Saving Time, Money, and Lives through Performance-Based Intersection Evaluation & Design

California LTAP Workshop

How to use the Intersection Safety and Operational Analysis Assessment Process

Sunrise
Transportation Strategies, LLC.

Brian L. Ray
brianlray1962@outlook.com

June 16-17, 2025

Agenda

- **Overview**
- Your decisions save lives
- ISOAP
- Have the courage to say “yes”
- Closing and questions

Overview

Caltrans policy supports performance-based approaches to reduce severe and fatal crashes...

…You have the opportunity in your planning and design decisions to save lives and money while you do it.

Overview

Caltrans as been applying performance-based planning and design activities even if the HDM has not yet caught up...

Why apply performance-based approaches?

…Because of the effectiveness of the results and the value-focused solutions that come from the processes!

Performance-based evaluations

Focusing on outcomes versus prescriptive dimensions or solutions

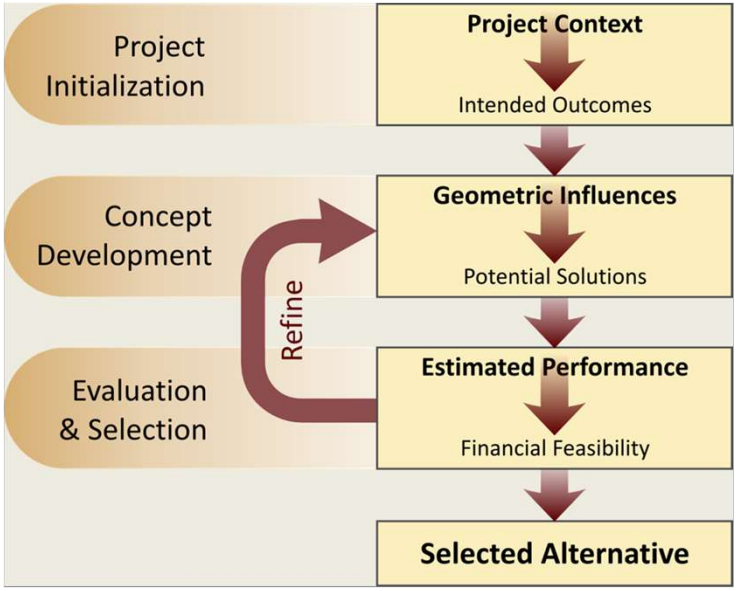
What are we trying to achieve? ***Whom are we trying to serve?***

- Identify intended target performance
- Intended outcomes guide geometrics
- Correct geometrics aim us toward target performance
- Attaining geometric performance targets help us meet project-level performance goals

Source: NCHRP Report 785: Performance-based Analysis of Geometric Design of Highways and Streets

Performance-based evaluations

- Initial performance-based model in NCHRP Report 785 *Performance-based Analysis of Geometric Design of Highways and Streets*
- FHWA used this model to support "performance-based practical design" (PBPD)
- Performance models in roundabout guidance:
  - NCHRP Report 672 *Roundabouts: An Informational Guide, 2nd Edition*
  - NCHRP Research Report 1043: *Guide for Roundabouts*
- Caltrans 2013 ICE Policy was performance-based
- ISOAP expands and updates the evaluations and tools



Source: NCHRP Report 785 Exhibit 5-1

Performance-based evaluations

NCHRP Research Report 959 *Diverging Diamond Interchange Informational Guide*

- General performance categories:
  - Verifying design users are integrated
  - Stopping sight distance (SSD)
  - Intersection sight distance (ISD)
  - View angle considerations

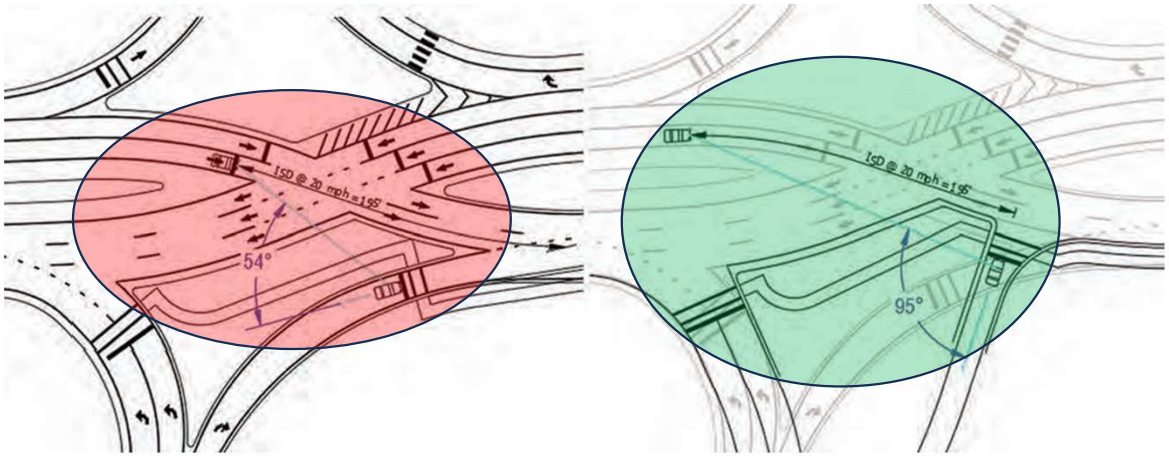


Exhibit 6-60. View angles and ISD.

