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GETTING TO THE OTHER SIDE

Safe Navigation for Pedestrians and Bicyclists at Alternative and Other Intersections and Interchanges

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Above: Contending with two-way traffic and turning lanes, a pair of pedestrians wait their turn to cross a busy street in Chicago, Illinois. Traditionally, roadway engineers and planners have placed priority on traffic flow and driver safety. Now there is a move toward designing intersections that consider the needs—and safety—of pedestrians and bicyclists alike.

A driver makes a right turn, travels about 500 to 800 feet, then enters a left-turn lane to make a U-turn, rather than crossing or turning left on a high-speed road. This configuration, called a restricted crossing U-turn (RCUT) intersection,¹ is one of many alternative intersection and interchange (A.I.I.) designs that has emerged in the past decade.

Since driving an extra 500 feet can take only seconds, the RCUT intersection design significantly reduces the chance of a severe or fatal car crash from left turns on high-speed roads. For motor vehicle drivers, the RCUT and many of its A.I.I. cousins provide operations and safety benefits over a traditional intersection with direct left turns.

For a bicyclist at most RCUTs, however, crossing or turning left means contending with drivers in that 500 feet of roadway, as

well as a left-turn lane. For a pedestrian, it means crossing an unfamiliar intersection and encountering out-of-direction travel. Neither of these experiences are convenient or comfortable, and some movements—like a bicyclist forced to weave across lanes of fast-moving traffic to a U-turn bay—can be dangerous (Figure 1). But are these experiences worse than at whatever the conventional design of this intersection would be? What if there are ways to mitigate the safety and comfort concerns at conventional—as well as RCUT—intersections? How can engineers and planners compare these design alternatives for aspects of multimodal safety and comfort?

The experience for people walking and biking at an RCUT intersection reflects a common issue among many alternative intersections built to date: Pedestrians and bicyclists have not been prioritized in the design. *National Cooperative Highway Research Program (NCHRP) Research Report 948: Guide for Pedestrian and Bicyclist Safety at Alternative and Other Intersections*

¹ This FHWA brief provides details about RCUT intersections at <https://www.fhwa.dot.gov/publications/research/safety/09059/>.

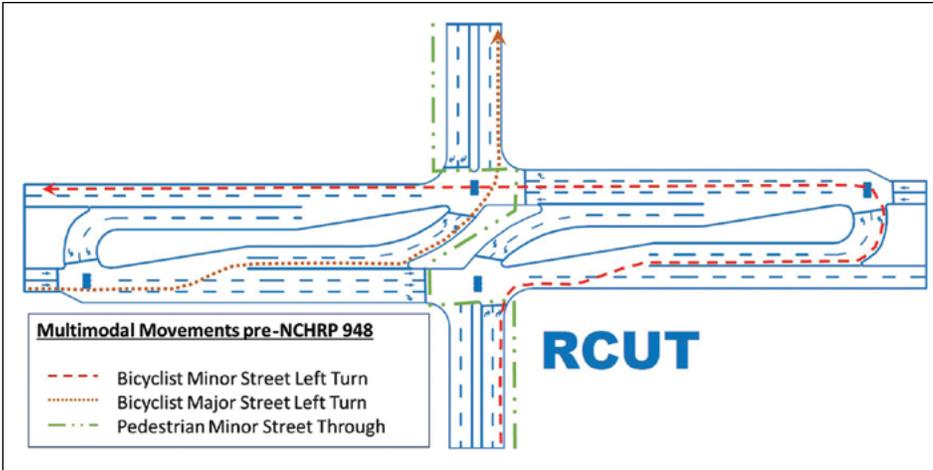


FIGURE 1 Pedestrian and bicyclist movements at RCUT before *NCHRP Research Report 948*. (Source: Kittelson.)

and Interchanges addresses how this can be measured and how improvements can be evaluated.

Designing to Integrate All Users

An RCUT is just one example of an A.I.I., a category that encompasses complex intersections designed to improve efficiency and safety for drivers. Common A.I.I.s include the diverging diamond interchange, median U-turn, displaced left turn, quadrant roadway, jug handle, and continuous green-T.

