Introduction to the FHWA Handbook for Designing Roadways for the Aging Population

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Acknowledgements

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  – FTA
  – FRA
  – PBIC
Presentation Agenda

• Overview of Handbook
• Part I – Treatments and Recommendations
• Part II – Rationale and Supporting Evidence
• Appendices
• Discussion
Overview – Brief History

• Increase in aging persons in the population and as road users

• Steadily increasing proportion of drivers and pedestrians with declining abilities to:
  – See and hear
  – Walk or operate a vehicle
  – Process information and make decisions
Overview – Brief History

  – First practical information source for highway designers and engineers that linked age-related declines to engineering treatments

• Practitioner feedback led to *Highway Design Handbook for Older Drivers and Pedestrians* (2001)
Overview – *Handbook* Content

- Current *Handbook* is third edition in series
- Key changes
  - New title: *Handbook for Designing Roadways for the Aging Population*
  - Inclusion of newer research
  - True HTML version in addition to print and PDF
Overview – *Handbook Content*

- Similar layout to previous edition
  - Front matter and Chapter 1: introduction, overview, and worksheets
  - Part I (Chapters 2-6): treatments & recommendations
  - Part II (Chapters 7-11): rationale & supporting evidence
  - Appendices: tech notes, glossary, references
- Similar focus on five categories of treatments
Overview – *Handbook* Content

• Chapter 1: How to Use the *Handbook*
  – Description of *Handbook* organization
  – Definition of relationship codes to key references
  – Definition of abbreviations of key references
  – List of additional resources
  – Worksheets and procedure for determining when to implement *Handbook* treatments
Design Element — each design element is numbered to allow for quick reference.

Category — identifies the current section of the guide.

Recommendations — each recommendation is identified with a letter for quick reference.

Figures — figures are used throughout the guide to illustrate the recommendations. They are numbered for easy reference.

Relationship Codes — each recommendation includes numbered references to supporting information in the design guides most frequently used by practitioners. A legend at the bottom of the page defines the relationship codes.

References: MUTCD, NCHRP 900-9-1

Street Name Signs

A. Letter Heights and Sign Boarder

To accommodate the reduction in visual acuity associated with increasing age, minimum letter heights of 6 in for uppercase letters and 4.5 in for lowercase letters are recommended for use on ground-mounted street-name signs (MUTCD D5.1-1, as shown in Figure 18) on all roads where the posted speed limit is 15 mph or below. On all roads where the posted speed limit is greater than 25 mph, letter heights of 8 in for uppercase letters and 6 in for lowercase letters should be used.

The use of overhead-mounted street-name signs is recommended at major intersections as a supplement to ground-mounted street-name signs. Minimum letter heights of 12 in for uppercase letters and 9 in for lowercase letters are recommended by the MUTCD.

In the design of street-name signs, the use of larger letter heights may require a larger sign panel. The border may be eliminated on street-name signs if necessary to minimize sign panel size while accommodating the larger letter sizes.

References: MUTCD, NCHRP 900-9-1

Advance Street-Name Plaque

Where an advance intersection warning sign is installed (MUTCD W2-1), it should be accompanied by an advance street name plaque (W16-8P) using minimum letter heights of 6 in for uppercase letters and 4.5 in for lowercase letters (see Figure 19). Where an advance traffic control W2-5 series is installed on a multi-lane approach, an advance plaque (W16-8P or W16-3A), using the same minimum letter height specified above, should be considered.

References: MUTCD, NCHRP 900-9-1

Interpretations, Experimental, and Changes

REFERENCES LEGEND
1. consistent with MUTCD
2. preferred among existing guides
3. new application of the practice
4. new application of current practice
5. permissible only in accordance with MUTCD section 5A.3.3
6. more specific, detailed or stringent

Handbook for Designing Roadways for the Aging Population
Part I – Treatments

• One treatment category per chapter
  – Chapter 2: Intersections
  – Chapter 3: Interchanges
  – Chapter 4: Roadway Segments
  – Chapter 5: Construction/Work Zones
  – Chapter 6: Highway-Rail Grade Crossings
## Part I – Treatments

<table>
<thead>
<tr>
<th>Category</th>
<th>Proven Practices</th>
<th>Promising Practices</th>
<th>Total Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intersections</td>
<td>16</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>Interchanges</td>
<td>6</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Roadway Segments</td>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Work Zones</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Highway-Rail Grade Crossings</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33</strong></td>
<td><strong>18</strong></td>
<td><strong>51</strong></td>
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</tbody>
</table>
Chapter 2 – Intersections

• 16 Proven Practices and 8 Promising Practices, including:
  – Intersection design (skew angle, reduced LT conflict)
  – Channelization
  – Curb design, radius, and delineation
  – Signalization for left- and right-turn movements
  – Signing
  – Pedestrian crossing treatments
  – Roundabouts
Chapter 2 – Intersections

• Intersecting Angle
  – 90 degrees is preferred; 75 degrees is allowed, but turning restrictions may be needed
Chapter 2 – Promising Practices