Source: NCHRP Research Report 959

Performance-based evaluations

NCHRP Research Report 959 *Diverging Diamond Interchange Informational Guide*

- DDI-specific performance categories:
  - Speed profile
  - Approach vista
  - Path alignment
  - Vista through crossover

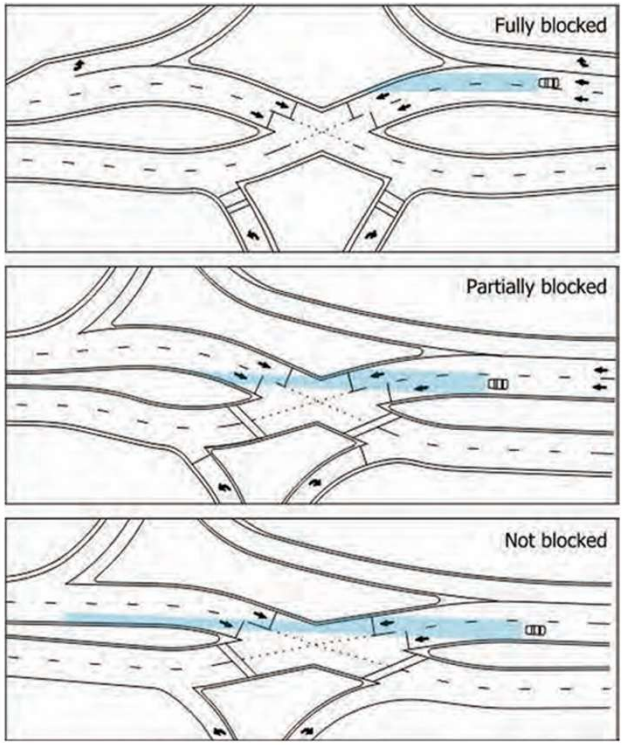


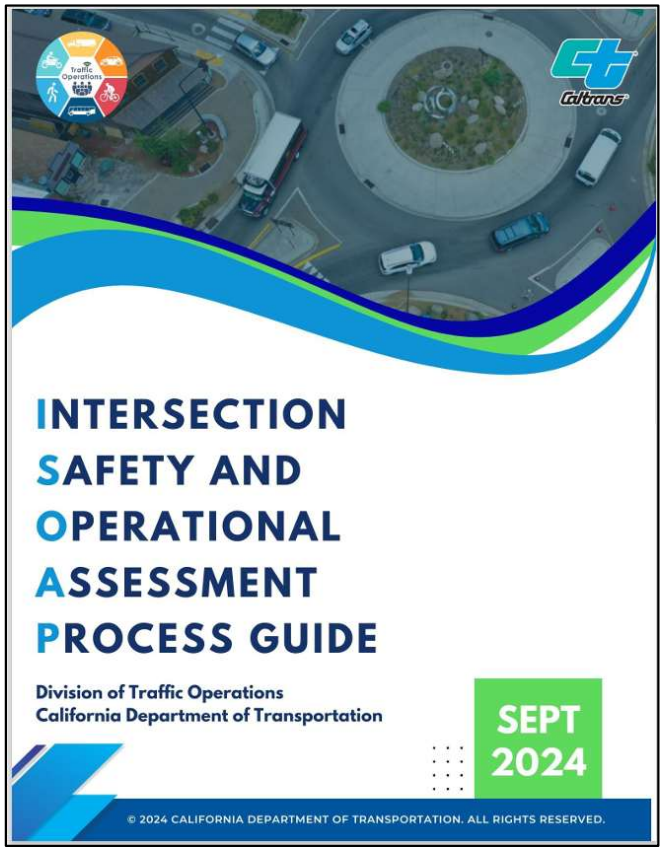
Exhibit 6-66. Three examples of terminal vistas.

Source: NCHRP Research Report 959

Performance-based evaluations

- "ISOAP" is an Intersection Control Evaluation (ICE) methodology
- ICE has evolved nationally since the mid-2010s
- Caltrans was an early ICE adapter (2013)
- Other states expanded ICE evaluations in tools such as SPICE and CAP-X
- New national guidance: NCHRP Research Report 1087: *Guide for Intersection Control Evaluation*

Supplement with other national guidance!



Overview Summary

- Performance-based analysis and design allows us to tailor solutions to meet each project's needs.
- Flexibility in roadway design is supported by using a performance-based approach to determine and document design decisions.
- Documenting planning and design "intended outcomes" and optimizing the value of project solutions reduces liability risk.
- Moving away from dimension-driven design can require a change in mind set for some professionals.

You can do this!