To achieve these benefits for drivers, A.I.I.s adjust geometric features (e.g., a reversal of traffic lanes from their traditional directions), which can be unintuitive or uncomfortable for people walking and biking and could increase their risk or exposure at the intersection. In addition, pedestrian paths and bicycle facilities may cross through islands or take different routes than expected. The concern is acute for pedestrians with disabilities.

NCHRP Research Report 948 is a response to these realities. The report is a guide for transportation practitioners to improve pedestrian and bicycle safety and quality of service at intersections—including A.I.I.s—through planning, design, and operational treatments.

Guiding Principles

The NCHRP report is rooted in a performance-based design approach that is familiar to many transportation professionals through *NCHRP Report 672: Roundabouts: An Informational Guide, Second Edition* and

NCHRP Report 785: Performance-Based Analysis of Geometric Design of Highways and Streets. *NCHRP Research Report 948* adapts many of the guiding principles of these earlier NCHRP reports to the specific challenge of pedestrian and bicyclist safety at intersections, including the alternative designs.

Through a two-year research effort that included field-based data collection of people walking and bicycling through A.I.I.s, national focus groups in locations where a high rate of existing A.I.I. design is constructed, and engagement with national experts that generated more than 8,000 comments, *NCHRP Research Report 948* provides a performance-based assessment method that can be applied in the concept or final design stages, as well as in safety audits of existing locations.

A Test of “20 Questions”

At the heart of *NCHRP Research Report 948* is a quantitative analysis method built around 20 design flags: 20 performance-based design checks a designer may evaluate when assessing the level of

#	Flag Description	Pedestrian	Bicycle
1	Motor Vehicle Right Turns		
2	Uncomfortable/Tight Walking Environment		
3	Nonintuitive Motor Vehicle Movements		
4	Crossing Yield- or Uncontrolled Vehicle Paths		
5	Indirect Paths		
6	Executing Unusual Movements		
7	Multilane Crossings		
8	Long Red Times		
9	Undefined Crossing at Intersections		
10	Motor Vehicle Left Turns		
11	Intersecting Driveways and Side Streets		
12	Sight Distance for Gap Acceptance Movements		
13	Grade Change		
14	Riding in Mixed Traffic		
15	Bicycle Clearance Times		
16	Bicyclist Crossing Motor Vehicle Travel Lane(s)		
17	Channelized Lanes		
18	Turning Motorists Crossing Bicycle Path		
19	Riding Between Travel Lanes, Lane Additions, or Lane Merges		
20	Off-Tracking Trucks in Multilane Curves		

FIGURE 2 Applicability of flags to pedestrian and bicyclist movements. (Source: Kittelson.)

comfort and safety for multimodal users at an intersection or interchange.

The 20 design flags highlight design characteristics that impact safety and quality of service for people walking and biking, regardless of the intersection type. Examples include tight walking environments, nonintuitive motor vehicle movements, grade changes, and motorists crossing bicycle paths. The list is meant to be a tool for evaluation and comparison that is worked through during the design phase, one flag at a time (Figure 2). Some of the flags are associated with pedestrian movements, some with bicyclist movements, and some apply to both user groups.

Each of the 20 flags includes thresholds for a yellow flag and for a red flag

at a given intersection. A yellow flag is generally associated with user comfort and a red flag with safety. Working through the list gives a percentage of red flags and a percentage of yellow flags for the intersection design being studied. To help convey the nuances of these design flags, the guide encompasses nearly 200 original graphics that illustrate the design flags, countermeasures, and alternative intersection and interchange design concepts (Figure 3).

The flags also can be used to indicate where safety countermeasures would be appropriate. To assist practitioners with these design and countermeasure decisions, the guide includes a chapter dedicated specifically to countermeasures

and treatments that can help address the design flags. In addition, four chapters of the guide are dedicated to providing solutions to specific intersections: the RCUT, median U-turn, displaced left turn, and diverging diamond interchange.