• Signal Head Visibility
  – One signal head per lane, centered over each lane
  – Shared signal for left turns if using green ball, or separate signal using flashing yellow arrow

Image Credit: Marcus Brewer, Texas A&M Transportation Institute
Chapter 3 – Interchanges

- 6 Proven Practices and 2 Promising Practices:
  - Exit signs and markings
  - Freeway entrance traffic control devices
  - Delineation
  - Acceleration/deceleration lane design
  - Interchange lighting
  - Restricted or prohibited movements
  - Route shield markings at major freeway junctions
  - Wrong-way driving countermeasures
Chapter 3 – Interchanges

• Freeway Entrance Traffic Control Devices
  – Freeway Entrance guide sign recommended
  – Additional signs & markings for adjacent entrance/exit ramps
  – Diagrammatic entrance signs
Chapter 4 – Roadway Segments

• 4 Proven Practices and 6 Promising Practices:
  – Horizontal and vertical curves
  – Passing zones
  – Lane control devices
  – Lane drop markings
  – Contrast markings on concrete pavement
  – Most retroreflective markings available
  – Curve warning markings
  – High friction surface treatments
  – Road diets
Chapter 4 – Roadway Segments

• Horizontal Curves
  – Maintain white edge lines to specified contrast level
  – Use RRPMs on centerline for large radii and to improve nighttime wet pavement visibility
  – Use chevrons to provide additional guidance

Image Credit: Adam Pike, Texas A&M Transportation Institute
Chapter 5 – Construction/Work Zones

• 5 Proven Practices and 2 Promising Practices:
  – Signing and advance warning
  – Portable changeable (variable) message signs
  – Channelization (path guidance)
  – Delineation of crossovers/alternate travel paths
  – Temporary pavement markings
  – Increased letter height for temporary signs
  – Work zone road safety audit
Chapter 5 – Construction/Work Zones

• Portable Changeable Message Signs
  – No more than two phases
  – Each phase displayed $\geq$ 3 s
  – Units of information:
    • No more than one per line
    • No more than three in single phase
    • No more than four in two phases
Chapter 6 – Highway-Rail Grade Crossings

• 2 Proven Practices:
  – Passive traffic control devices
  – Lighting
Chapter 6 – Highway-Rail Grade Crossings

- Passive Traffic Control Devices
  - Post-mounted delineators spaced 50 ft or closer
Part II – Rationale and Supporting Evidence

• One treatment category per chapter
  – Chapter 7: Intersections
  – Chapter 8: Interchanges
  – Chapter 9: Roadway Segments
  – Chapter 10: Construction/Work Zones
  – Chapter 11: Highway-Rail Grade Crossings
Part II – Rationale and Supporting Evidence

Intersecting Angle (Skew)

There is broad agreement that right-angle intersections are the preferred design. Decreasing the angle of the intersection makes detection of and judgments about potential conflicting vehicles on crossing roadways much more difficult. In addition, the amount of time required to maneuver through the intersection increases, for both vehicles and pedestrians, due to the increased pavement area. However, there is some inconsistency among reference sources concerning the degree of skew that can be safely designed into an intersection. The Green Book states that although a right-angle crossing normally is desired, an angle of 60 degrees provides most of the benefits that are obtained with a right-angle intersection. Subsequently, factors to adjust intersection sight distances for skewness are suggested for use only when angles are less than 60 degrees (AASHTO, 2011). However, another source on subdivision street design states that: “Skewed intersections should be avoided, and in no case should the angle be less than 75 degrees” (Institute of Transportation Engineers [TEH], 1984). The Traffic Engineering Handbook (TEH, 1999) states that: “Crossing roadways should intersect at 90 degrees if possible, and not less than 75 degrees.” It further states that: “Intersections with

Table 9. Cross-References of Related Entries for Intersecting Angle (Skew).

