Confused about Signing and Marking at Multi-Lane Roundabouts?

Safety Impacts of Signing and Pavement Markings on Property-Damage-Only Crashes at Multi-Lane Roundabouts

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INTRODUCTION

OUTLINE

A. INTRODUCTION – HUMAN FACTORS

B. BEST PRACTICES & MUTCD
   1. Lane Use Assignment
   2. Circulatory Lane Lines
   3. Yield Lines

C. CASE STUDIES
   - In-Service Design Review and Modification Results
   - Optimization Process
Multi-lane roundabouts pose challenges for signing and marking best practices.
It’s been a **headache** for the Police Department.

Responded to 136 accidents at the location in 12 months

“We’ve haven’t had that number of wrecks in the last 10 years…”

Police Captain
INTRODUCTION

Information Processing:

- Driver behavior is strongly influenced by geometrics signs and pavement markings.

Key:
- Simplify Decision-Making
- Provide Clear - Concise Information
- Intuitive & Easy to Understand

“Education at the Point of Contact”
Information Processing

“Negotiating intersections involves the absorption and processing of visual information presented to the driver, primarily by the signs and pavement markings”
Markings and Signs should be designed and located to:

- Minimize detection, reading and processing time
- Maximize comprehension
- “Adhere to Drivers Expectations”
INTRODUCTION - EXAMPLES

Information Overload

IT'S EASY TO OVER DO IT!
INTRODUCTION - EXAMPLES

- Information Overload
• “Cookbook approach not advised”

• “Principles should be basis”

INTRODUCTION - EXAMPLES
INTRODUCTION - EXAMPLES

- Minimize detection, reading and processing time
- Maximize comprehension
- Avoid Information Overload
INTRODUCTION

- Minimize detection, reading and processing time
- Maximize comprehension
- Avoid Information Overload
INTRODUCTION – UK (GOOD) EXAMPLE

HUMAN FACTORS RESEARCH

- Place signs according to the importance of their information
- Organize information into larger units with Color and Shape
- Visual Presentation
EXIT SIGNING

Exit Sign Confirms exit leg choice

‘Tilt’ Arrow borrowed from Off-Ramps,
‘Tilt’ Arrow borrowed from Off-Ramps,
Chevron End Shaped Exit Destination Signs.

- Chevron End improve recognition of the direction of the destination
- Efficient Use of Sign Size to Maximize information Delivery

Exit Signing chevron end minimizes detection and provides advance recognition of leg choice
B. MUTCD
MUTCD 2003

Professor Gene Hawkins, Texas A&M Past Chair of NUTCD Committee

“Practice Still Evolving”

- MUTCD is consensus based approach
  - Many voting on content had little or no practical RAB experience
1. Lane Use Assignment
   - Fish Hook or
   - Standard

2. Circulatory Roadway Markings
   - Solid/Skip vs
   - Consistent Line

3. Yield/Entry Markings
   - Edge Line Extended, and Sharks Teeth
   - vs Singular Heavy Demarcation
1. Lane-Use Assignment

- Diagrammatical (Fish Hook) vs Standard
1. MUTCD Lane Use Assignment

Standard = Familiar Driver Convention = driver expectancy

Fish Hook = New Convention = Drivers Un-Familiar
1. MUTCD Lane Use Assignment

Standard within circulating roadway

- Inconsistent – Driver Expectancy?

Fish Hook on Approach,
1. MUTCD Lane Use Assignment

Multi-Lane = High Risk of Information Overload
1. MUTCD Lane Use Assignment

Standard Pavement Marking Arrows

Standard Lane-Use Assignments
2. Circulating Roadway Markings

- Solid and Skip
- Consistent Line Type
- Lane Widths (equal or un-equal)
Drivers behave/react based on learned expectations = “Driver Expectancy”
2. MUTCD Circulatory Roadway Markings

Solid / Skip = Problematic - Violates Driver Expectancy

Consistent Line Type = Driver Expectancy
Solid then skip circulating markings
Consistent arrows on approach and circulating
2. MUTCD Circulatory Roadway Markings