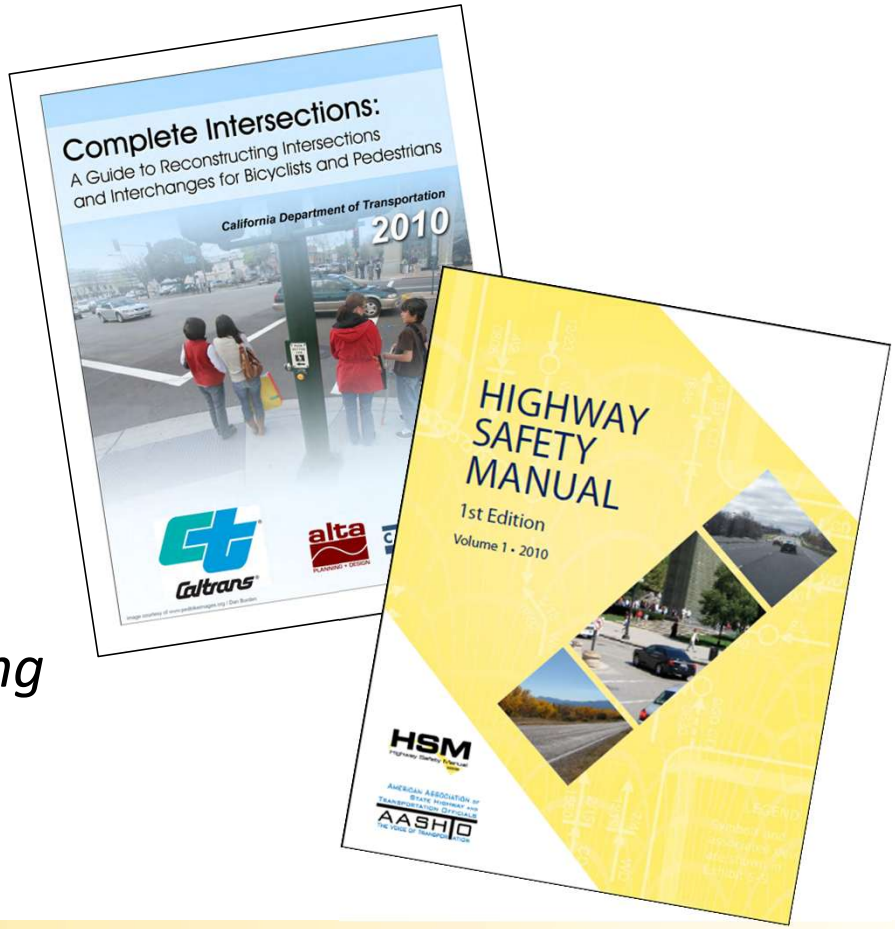
Agenda

- Overview
- **Your decisions save lives**
- ISOAP
- Have the courage to say “yes”
- Closing and questions

Your decisions save lives

- The 2010 Highway Safety Manual established “crashes” and “collisions” and “safety performance” as crash frequency and severity
- National and Caltrans Policies and Directives focus on reducing crash severity

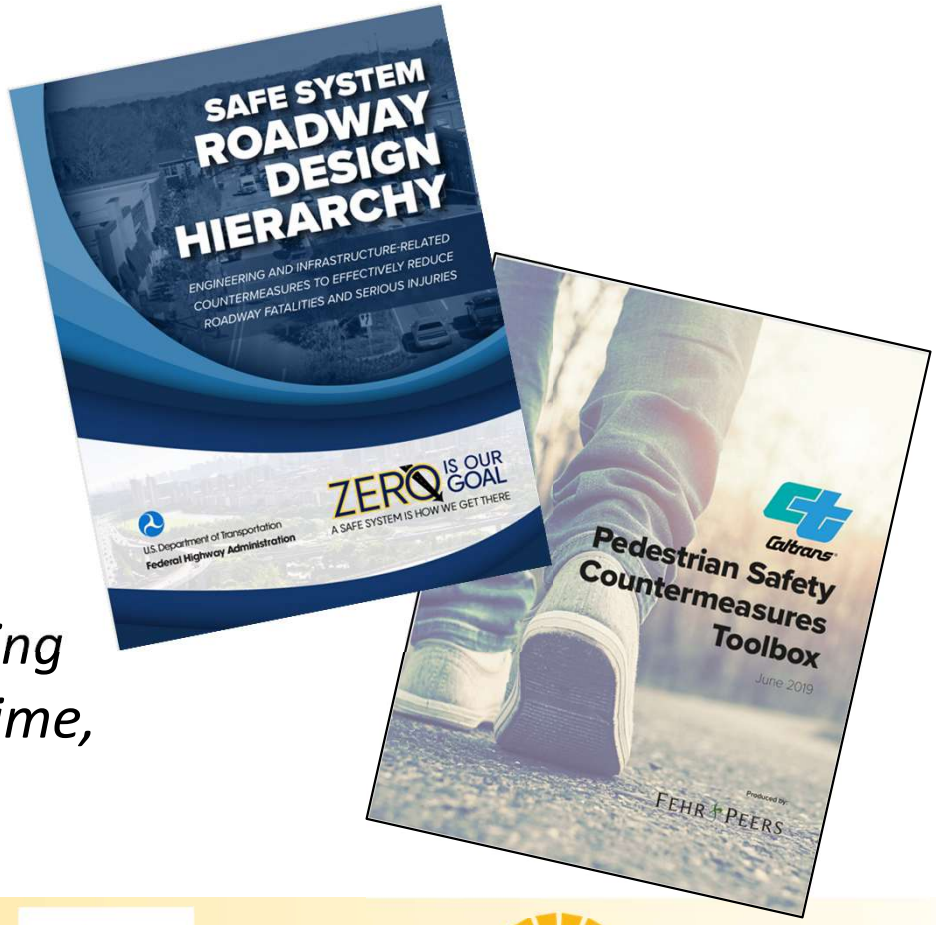
The choices you make in intersection planning and design can have the biggest positive effect on pedestrians and bicyclists!



Your decisions save lives

- Intersection evaluation is the biggest opportunity to save lives for all users; AND especially pedestrians and bicylists
- Safe System Approach sets up priorities in our planning and design decisions

Learn the key factors of intersection planning and design to be most effective in saving time, money, and lives in your work!



Agenda

- Overview
- Your decisions save lives
- **ISOAP**
- Have the courage to say “yes”
- Closing and questions

ISOAP

"…You should be able to do Step 1 ICE on the back of a napkin!"

Paul T. McClintic, PE
Caltrans D5 Traffic Engineer (Retired)

ISOAP is two stages for a reason!