A Methodology That Serves All Intersections

The project started out with a focus on the alternative intersection and interchange designs, but it was quickly determined that the true value in an assessment method was in the comparison of an A.I.I. to a conventional design. This realization was so profound that it ultimately led to a title change midway through the project. What was originally

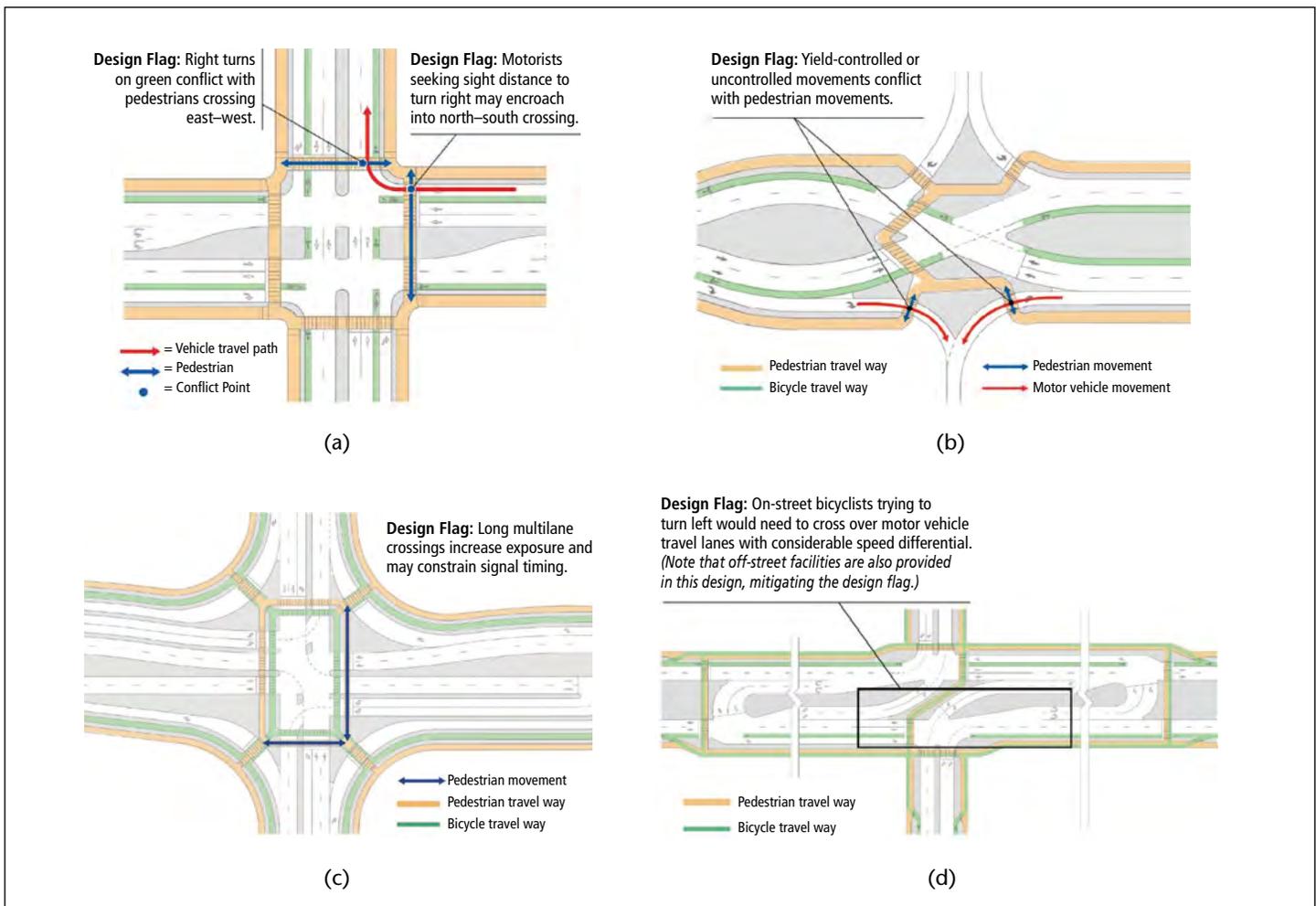


FIGURE 3 Examples of design flags include (a) Design Flag 1—motor vehicle right turn, (b) Design Flag 4—crossing yield-controlled or uncontrolled vehicle paths, (c) Design Flag 7—multilane crossings, and (d) Design Flag 14—riding in mixed traffic. (Source: NCHRP Research Report 948.)

