10 ISSUE BRIEFS

Older Road Users at Intersections

In the next 30 years, there will be a significant shift in the demographic profile of the United States according to U.S. Census Bureau projections. The U.S. population 65 or older was 12.5 percent in 2007.[1] The U.S. Census Bureau estimates that 20.4 percent of the population will be 65 or older by 2040, an increase of approximately 70 percent.[2] The overall demographic shift is shown in Figure 1 for the years 2000 and 2040.

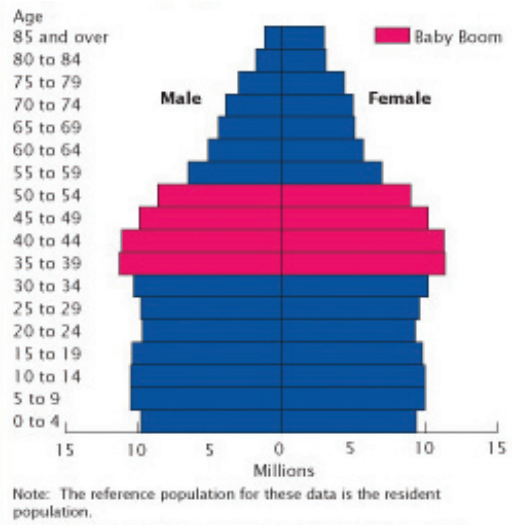

Figure 1: Population by age and sex: 2000

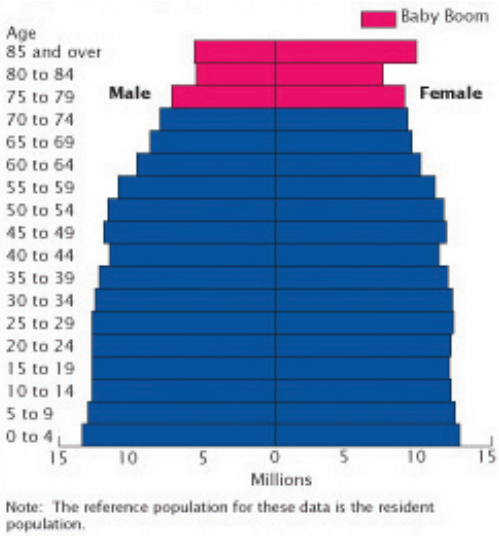

Figure 2: Population by age and sex: 2040

Source: He, Wan, Manisha Sengupta, Victoria A. Velkoff , and Kimberly A. DeBarros, U.S. Census Bureau, Current Population Reports, P23-209, 65+ in the United States: 2005, U.S. Government Printing Office, Washington, DC, 2005.

This historical trend of the older population increasing faster than the general population will continue through the 21st century. The most recent census projections indicate a 78 percent increase of the older population while the total population increases 18 percent between 2010 and 2030.[3]

Overview – Older Road Users

Most Americans are dependent on the automobile to satisfy their mobility needs, especially in suburban and rural areas of the country. According to national transportation survey data, 90 percent of trips taken by older adults are by personal vehicle. Of that 90 percent, 70 percent

1. U.S. Census Bureau, American Community Survey, 2005-2007 American Community Survey 3-Year Estimates, Table S0101. Age and Sex. http://factfinder.census.gov/servlet/STTable?_bm=y&-geo_id=01000US&-qr_name=ACS_2007_3YR_G00_S0101&-ds_name=ACS_2007_3YR_G00_
2. He, Wan, Manisha Sengupta, Victoria A. Velkoff , and Kimberly A. DeBarros, U.S. Census Bureau, Current Population Reports, P23-209, 65+ in the United States:2005, U.S. Government Printing Office, Washington, DC, 2005. Figure 2.6: Percent Aged 65 and Over of the Total Population: 2000 to 2050, pg. 13. Original Source: Percent Aged 65 and Over of the Total Population: 2000 to 2050.
3. Ibid.