Fast and efficient screening of inferior concepts…

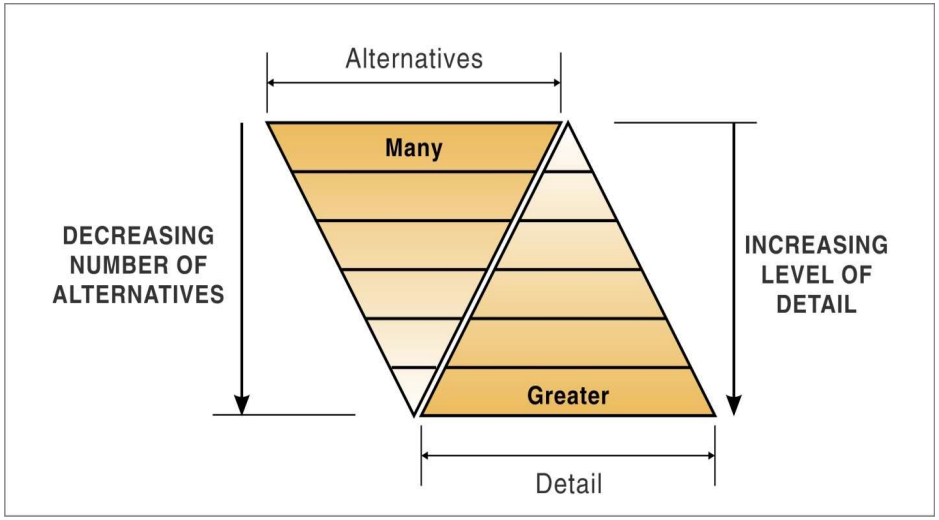
Advancing promising solutions for more detailed assessments!

The principle still stands!

ISOAP

Focus on the "Analysis" and don't let "Process" take control

- Do just enough work to answer the questions at hand (screen and advance)
- Work smartly: "form" then "control strategy"
- Form first allows whole categories to be screened
  - Diamonds versus Partial cloverleaf forms
- RCUT, MUT, DLT are "forms"
  - RCUT and MUT can be stop, yield, or signalized
- A DDI can be signalized or a divergabout



Jack E. Leisch Functional Design Process

ISOAP

Thoughtfully apply solutions versus working the list

- There will always be a new intersection or interchange form.
- That does not mean all new forms are appropriate.
- A “Continuous Tee” is for a three leg intersection
- “Echelon” and “Center Turn Overpass” are grade separations
- A “Pedestrian Hybrid Beacon” is for pedestrian service
- A DDI is one variation of a diamond interchange
- There are other reduced conflict diamond forms!

The list will never be comprehensive!

Control Strategy	Is it a viable strategy? (Y/N)
Minor Road Stop	
Right In/Right Out	
3/4 Movements	
All-Way Stop	
Traffic Signal	
Continuous Tee Signal	
PHB	
Roundabout	
Displaced Left-Turn	
Median U-Turn	
RCUT	
Jughandle	
Quadrant Roadway	
Thru-Cut	
Echelon	
Center Turn Overpass	
DDI	

Source: ISOAP Process Guide

ISOAP

SR 156/SR 25

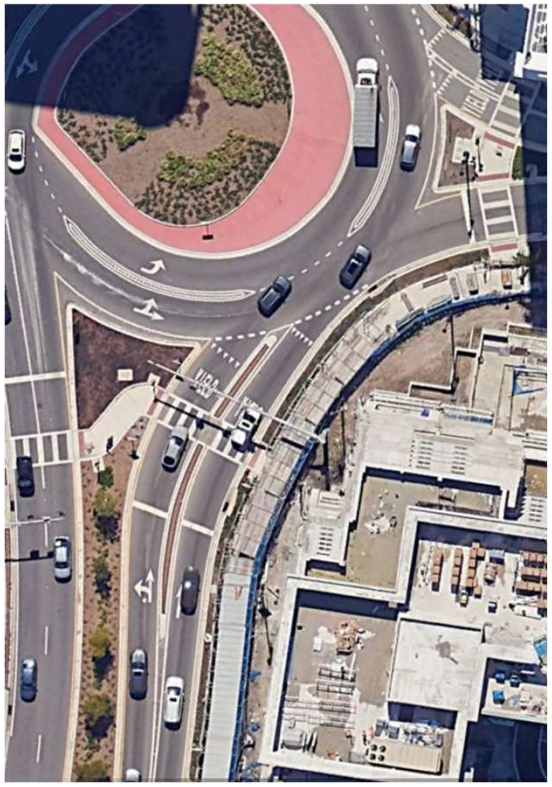
- *"…A turbo roundabout is a multilane roundabout that uses spiral road geometry and physical channelization to maintain driver lane discipline in the circulatory roadway…"*

  Source: NCHRP Research Report 1043 Guide for Roundabouts

- Not all forms are the Dutch variety

Fruitville Rd./ Tamiami Tr. (Sarasota FL)

Fruitville Rd./ Tamiami Tr. (Sarasota FL)



ISOAP

Learn the forms….use the correct names

These are the names used to market the form:

- "Continuous Flow Intersection" (CFI)
  Displaced Left-Turn (DLT)
- "Super Street"
  Restricted Crossing U-Turn (RCUT)
- "Urban Interchange"
  Single-point Diamond Interchange
- "Michigan Left"
  Median U-Turn (MUT)

Did you know a "HAWK Signal" was originally called the "HAWK Beacon"?

- HAWK stands for "High-Intensity Activated Crosswalk"
- Since a "signal" can not rest in dark, it must be a beacon
- It's formally called a "Pedestrian Hybrid Beacon" (PHB)

Agenda

- Overview
- Your decisions save lives
- ISOAP
- **Have the courage to say “yes”**
- Closing and questions

Have the courage to say “yes”

...it feels easy to say “no”

…You want to gain confidence and learn to say “yes”

“I need more analysis is the same as saying “no””

How can you gain the confidence to learn to say “yes”?