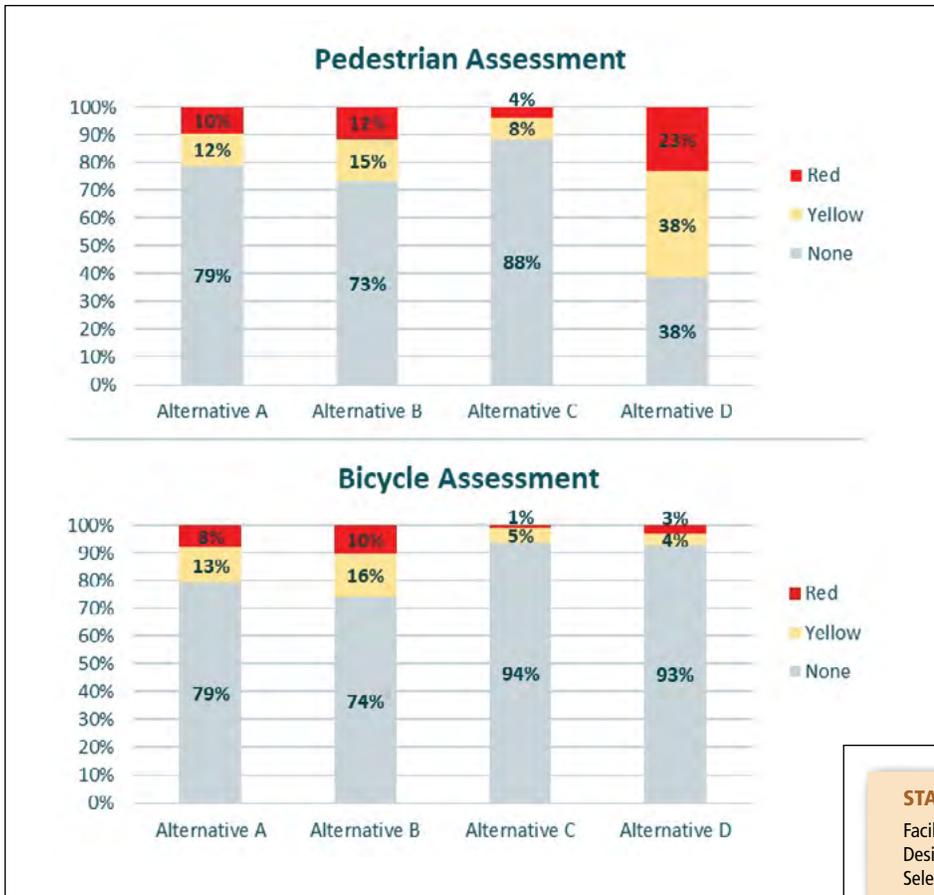


FIGURE 4 Potential outcome of the 20 Design Flag method. (Source: NCHRP Research Report 948.)

named *Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges (A.I.I.)* became *Guide for Pedestrian and Bicycle Safety at Alternative and Other Intersections and Interchanges*.

The performance-based design process and the 20 Design Flag method are geared to evaluating design elements of an intersection rather than the intersection form as a whole. As such, the method benefits agencies despite whether they are currently evaluating alternative designs. In fact, the guide provides specific examples of design flags for conventional designs.