Design Evaluation/Optimization Process

Circulatory Equal widths not recommended:

- Entry to Circulating Alignment important for lane utilization
- Creates Flat Entry Angle and Poor View Angle Left
2. MUTCD Circulatory Roadway Markings

Consistent Circulatory Markings

11’ Inside
17’ Outside

Creates good entry to circulating alignment and effective lane utilization at entry
2. MUTCD Circulatory Roadway Markings

Circulatory Markings:
- Consistent Line Type
- 6’ Seg, 3’Gap
- 11’ Inside
- 18’ Outside
3. Entry Markings / Yield Line
3. MUTCD Entry Markings - Yield Lines

- “edge line extended” line guidance on a highway -
- exacerbates poor view angle left, = flatter entries=merging = Priority Message confused
- Too much information compressed into short distance = Information Overload

Edge Line Extended, and Sharks Teeth
3. MUTCD Entry Markings - Yield Lines

- Simplified Messaging via line types weights & arrangement.
- Improves view angle left,
- Entry priority clear
Design Process Example
Holman Highway Interchange
3. MUTCD Entry Markings - Yield Lines
1. Minimize detection, reading and processing time
2. Maximize comprehension
1. Minimize detection, reading and processing time
2. Maximize comprehension
C. Markings and Signing Modification
Case Studies

1. Entry Area/Yield Line & Circulatory Markings
2. Signing & Circulatory Markings
Clear Pattern of Crashes/Driver Confusion Attributed to Design Principles

Case Study #1

FHWA P2P Program: Data Courtesy of SCDOT Safety Dept.
Case Study #1

Entry Alignment and Natural Path Principles

Existing Confusing Messaging

Before

Singular Bold Priority Line

After
Case Study #1

Circulating Marking Type and Alignment

Existing Confusing Messaging

Before

Clarity in Priority Messaging

AFTER

11'
Case Study #1

Design Optimization

High View Angle = 17 - 20 deg

Looks more like a merge condition

Confuses Priority at Yield Line
Case Study #1

Design Optimization

Yield Line and Circulating Changes together = Sig Improvement

View Angle = 6 deg

Clarifies Priority at Yield Line
5 yr ave crash rate reduced 50% - a good win in my book.

I’m sure pavement markings may need refreshing after 5 years but I was pleased with the results considering the geometry remains the same.

...the crash reductions we achieved are strong evidence of the importance of optimized markings.

Thanks for all your assistance

Joey Riddle, PE
Safety Program Engineer
SCDOT
Case Study #2

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**Effect of Signing and Striping on the Safety of a Two-Lane Roundabout**

Minnesota Traffic Observatory, University of Minnesota  
John Boudas  

City of Richfield  
Krisson Asher  

MTJ Engineering  
Kirk Johnson  

Hennepin County  
Joe Koeg  

MnDOT  
Mike Shekow  

**University of Minnesota**
Solid then skip circulating markings
Consistent arrows on approach and circulating
80% Reduction of wrong movements from outside lane

Consistent circulating markings
Roundabout Design –

25-30% IMPROVEMENT YIELDING RATES w/R1-6

Source: John Hourdos
Minnesota Traffic Observatory, University of MN
Case studies show:

- Safety benefits were derived by adhering to human factors and engineering principles to implement:
  1. simplified, less dense signing;
  2. clarity in pavement marking line types and weight, both at entry and circulating; and
  3. correct positioning of entry, circulating, and exit lane markings relative to each other

- Some of the recommendations within the 2009 MUTCD contradict these principles.
Driver behavior is strongly influenced by signs and pavement markings.

- Simplify Decision-Making
- Provide Clear - Concise Information
- Intuitive & Easy to Understand
- Adhere to Driver Expectations
Thank You/Questions

Mark T. Johnson,
MTJ Roundabout Engineering
- Key Contributor to WIDOT Roundabout Design Program
- Co-Author of FHWA 2010 Roundabout Guide
- FHWA Authorized P2P Reviewer