Learn “fundamental principles”

- Learning and applying “fundamental principles” helps you be more confident to apply “engineering judgement.”
- This example shows fundamental principles in:
  - Slowing vehicle speeds at the crossing
  - Increasing visibility to and distance from the crossing
  - Improving the view angle for the turning driver

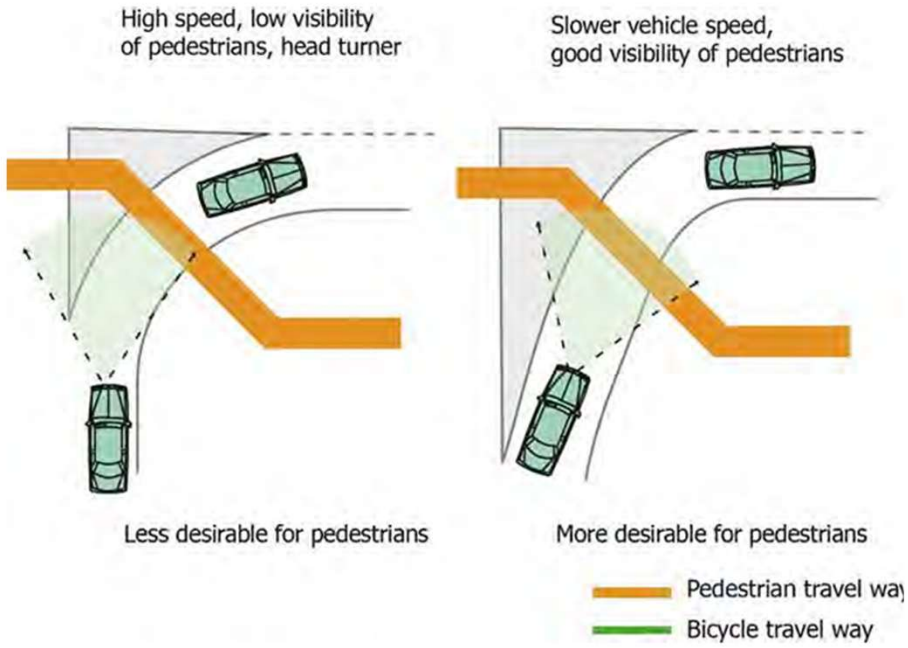


Exhibit 5-7. Channelized right-turn design. Source: NCHRP Report 834 (4).

Source: NCHRP Research Report 948

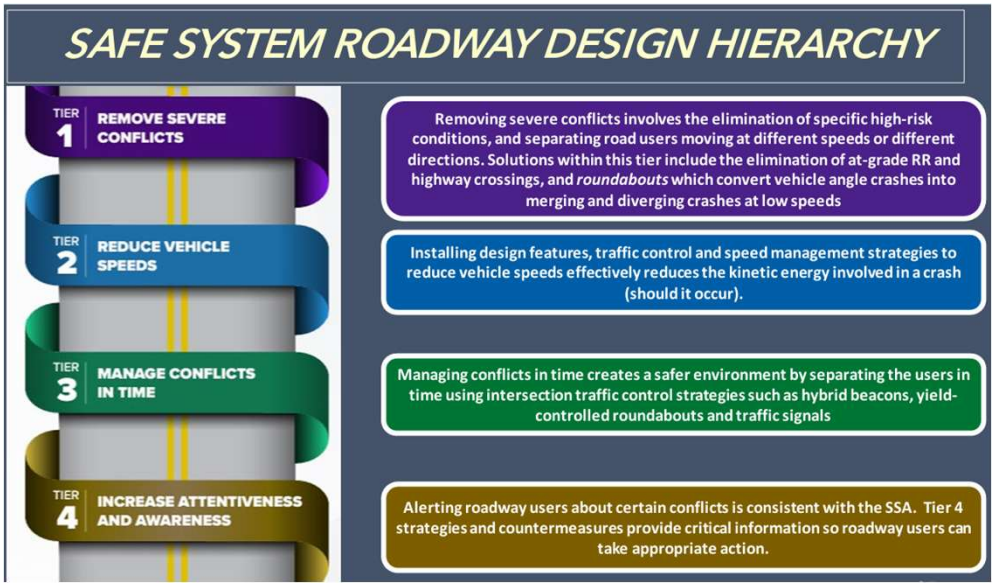
Learn and apply new concepts

Are you familiar with “protected intersections?”

Using design elements to reduce conflicts between bicyclists, pedestrians, and motor vehicles.

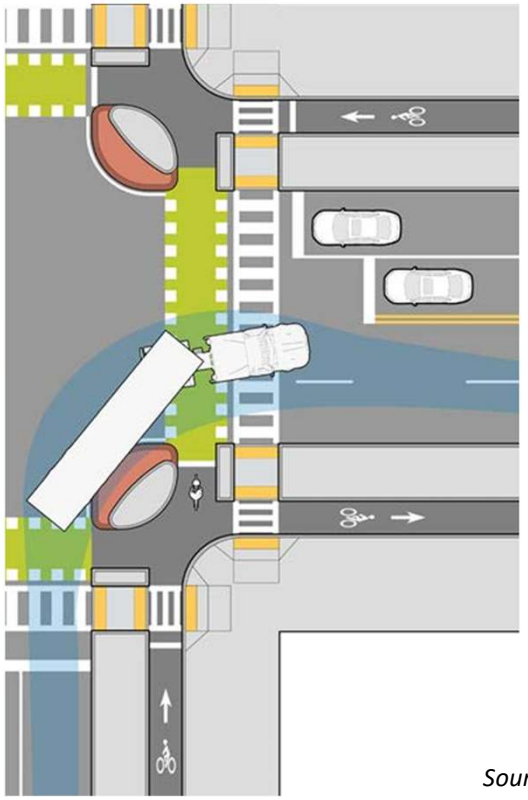
- Principles
  - Minimize exposure to conflicts
  - Reduce speeds at conflict points
  - Communicate right-of-way priority
  - Provide adequate sight distance