The 20 Design Flag method is applied to all pedestrian and bicyclist movements through an intersection, which are then tallied to the total of yellow and red flags identified. The percentages of flags allow for comparison of proposed designs and

can be used in screening designs to move forward. In Figure 4, four intersection alternatives are evaluated and compared relative to their safety for multimodal users. This quantitative look at intersections is the first time designers can explicitly consider the effects of design choices on the safety of pedestrians and bicyclists.

These results can now be used in combination with other desired design outcomes, including heavy vehicle accommodations, fastest path checks, and sight distance. Through an iterative design process to address the multimodal safety and other

intended outcomes, an optimal design solution is developed that ultimately serves all users.

Relationship to Project Development and Intersection Control Evaluation

The NCHRP Research Report 948 methodology is intended to be integrated into an agency's project development, including a formalized intersection control evaluation (ICE) process. The performance-based assessment process is ideally suited for what many agencies refer to as Stage 2 of an ICE process: a stage at which the feasible list of intersection concepts has been reduced to three or four alternatives (Figure 5). The 20 Design Flag method is intended to

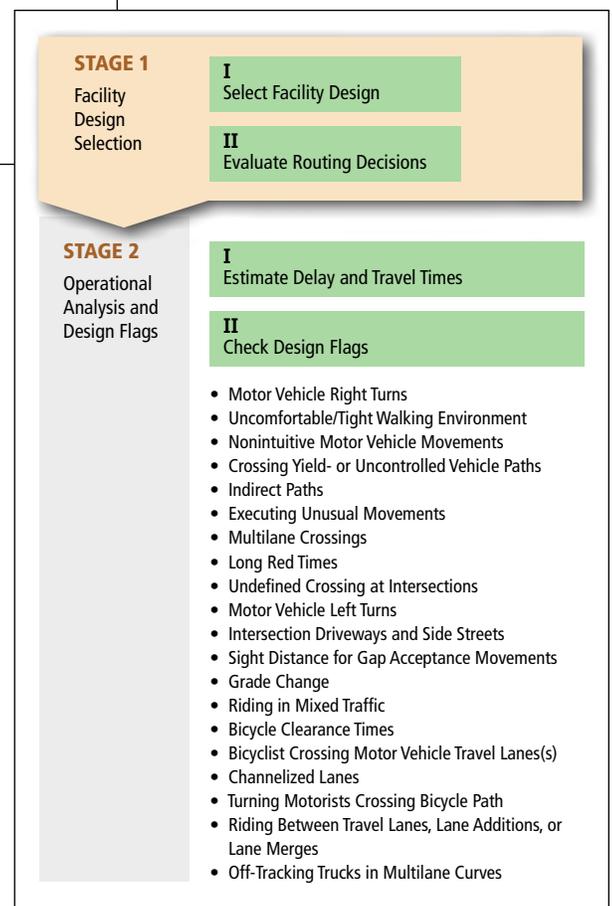


FIGURE 5 Two-stage ICE assessment for nonmotorized users.

fill a specific gap at this stage of ICE. In addition, the guide provides direction for Stage 1 of ICE, at which agencies may be confronted with a much larger potential pool of design alternatives.

Reenvisioning Standard Designs

NCHRP Research Report 948 provides detailed strategies for the four most common A.I.I. designs—RCUT, median U-turn,

displaced left turn, and diverging diamond interchange—and reenvision what engineers and planners think of as standard designs. A striking review of 141 existing RCUTs across the United States showed that 113 sites (80 percent) did not have pedestrian or bicyclist facilities, and only 11 sites (7.8 percent) had a way for pedestrians to cross the mainline arterial. In an effort to change this, the guide presents new ways of looking at RCUTs, as well as the other

designs, with new concepts that integrate multimodal users from the start (Figure 6). Over time, the hope is that agencies will begin to rethink their approaches to these intersections and integrate all users in their designs from the start.