U.S.Department of Transportation
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involve the older adult driving the vehicle.[4]

The increased likelihood of an older road user being injured or killed in a crash is the real safety concern. Compared with an overall fatality rate of 2 per 1,000 crashes, persons ages 65 to 74 have a fatality rate of 3.2. For those 75 to 84, the rate is 5.3, and at 85 and above it climbs to 8.6.[5] Examining safety from a fatality per licensed driver (Figure 3) or per mile traveled (Figure 4) perspective; the increase is dramatic for older road users. This is largely due to increased susceptibility to injury, particularly chest injuries, and medical complications among older drivers rather than an increased tendency to get into crashes.[6]

The rate of pedestrian deaths per 100,000 people in 2007 was almost twice as high for people 70 and older combined (2.7 per 100,000) than for those younger than 70 combined (1.4 per 100,000).[7]

In 2007, 2,202 of 8,703 fatalities at intersections (25 percent) involved older persons, while older persons make up only 12.4 percent of the resident U.S. population as shown in Table 1. Older persons are overrepresented by a factor of 2:1 for the over 65 age group. For the over-85 age group, there is an over-representation of 3 to 1 in intersection fatalities compared to the age group.

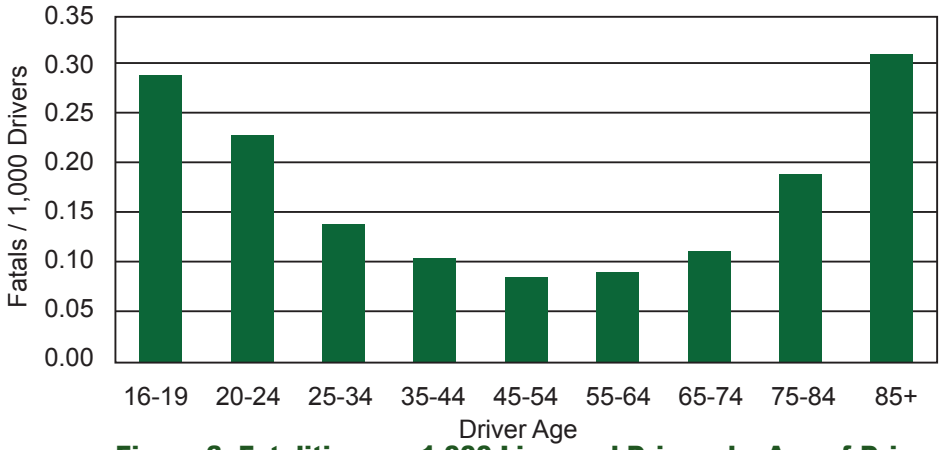

Figure 3: Fatalities per 1,000 Licensed Drivers by Age of Driver

Source: National Cooperative Highway Research Program. Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 9: A Guide for Reducing Collisions Involving Older Drivers. Transportation Research Board, Washington, DC. 2004, pg. III-2.