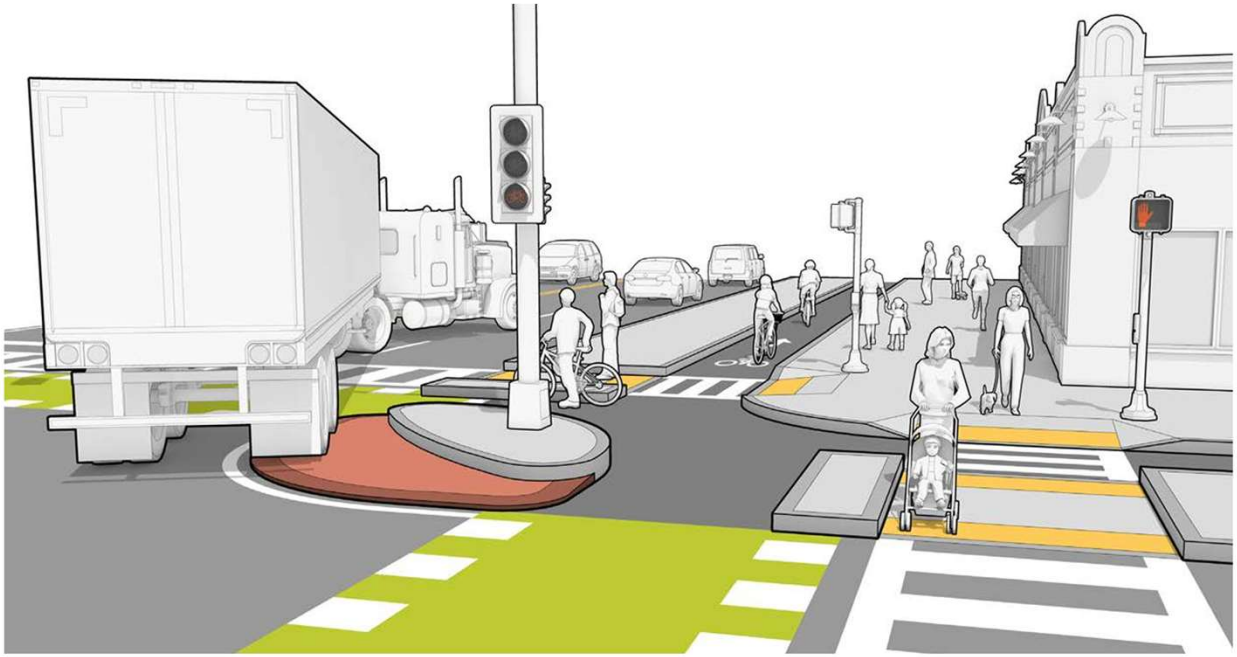
Source: MassDOT Separated Bike Lane Planning & Design Guide



Learn and apply new concepts

Protected intersection examples





Source: MassDOT Separated Bike Lane Planning & Design Guide

Learn and apply new concepts

Protected intersection examples

Exhibit 10.33. Widened and shared-use crossing at roundabout.

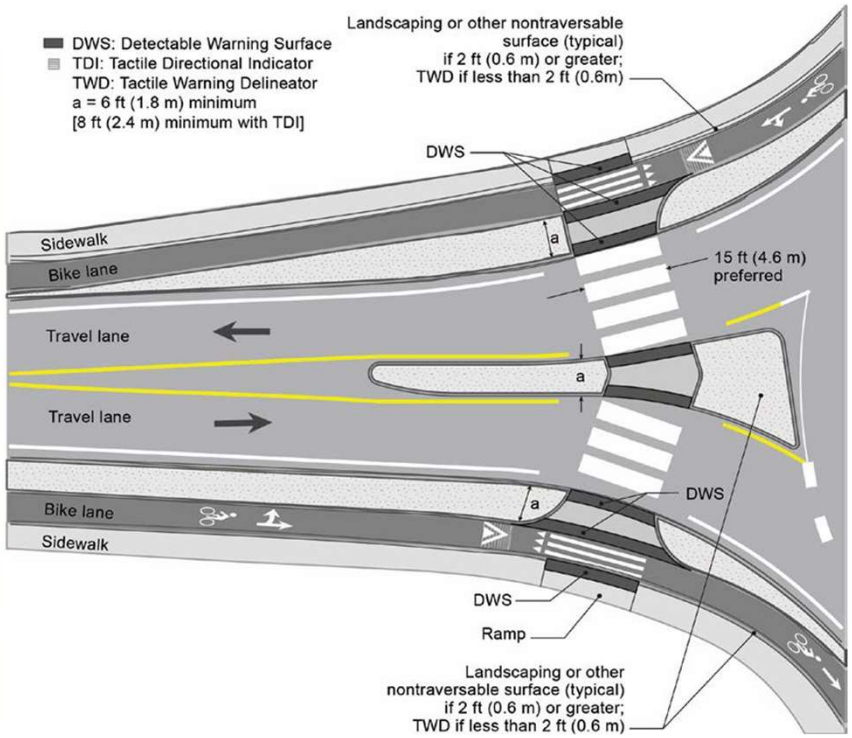
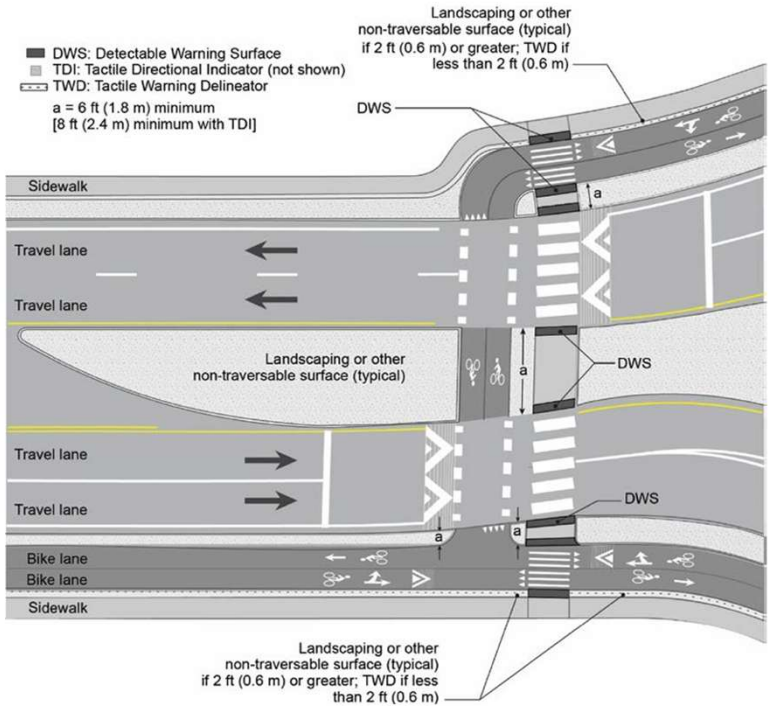