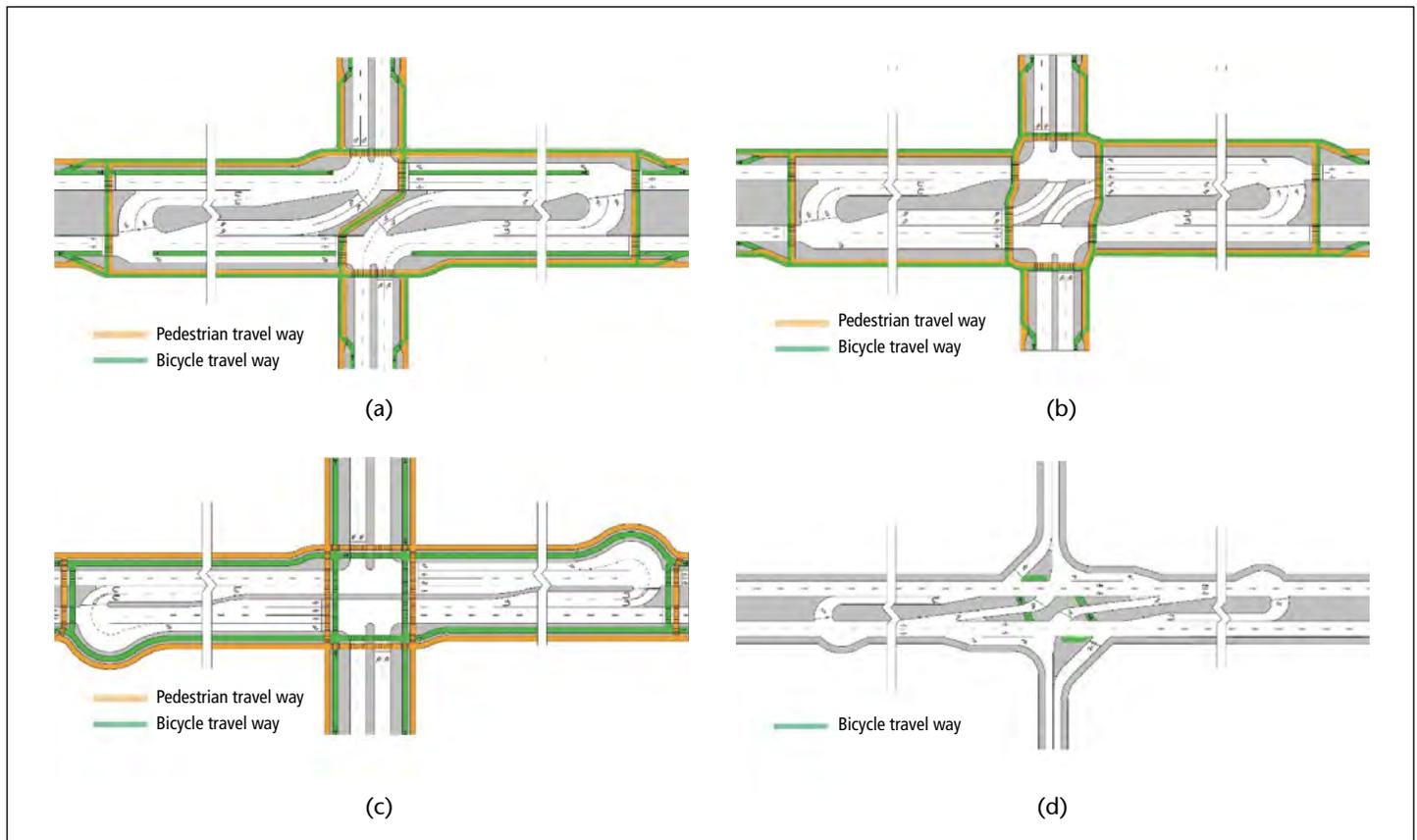


FIGURE 6 New RCUT design concepts to integrate all users include (a) RCUT with on-street bike lanes and shared-use path and diagonal crossing, (b) RCUT with shared-use path and direct crossings, (c) RCUT without any left turns with protected bike lanes, and (d) RCUT for rural application without pedestrian facilities with bicycle cut-throughs. (Source: NCHRP Research Report 948.)