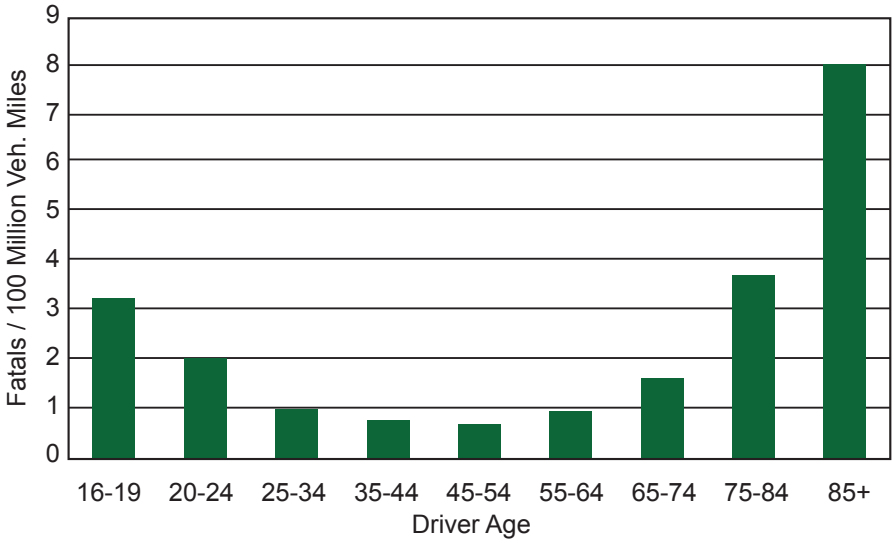

Figure 4: Fatalities per 100 Million Vehicle Miles by Age of Driver

Source: National Cooperative Highway Research Program. Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 9: A Guide for Reducing Collisions Involving Older Drivers. Transportation Research Board, Washington, DC. 2004, pg. III-2.

Issues Facing Older Road Users

Each person ages differently. As age increases, older people develop physical, sensory, and cognitive limitations that often restrict their ability to drive, walk, or use public transportation. Illnesses, medications, and impairments make it difficult for them to use the transportation they need. Aging affects a variety of skills needed for safe driving. Challenges that commonly affect a person's mobility as they age include the following:

- Reductions in strength, flexibility, hearing, and range of motion caused by arthritis or other conditions can negatively impact driving.
- Many visual functions—including static and dynamic visual acuity, contrast sensitivity, and glare sensitivity—deteriorate with age.
- Normative aging most often affects cognitive changes, such as working memory, selective attention, reaction time, and processing speed.[8]

4. National Cooperative Highway Research Program. Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 9: *A Guide for Reducing Collisions Involving Older Drivers*. Transportation Research Board, Washington, DC 2004, pg. III-1.
5. Ibid.
6. Insurance Institute of Highway Safety, Fatality Facts: Older People http://www.iihs.org/research/fatality_facts_2007/olderpeople.html.
7. FHWA, Office of Safety. Older Road Users Web Page. http://safety.fhwa.dot.gov/older_users/#training.
8. National Cooperative Highway Research Program. Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 9: A Guide for Reducing Collisions Involving Older Drivers. Transportation Research Board, Washington, DC 2004, pg. II-1.

Table 1: Older Population as Related to Older Person Intersection Fatalities

	Population		Intersection Fatalities		
	Number	Percentage	Number	Percentage	
					Over-representation Factor
Age 65-74 population	19,051	6.3 %	818	9.4 %	1.49
Age 75-84 population	13,138	4.3 %	931	10.7 %	2.49
Age 85+	5,334	1.7 %	453	5.2 %	3.06
	37,523	12.4 %	2,202	25.5 %	2.06

* 19 fatalities are unknown and are not included in the total percentage calculation.

Today's generation of older Americans drive farther and more often. While older drivers are among the safest road users, the aging process makes driving safely more difficult for some. At the same time increasing frailty put older road users at greater risk of serious injury.

The intersection environment requires complex perception-reaction and speed-distance judgments under time constraints for pedestrians, bicyclists, motorcyclists, and drivers. This scenario for intersection operations can be more problematic for older road users than for their younger counterparts. Highway design and traffic controls can be improved to better meet the aging population's needs.

Policy, Program and Project Development Considerations

To address issues associated with older road users, multiple strategies should be developed within an agency to organize and focus efforts. Those strategies may include:

- Establish a broad-based coalition to plan to address older adults' transportation needs.[9]
- Provide supplemental training to develop staff skills design for older road users.
- Revise/update agency policies, processes and procedures to better address the needs of older road users.
  - o Incorporate methods to reduce vehicle travel speeds in areas where vehicles and pedestrians interact and where older road users need more time to make decisions and execute changes.
  - o Make the physical layout of transportation systems easy to navigate for older road users who have lost some of their dexterity.
  - o Make it easy for older drivers and pedestrians to notice, read, understand, and respond to visual cues and information.[10]
- Modify and/or adapt design guidelines to address the needs of older road users.
- Collect data that reinforces knowledge-based decision making concerning the allocation of resources to improve intersection performance for older road users
- Establish, within an overall asset management program, the allocation of resources and timelines to make improvements/upgrades for older road users through either new construction, reconstruction, or regular maintenance activities.

