the shortest distance between two points."[20] This is known as a desire line. Innovative guides advise practitioners to locate crossings where pedestrians are most apt to use them based on observation and modeling.

- "There is evidence of pedestrian activity, such as visibly worn paths or pedestrian volume counts…"[21]
- "In general, whatever their mode, people will not travel out of direction unless it is necessary. This behavior is observed in pedestrians, who will cross the street wherever they feel it is convenient. The distance between comfortable opportunities to cross a street should be related to the frequency of uses along the street that generate crossings (shops, transit stops, etc.)."[22]
- "Additional computer modeling of 'desire lines' for pedestrian movement provided evidence to review the location of proposed and existing crossing facilities... The design guidance produced enabled Transport for London to improve crossing layouts to fit closely along pedestrian desire lines, leading to a reduction in severance in the area.[23]
- "Use of informal crossings to respond to pedestrian desire lines, and to improve the availability of crossing points."[24]

Pedestrian Desire Lines and the Driving Network

Issues arise when the pedestrian desire lines are at odds with the driving network. Sometimes this is unavoidable, but in many instances not enough care has been given to providing for pedestrians. Figure 6 illustrates particularly egregious examples. In Philadelphia, the main entrance to the famed Art Museum (with the steps from the movie "Rocky") has been severed from adjacent park lands by a 5-lane, one-way roadway. In Al Ain and Brasilia transit stops have been located without regard to pedestrian access. In Dortmund the six-lane boulevard is routinely crossed by people from the adjoining side street. Note that two of the examples involve bus stops, an extreme perversion.

Desire Lines, Urban Design, and the Walking Network

Urban design has a direct impact on desire lines. The six diagrams in Figure 8 illustrate how the form and layout of buildings (urban design) can affect where people are meant to cross the street.

Figure 6. Examples of pedestrian desire lines conflicting with the auto traffic network. From top left to right: Philadelphia, PA (USA), Al Ain (UAE), Brasilia (Brazil), Dortmund (Germany).

The top left shows a classic example of buildings built to the edge of the street. There are crossing points at the corner. The buildings in the top center have chamfered corners, thus creating additional crossing points at the edge of the chamfer. In the top right, the buildings have been articulated with opening at the center, like a courtyard building. Accordingly, there would be demand for a midblock crossing at the courtyard. The bottom left shows buildings with alleys or passageways, which create a secondary pedestrian network. It creates demand for a midblock crossing. The buildings in the bottom center have diagonal passageways. They are more aligned with the street network, but a triangle is a poor development parcel. In the bottom right the buildings are completely disassociated from the street grid, thus creating random desire lines for crossing points. While the building shapes may be interesting, they create headaches for both pedestrian and auto circulation.

Existing guidance is well equipped to deal with the first and fifth scenarios. The second type introduces the conundrum of accommodating people walking in various directions at the intersection, which complicates traffic signals. The midblock crossings of the third and forth scenarios can be accommodated, as long as the pedestrian traffic is given the same credence as auto traffic. The sixth type reminds us of the imperative to work with urban designers to create a system that works for all.

The images in Figure 9 illustrate the impact of urban design on the walking network. In Phoenix, AZ, USA, the red lines identify midblock passages, plazas, and walkways along

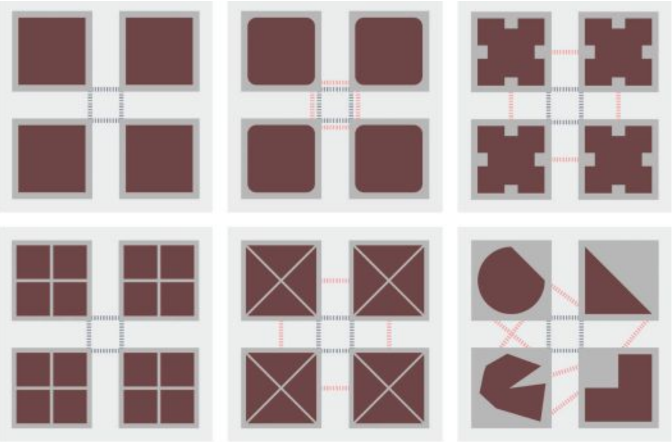


Figure 8. Diagrams of the relationship between street grid, building form, and crossing points. Primary crossing points are shown in grey, secondary are in red.

unusually shaped buildings. Where these lines cross the street grid one would expect to find people wanting to cross the street (a desire line). Note that the street grid is based on 400-foot square blocks, thus a midblock crossing would be every 200 ft. In Cape Town, South Africa the red lines identify paths worn in the median by people crossing the street. These paths align with the streets, plazas and openings of the developments. The images of Charlotte, VA, USA and Bogotá, Colombia show paths continuing where streets do not.