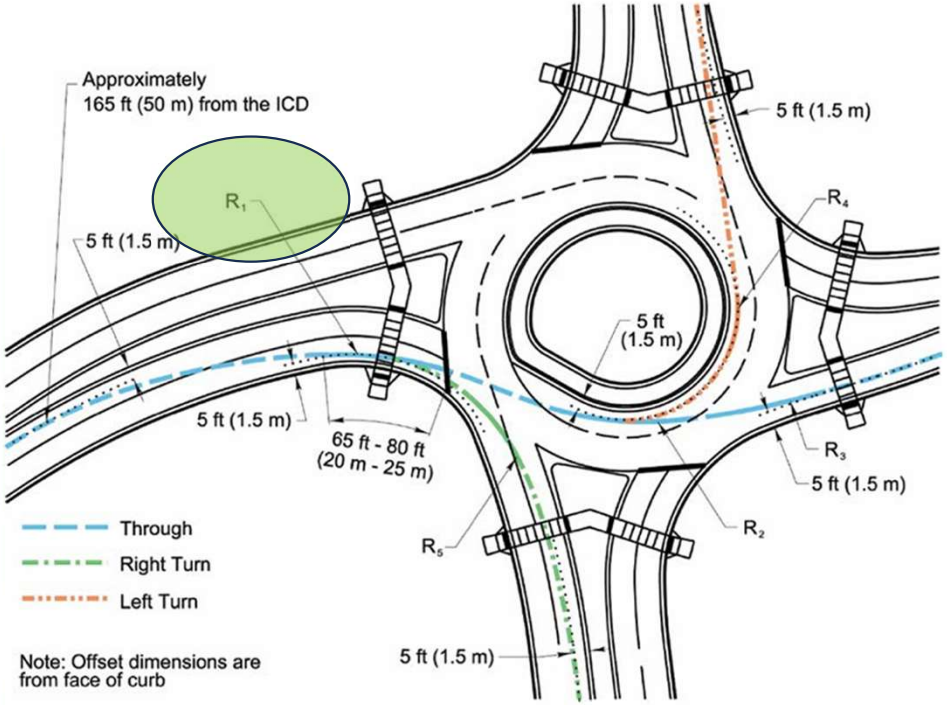
Exhibit 10.32. Separate pedestrian and bicycle crossings at a multilane roundabout entry with two-way cycle track.



Source: NCHRP Research Report 1043 Guide for Roundabouts

Understand “precision” versus “accuracy”

Exhibit A.4a. Fastest vehicle paths for a multilane roundabout.



SOURCE: Adapted from Georgia Department of Transportation (*1*).

US Customary

Equation 9.3

$$V = 3.4415R^{0.3861}, \quad for\ e = +0.02, R \leq 400\ ft$$

Equation 9.4

$$V = 3.4614R^{0.3673}, \quad for\ e = -0.02, R \leq 400\ ft$$

where

V = predicted speed (mph),

R = radius of curve (ft), and

e = superelevation (ft/ft).