During the project development phase of each project involving new construction or reconstruction of an existing intersection, practitioners should seek answers to the following questions:

- Is there a demonstrated crash problem with older drivers or pedestrians?
- Has any aspect of design or o perations at the project location been associated with complaints to local or state officials from older road users?
- Are you aware of a potential safety problem, either through personal observation or agency documentation, based on your own engineering judgment?
- Is this project located on a direct link to a travel origin or destination for which older people constitute a significant proportion of current road users?
- Is the project located in an area experiencing an increase in the proportion of residents aged 65 and older?
- Is this project located in an area that will constitute a significant proportion of future older road users, perhaps where there is a planned medical center or senior housing project nearby?

Engineering Applications To Support Older Road Users

The solutions to reduce older road user crashes incorporated into this briefing sheet have been sourced from the FHWA *Older Driver Design Handbook*, AARP *Planning for Complete Streets for an Aging America*, and National Cooperative Highway Research Program Report 500, Vol. 9: *A Guide for Reducing Collisions Involving Older Drivers*. These solutions should benefit all

9. Ibid.

10. Lynott, Jane, et al. *Planning Complete Streets for an Aging America*, AARP Washington, DC 2009.

road users, not just older people. It is acknowledged that intersection projects may have constraints, such as high construction costs, the need for additional right-of-way, local access management requirements, sight distance and other issues that may preclude the use of the suggested solutions. In all cases, professional engineering judgment must be used to determine the use or non-use of a particular solution set.

Design

- Provide left turn lanes at intersections if right of way allows.
- Use positive offset of opposing left-turn lanes to increase the safety to assist older drivers to position themselves within the intersection before initiating a left turn.
- Use a minimum receiving lane width of 12 ft. accompanied, wherever practical, by a minimum 4-ft. shoulder.
- In the design of new facilities or redesign of existing facilities where right-of-way is not restricted, all intersecting roadways, and railroad grade crossings should meet at a 90-degree angle. Where right-of-way restrictions are present, intersecting roadways, and railroad grade crossings should meet at an angle of no less than 75 degrees.
- Where roadways intersect at 90 degrees and are joined with a simple radius curve, provide an effective cornering radius in the range of 25 ft. to 30 ft. to: (a) facilitate vehicle turning movements, (b) moderate the speed of turning vehicles, and (c) avoid unnecessary lengthening of pedestrian crossing distances.
- For left- and right-turn lane treatments, provide raised channelization with sloping curbed medians.
- Provide or upgrade lighting at intersections, horizontal curves, and railroad grade crossings.
- Provide improved traffic control in work zones to create common driver expectancy, including the areas of:
  - Advance signing for lane closures.
  - Variable message sign practices.
  - Channelization practices.
  - Alternate travel paths.
  - Temporary pavement markings.
- Provide separate right turn lanes if right of way allows.
- Provide a continuous sidewalk through railroad grade crossings, again intersecting at a 90 degree angle and no less than a 75 degree angle. This sidewalk shall have grade crossing protection, either separate or combined with the roadway crossing protective device.

Traffic Control Signs

- Install larger (oversized) regulatory and warning signs.
- Use signs fabricated using high intensity retro-reflective or fluorescent prismatic sheeting.
- Use redundant street-name signing for major intersections with an advance street-name sign placed upstream of the intersection at a midblock location.
- Increase sign lettering size for street names, directional signing, and advance intersection signing.
- Install more overhead-lighted advance signing prior to major intersections. Include overhead lane-use control signs to help drivers get into the proper lane in advance of the intersection.
- Use overhead-mounted street name signs as a supplement to post-mounted street-name signs; when using advance intersection warning signs, accompany the signs with an advance street name plaque.
- Consider sign placement and mounting height in design of intersection and approaches.
- When different street names are used for different directions of travel on a crossroad, the names should be separated and accompanied by directional arrows on both advance midblock and intersection street-name signs.
- Where appropriate (e.g. dual turn lanes or where a through lane becomes a turn-only lane) use lane-use control signs at intersections on a signal mast arm or span wire.
- Where appropriate, use the **LEFT TURN YIELD ON GREEN** ● with protected-permitted mode left-turn signal phases.
- Where practical, use a redundant upstream **LEFT TURN YIELD ON GREEN** ● sign at the start of the left-turn lane, in addition to using the same sign adjacent to the signal face, to remind left-turning drivers of the requirement to yield to oncoming traffic before turning on green.
- Where a Right-Turn-On-Red (RTOR) is prohibited, use more than one **NO TURN ON RED** sign. A supplemental **NO TURN ON RED** sign should be placed on the overhead mast arm and at a location on either the near or opposite side of the intersection where it will be most conspicuous.
- At skewed intersections where the approach leg to the left intersects the driver's approach leg at an angle of less than 75 degrees, prohibit RTOR.