Figure 9. Walking Networks (from top left to right) in Phoenix, AZ (USA), Cape Town (SA), Charlotte, VA (USA), and Bogotá (Colombia).

Street Grid

Street grids hugely influence where people walk and where they cross the street. Older grids (pre-automobile) were platted according to a multitude of systems and measurements, but most have tighter (less than 200 ft.) grids that serve pedestrians well. For example, the 200-foot grid of Manhattan in New York was laid out according to the ship berths along the rivers. In Georgia, Savannah's roughly 200-foot grid was based on 135 cubits, a biblical unit.[25] Two hundred feet square is approximately one acre, and 200 ft. is about the distance one can walk in one minute. We also find evidence of this measurement in present-day grids that are being developed organically.

The four aerials in Figure 10 show grids of four very diverse cities: Ulaanbaatar, Mongolia; Chandigarh, India; Munich, Germany; and Portsmouth, NH, USA. They were chosen because each is highly walkable, but for different reasons. This particular area of Ulaanbaatar is suburban and organized organically by people new to the city. The majority of movement is by foot. Chandigarh is a planned city organized around the automobile. Yet within the superblocks are highly walkable areas with small streets, parks, plazas, and blocks. The downtown area of Munich retains much of its medieval structure, which was organized around foot traffic. Portsmouth is one of the older cities in the United States, and its downtown has been recognized for walkability. The grid structures of all these examples are roughly 50-60 meters (164–200 ft.) on the short side, even though the origins of the grids are markedly different.

It is impossible to say whether people's walking habits are based on the street grid, or vice-versa, but suffice to say there is a relationship between smaller grids and more walking.

Figure 10. 60 m (200 ft.) measurements in Ulaanbaatar, Mongolia (top left); Chandigarh, India (top right); Munich, Germany (bottom left); and Portsmouth NH, USA (bottom right)

Time-based Crossing Spacing Metric

Instead of a distance-based crossing spacing metric, it has been hypothesized that a time-based metric would be more responsive to varying conditions. For example, crossing a two-lane street with low speed vehicle traffic is different than crossing a six-lane, high-volume boulevard. A shorter spacing is reasonable for the former, while a longer spacing might make better sense for the latter. A time-based metric might be able to capture this.

- A time-based crossing spacing metric would include:
- Walking speed
- Distance walking along the street to the crossing point
- Time to wait for a gap in traffic or signal cycle
- Width of the street
- Distance returning to the starting point

There are potentially other variables such as vehicle speed and the presence of a median or pedestrian refuge island and speed of vehicles. Items such as cross street network, block size, pedestrian generators, and transit stops would determine default crossing locations, thus trumping the formula.

During the preparation of the *Abu Dhabi Urban Street Design Manual*, researchers were presented with the opportunity to document pedestrian crossing behavior in a relatively uniform setting. Downtown Abu Dhabi is characterized by superblocks with boulevards in a grid fashion and largely continuous rows of 20 story buildings. The superblocks range from 300 to 800 meters (984–2625 ft.) long per side. The boulevards are between 50 and 70 meters (164–230 ft.) wide with three lanes in each direction, a three meter wide median, and a service lane. Vehicle volumes and speed are spread fairly evenly throughout the area. Traffic signals are located at the intersections of the boulevards. Midblock crossings include signalized crosswalks, unsignalized marked crosswalks, and undesignated crossings indicated by paths worn in grass on the median or a break in the fence on the median. These occur on average every 108 meters (354 ft.).

To experiment with a time-based spacing metric, researchers timed people waiting for a gap in traffic at random crossing locations in June and July 2010. They recorded the times of people waiting at the curb, or walking along the street in anticipation of a gap to cross. A total of 100 observations were made. The maximum wait time was 102 seconds, with the minimum being 0. The 85th percentile wait was 48 seconds. As shown in the table below, the time to cross the street varies from two minutes and 17 seconds to three minutes and 18 seconds, depending on walking speed. Further research would be required to determine the universal applicability of this metric.

Figure 11. Estimation of a Time-based Crossing Spacing Metric

	0.9 m/s (3.0 ft/s)	**1.5 m/s (5.0 ft/s)**
Calculated time to walk to and from crossing location, s [average crossing spacing = 108 m (354 ft.)]	120	72
85th percentile of observed time waiting to cross, s	48	48
Calculated time to cross street, s [average street width = 27.5 m (90 ft)]	31	18
Total time to walk to crossing location, wait for a gap in traffic, and cross street, s	199	138
total in mm:ss format	**3:19**	**2:18**

Salient Points

This article has explored some of the salient points of how, when, and where one crosses the street:

- Current guidance and practice is largely unsubstantiated and favors driving;
- Crossing points should be more frequent than what current guidance describes;
- Walking and driving networks are not the same;
- Desire lines are key to understanding pedestrian crossing points; and
- Urban design impacts the walking network and desire lines.

Credit

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