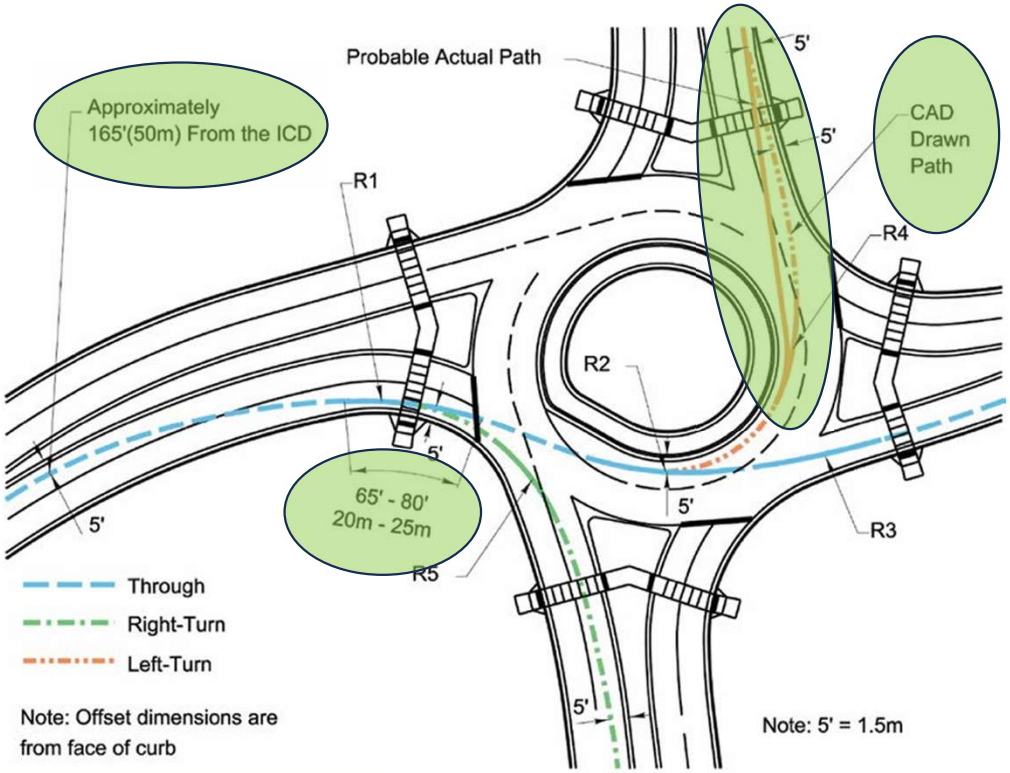
V=30.987 mph--Calculated

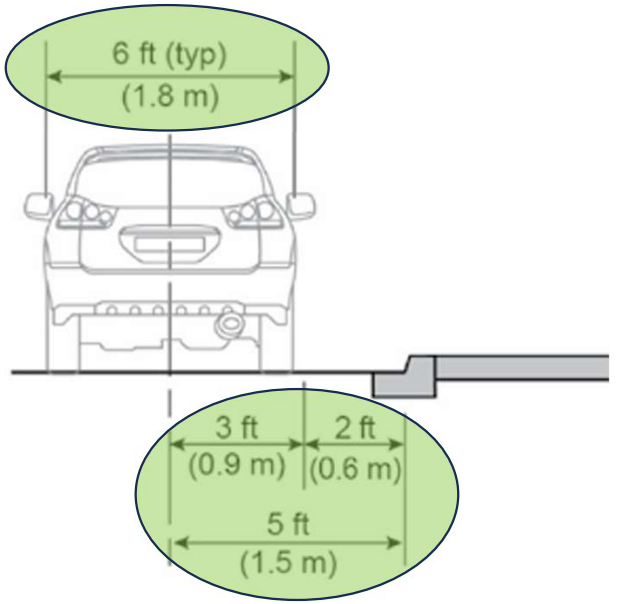
V=31.0 mph--Rounded

Is this a fatal flaw?

Source: NCHRP Research Report 1043 Guide for Roundabouts

Understand “precision” versus “accuracy”





What are all the project considerations?

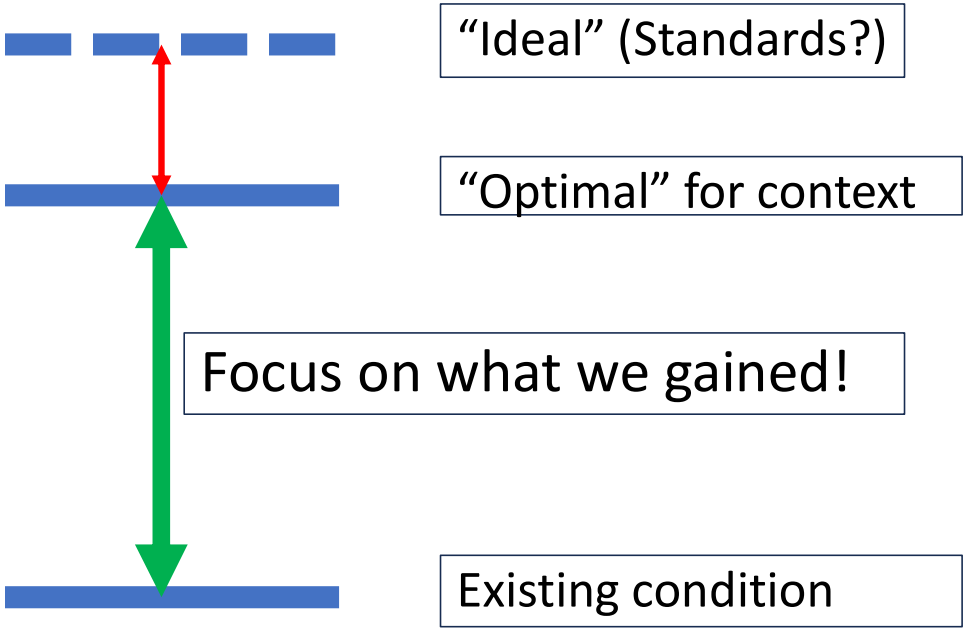
Source: NCHRP Research Report 1043 Guide for Roundabouts

Don’t hold out for perfection

- Focus on “optimal” solutions and how to attain the greatest value for the project context
- Don’t get locked up on what is missing

“…a roundabout design that is less than ideal could still provide superior safety and operational performance over other alternatives…”

NCHRP Research Report 1043
Guide for Roundabouts



Closing

Caltrans policy supports performance-based approaches to reduce severe and fatal crashes...

…You have the opportunity in your planning and design decisions to save lives and money while you do it.

Challenge yourself with continual learning to gain confidence in making planning and design decisions!

Questions

Brian L. Ray

brianlray1962@outlook.com