Pavement Markings

- Treat the median and island curbsides and curb horizontal surfaces with retro-reflectorized markings and maintain them at a minimum luminance contrast level.
- Provide more visible and durable pavement markings.
- Use retroreflective raised pavement markings.
- Consider recessed tape markings, oversized glass beads in paint and/or profile thermoplastic pavement markings.
- Use wider pavement markings.
- Use transverse pavement striping or rumble strips (if noise for surrounding residences is not a problem) upstream of stop-controlled intersections where there may be sight restrictions, high approach speeds, or a history of ran-STOP sign crashes. This treatment can also be used in rural areas where a STOP sign is encountered after a long distance with no traffic control devices.
- Delineate median noses using retro-reflective treatments to increase visibility and improve driver understanding.
- Where appropriate (e.g. for exclusive left- or right-turn lanes) use lane-use arrow pavement markings at appropriate distances in advance of a signalized intersection.
- Delineate the turning path of vehicles through intersection.

- Provide high visibility crosswalks.
- Provide advance **TRAFFIC SIGNAL AHEAD** pavement markings.
- Consider wet and nighttime visibility/ conspicuity of longitudinal pavement marking on intersection approaches.

Traffic Signal Operations

- Where minimum sight-distances cannot be achieved or where a pattern of permitted left-turn crashes occurs, eliminate permitted left turns and use protected-only left-turn operations.
- Consider the use of a separate signal face to control turning phase versus through movements;
- Use a leading protected left-turn phase wherever protected left-turn signal operation is implemented as opposed to a lagging protected left-turn phase.
- Consider the use of a leading protected left-turn phase wherever protected-only left-turn signal operation is implemented as opposed to a lagging protected left-turn phase. Lagging left-turn operations, however, are more beneficial for reducing vehicular/older pedestrian conflicts since the pedestrian crossing is normally completed before the beginning of the lag-left green arrow display.
- Consider providing protected left-turn signal phase at high-volume intersections (NCHRP 500).
- Consider providing flashing yellow arrow (FYA) as an alternative to circular green for permissive display for left turn movements due to a high level of understanding and correct response by left-turn drivers and a lower fail-critical rate than the circular green (NCHRP 493).
- Use of red left arrows instead of a circular red indication at left-turn signals.
- To accommodate age differences in perception-reaction time, use the yellow change interval and all-red clearance interval formulae in the Institute of Transportation Engineers (ITE) publication titled, *Traffic Engineering Handbook, Sixth Edition* (or subsequent recommended practice by ITE).
- Assume slower walking speeds for signal-clearance timing in the range of 3.5 feet per second if actual crossing times are not available. Time the clearance interval for a full crossing, or to a median, but not just to the middle of the farthest lane.