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Sections 2B.4, 4D.06, 40.09, 40.12, 40.13</td>
<td>Pg. 5-9, Final Paragraph</td>
<td>Pg. 9-5, 3rd bulleted item</td>
<td>Pg. V-25-V-26, Sect. on Strategy 3.1B10: Reduce Intersection Angle</td>
<td>Pg. 19, Top fig.</td>
<td>Pg. 243, 5th Principle Pg. 243, Sect. on Alignment Design</td>
</tr>
<tr>
<td>Pg. 9-10, Final Paragraph</td>
<td>Pg. 9-16, Final Paragraph</td>
<td>Pg. 9-25 through 9-27, Sect. 9.4.2 Alignment</td>
<td>Pg. 21, Item 5</td>
<td>Pg. 30, Para. 1 &amp; top three figs.</td>
<td>Pg. 21, Item 5</td>
</tr>
<tr>
<td>Pgs. 9-19 through 9-20, Sect. 9.3.3 Multiway Intersections</td>
<td>Pgs. 9-57 through 9-63, Tables 9-15 and 9-16</td>
<td>Pg. 25, Para. 2</td>
<td>Pg. 31, Para. 3 &amp; bottom left fig.</td>
<td>Pg. 25, Para. 2</td>
<td></td>
</tr>
<tr>
<td>Pgs. 9-42, Sect. on Oblique-Right Turns</td>
<td>Pgs. 9-47 through 9-68, Sects. on Diversional Islands, Refuge Islands, &amp; Island Size and Design</td>
<td>Pg. 30, Para. 1 &amp; top three figs.</td>
<td>Pgs. 42-44, Sect. on Angle of Intersection</td>
<td>Pg. 31, Para. 3 &amp; bottom left fig.</td>
<td>Pg. 31, Para. 3 &amp; bottom left fig.</td>
</tr>
<tr>
<td>Pgs. 9-98 Figure 9-37</td>
<td>Pgs. 9-112, Sect. on Oblique-Right Turn with Corner Islands</td>
<td>Pg. 45, Fig. 4-5</td>
<td>Pgs. 42-44, Sect. on Angle of Intersection</td>
<td>Pg. 45, Fig. 4-5</td>
<td>Pg. 45, Fig. 4-5</td>
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<tr>
<td>Pgs. 9-113 through 9-114 Table 9-18</td>
<td>Pgs. 9-54, Sect. 9.5.4 Effect of Skew</td>
<td>Pgs. 71, Top two figs.</td>
<td>Pgs. 42-44, Sect. on Angle of Intersection</td>
<td>Pgs. 71, Top two figs.</td>
<td>Pgs. 71, Top two figs.</td>
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<td>Pgs. 9-55, Figure 9-22</td>
<td>Pgs. 9-151 through 9-153, Sect. 9.8.5 Effect of Skew</td>
<td>Pgs. 100-105, Intersect. Nos. 7-9</td>
<td>Pgs. 243, 5th Principle</td>
<td>Pgs. 148-149, Intersect. No. 35</td>
<td>Pgs. 243, 5th Principle</td>
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</table>
Part II – Rationale and Supporting Evidence

• Summarizes empirical work related to the treatments of interest
• Naturalistic and controlled field studies, laboratory studies, crash data, etc.
• Additional figures and tables to highlight specific findings

Table 39. Design-Speed Recommendations For Modern Roundabouts By Roadway Class (Wallwork, 1999).

<table>
<thead>
<tr>
<th>Roadway Classification</th>
<th>Roundabout Design Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Road</td>
<td>12-15</td>
</tr>
<tr>
<td>Collector Road</td>
<td>15-18</td>
</tr>
<tr>
<td>Secondary Arterial</td>
<td>18-21</td>
</tr>
<tr>
<td>Major Arterial</td>
<td>21-23</td>
</tr>
<tr>
<td>Rural Roadway</td>
<td>Maximum 25</td>
</tr>
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</table>
Appendices

• Supplemental Technical Notes
• Glossary (~ 160 terms, acronyms, abbreviations)
• References (> 600 research reports, guidelines, policy documents, and journal articles)

APPENDIX C
Glossary

AADT. Annual Average Daily Traffic.
AASHTO. American Association of State and Highway Transportation Officials.
Ambient conditions. The visual background or surrounding atmospheric and visibility conditions.
Angular motion sensitivity. The ability of an observer to detect changes in the apparent distance and direction of movement of an object as a function of the change in the angular size of the visual stimulus on the observer’s retina.
Angular velocity threshold. The rate of change in angular size of a visual stimulus that is necessary for an observer to discern that an object’s motion has increased or decreased.
Annual average daily traffic (AADT). The total volume passing a point or segment of a highway facility in both directions for 1 year divided by the number of days in the year.
Apron. The mountable portion of the central island of a roundabout that is adjacent to the circulatory roadway. An apron is generally required on smaller roundabouts to accommodate the wheel tracking of large vehicles.
ASTM. American Society for Testing and Materials.
Attraction signing. Information-supplemental signs featuring logos or verbal messages pointing out places to visit or food, gas, and rest stop locations.
Barnes Dance timing. Type of exclusive signal timing phase where pedestrians may also cross diagonally in addition to crossing either street. Also referred to as scramble timing.
Brake reaction time. The interval between the instant that the driver recognizes the presence of an object or hazard on the roadway ahead and the instant that the driver actually applies the brakes.
Conclusion

The *Handbook for Designing Roadways for the Aging Population* provides an update to a long-standing FHWA resource to help practitioners consider aging road users in their designs.

While the *Handbook* does not constitute a standard, it does provide a wide range of recommendations and references on treatments to consider.
How to Obtain

• Electronic copy:
  – Will soon be available from the FHWA Office of Safety Website
  – PDF and HTML versions

• Printed copy:
  – Can order from FHWA Office of Safety
Discussion / Q&A
Thank you for attending!

• Marcus A. Brewer, P.E.
  (979) 845-7321
  m-brewer@tamu.edu

• Handbook and other resources
  – http://safety.fhwa.dot.gov/older_users/#training