Traffic Signal Hardware

- Use LED modules for traffic and pedestrian signal indications.
- Install larger (12 in.) signal modules for all signal indications.
- Consistently use back plates with traffic signals on all roads with operating speeds of 40 mph or higher. The use of back plates with traffic signals on roads where the operating speeds are lower than 40 mph should be considered where there may be special factors such as sun glare, a potential for wrong-way movement, and/or high nighttime pedestrian volumes.
- Conduct regular cleaning of signal indication modules and modules when output has degraded by 20 percent or more from peak performance for all fixed lighting installations at intersections.
- Install additional signal heads.
- Install more overhead traffic signals.
- Consider using post-mounted signals (sometimes called “secondary,” “low level” and “far-side left signal heads”) to accommodate left-turn drivers waiting in the intersection to turn (permissive-only). Older drivers sometimes cannot easily view an overhead signal (which is usually to their right) at the same time they are looking for gaps in opposing traffic, especially if the overhead signals are strung on a diagonal span wire.
- Consider additional supplemental signal heads if advance visibility is restricted.
- Consider including a signal head over each approach lane.
- Provide advance warning flashing for the traffic signal.
- When provided, place pedestrian push button(s) in an ADA compliant and consistent location proximate to the intersection.
- Consider the visibility of traffic and pedestrian signal head location(s) in design as it relates to older road users.
- Consider using Countdown Pedestrian Signals. Older pedestrians benefit from the additional information especially when the pedestrian change interval begins when an older pedestrian is halfway across the intersection.[11]

Resources

FHWA Manual on Uniform Traffic Control Devices for Streets and Highways. 2003. http://mutcd.fhwa.dot.gov.

Safe Mobility for Older People Notebook. http://www.aaafoundation.org/pdf/external/SafeMobility.pdf.

University of Michigan, Transportation Research Institute: *Promising Approaches for Enhancing Elderly Mobility.* http://deepblue.lib.umich.edu/handle/2027.42/1536.

University of Florida: Florida Senior Safety Resource Center. http://fssrc.phhp.ufl.edu/.

AAA Foundation for Traffic Safety: Senior Driver Web Site http://www.seniordrivers.org/home/.

AAA National: AAA Road wise Review: *A Tool to Help Seniors Drive Safely Longer.* http://www.aaapublicaffairs.com/Main/Default.asp?CategoryID=3&SubCategoryID=38&ContentID=315.

University of Michigan, Transportation Research Institute: *Driving Decisions Workbook.* http://deepblue.lib.umich.edu/handle/2027.42/1321.

National Highway Traffic Safety Administration: Active Aging Programs. http://www.nhtsa.dot.gov/people/injury/olddrive/.

American Society on Aging (ASA): *Road Map to Driving Wellness.* http://asaging.org/cdc/module4/home.cfm.

11. FHWA Final Report, Countdown Pedestrian Signals: *A Comparison of Alternative Pedestrian Change Interval Displays*, March 2005, Jeremiah Singer, Neil Lerner, Westat, pg.16.

AARP Older Driver Safety. http://www.aarp.org/families/driver_safety/.

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U.S. DOT, Safe Mobility for a Maturing Society: Challenges and Opportunities, November 2003. http://www.eyes.uab.edu/safemobility/SafeMobility.pdf.

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AARP Public Policy Institute: *Planning Complete Streets for an Aging America.*

NHTSA Traffic Safety Facts: Older Population. http://safety.fhwa.dot.gov/facts/.

FHWA Intersection Fatality Comparison 2006 vs. 2007. http://safety.fhwa.dot.gov/intersections/docs/inter_fats06_07.pdf.

U.S. Census Bureau: Historical Population Estimates. http://www.census.gov/statab/hist/HS-01.pdf.

FHWA Older Driver Highway Design Handbook. Jan. 1998. Publication FHWA-RD-97-135. http://ntl.bts.gov/DOCS/older/home/index.html.

ITE Traffic Engineering Handbook, 6th Edition. 2009.

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Department of Health and Human Services. *Healthy People 2010. Second Edition*. With understanding and improving health and objectives for improving health. 2 vols. Washington, DC: Government Printing Office; 2000.

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National Highway Traffic Safety Administration, Department of Transportation. Traffic Safety Facts 2007: Older Population. Washington, DC: NHTSA; 2008. http://www.nhtsa.gov/portal/site/nhtsa/menuitem.31176b9b03647a189ca8e410dba046a0/.

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