

TRANSPORTATION  
RESEARCH

Number 370, May 1991

# CIRCULAR



## Research Problem Statements Impact of Aging Driver Population on Geometric Design

**RESEARCH PROBLEM STATEMENTS  
IMPACT OF AGING DRIVER POPULATION  
ON GEOMETRIC DESIGN**

**OPERATION, SAFETY, AND MAINTENANCE OF TRANSPORTATION FACILITIES**

H. Douglas Robertson, Chairman  
Group 3 Council  
University of North Carolina  
Charlotte, N.C.

**COMMITTEE ON OPERATIONAL EFFECTS OF GEOMETRICS  
(As of January, 1991)**

Jerome W. Hall, Chairman  
Department of Civil Engineering  
University of New Mexico  
Albuquerque, N.M.

Jack W. Anderson  
Myung-Soon Chang  
Ronald W. Eck  
Daniel B. Fambro  
Don Jay Gripne  
Douglas W. Harwood

Richard P. Kramer  
Mark A. Marek  
Robert P. Morris  
Ronald C. Pfefer  
Abishai Polus  
Ramey O. Rogness

R. Kenneth Shearin  
Justin True  
Daniel S. Turner  
Stephen N. Van Winkle  
Walter E. Witt  
Paul H. Wright

Richard A. Cunard, Transportation Research Board

Subscriber Category  
IIA highway and facility design

Transportation Research Board  
National Research Council  
2101 Constitution Avenue, N.W.  
Washington, D.C. 20418

---

**The Transportation Research Board** is a unit of the National Research Council, which serves as an independent advisor to the federal government on scientific and technical questions of national importance. The Research Council, jointly administered by the National Academy of Sciences, the National Academy of Engineering, and the Institute

## INTRODUCTION

Committee A3A08, Operational Effects of Geometrics, regards identifying research needs and communicating them to the transportation research community as one of its major functions. The Committee has regularly evaluated and published research problem statements; publication of this circular is a continuation of that activity.

In 1989, the Committee departed from its normal practice of accepting research problem statements on any aspect of operational effects of geometrics by focusing on the topic "impact of the aging driver population on geometric design". In 1985, a subcommittee had been formed to : (1) identify and review sources of information on the relationship between aging drivers and design and operational practices; (2) identify geometric and traffic control elements most closely related to accidents involving aging drivers; (3) develop recommendations for research projects to determine the need for changes in design and operational policies for specific roadway elements, and (4) make the research recommendations known to the highway community through publication of research problem statements.

Transportation Research Circular 317, published in June 1987, presented the results of objectives (1) and (2) above. The Circular included a list of potential countermeasures for further study and an annotated bibliography. The publication summarized some of the voids and conflicts existing in information pertaining to aging drivers and geometric design. The summaries set the direction for the follow-on subcommittee task, that is, preparing detailed research problem statements in a form suitable for publication.

The Committee received seven research problem statements for evaluation during 1989. These research problem statements were circulated to the Committee membership, who was asked to evaluate each of them for perceived importance, for allocation of a hypothetical research budget, and for probability of success. Members were also asked to provide a brief rationale for each evaluation.

Thirteen Committee members responded to this request. Requests were summarized in such a way that the anonymity of the respondents was maintained. A summary of the results was distributed to the entire Committee for comments and suggestions.

Evaluation results showed a wide diversity among individual Committee members in their assessment of each of the problem statements. All but two statements received the highest possible ranking from at least one evaluator. Only one statement failed to receive worse

than a ranking of 5. However, there appeared to be consensus among Committee members as far as categorizing the relative importance of the individual problem statements.

The seven research problem statements evaluated by the Committee are presented below in priority order. The first two statements were classified as highest priority and were considered important enough to warrant immediate attention. The next four statements were considered to be of intermediate priority and were regarded as problems that need to be addressed.

The final statement is published in summary form since it was felt to be of lower priority. It should be noted that research addressing part of this problem is currently underway.

### PROBLEM STATEMENTS RATED AS HIGHEST PRIORITY

#### Low-Cost Geometric and Operational Improvements at Intersections

**Problem Statement:** Accident data indicate that intersections are particularly troublesome for older drivers. While rear-end collisions and accidents at signalized intersections represent the most common form of accident involvement, there are also a high proportion of stop and yield sign and driveway incidents. This is likely the result of declining visual, cognitive, and motor task performance. The speed required to see, decide, and act to negotiate intersections can overtax the capabilities of some older drivers. Many current design and traffic control practices and standards need to be re-examined and modified based on current information about driver performance.

Obviously, it is not feasible to modify or rebuild every intersection so that it will better accommodate older drivers. However, as specific performance deficiencies of older drivers are being identified through human factors research, it should be possible to develop and field test low-cost improvements for intersections. It is envisioned that these improvements would involve a combination of geometric and traffic control changes. The identified approaches could also be implemented at locations of new commercial development access.

**Research Objectives:** Study goal would be to evaluate low-cost geometric and operational improvements that would enhance safety at locations that older drivers find troublesome. Specific objectives would be to:

- Conduct a literature search to identify specific driving performance deficiencies of older drivers;
- Identify, based on the literature review, low-cost combinations of geometric and operational improvements to facilitate negotiation of the intersection by older drivers; and
- Field test the most promising improvements at several locations.

**Key Words:** aging drivers, driveway design, driving performance, geometric design, intersection design, traffic operations.

**Related Work:** TRB Special Report 218 provides an excellent overview of older driver performance deficiencies as related to geometric design and traffic operations. However, there is not sufficient detail to help the engineer implement specific improvements. The human factors, medical, and gerontological literature is providing an increasing amount of data about specific older driver characteristics. This information needs to be critically reviewed and adapted for highway and traffic engineering purposes.

**Urgency/Priority:** This research should receive a high priority. The population as a whole is aging at the same time intersections are being added at a rapid rate. This incompatibility needs to be examined now to minimize future problems.

**Costs:** \$250,000.

**User Community:** AASHTO, FHWA, county and city traffic engineers.

**Implementation:** The improvements identified as a result of this research will be immediately useful to highway agencies in decision-making relative to intersection and traffic operations.

**Effectiveness:** Research results will be useful in enhancing the effectiveness of highway safety improvement monies. Not only older drivers, but all motorists will benefit from improved safety and operational efficiency.

#### **Effectiveness of Larger Street Name Information Signs**

**Problem Statement:** Research indicates that as a person grows older, his or her visual acuity deteriorates to the point where the 50/1 standard for letter size should be revised. Since the older population is increasing very

rapidly, it may now be the time to change the letter size to 40/1.

**Research Objective:** To make the decision to increase sign and letter size to accommodate the older driver with proper information, necessary to making rapid decisions, etc.

**Key Words:** Larger signs, letter sizes, older driver, informational signs, visual acuity.

**Related Work:** *Special Report 218: Transportation in an Aging Society*, TRB.

**Urgency/Priority:** Should be determined as soon as possible - Urgent.

**Cost:** \$100,000 for selected locations (high percentage of accidents involving drivers 65 and over).

**User Community:** All transportation agencies (AASHTO, FHWA, State, County and City).

**Implementation:** Replacement with larger signs to take place as signs deteriorate and must be refurbished or replaced.

**Effectiveness:** Should eventually show a reduction in highway-related accidents.

#### **PROBLEM STATEMENTS RATED AS INTERMEDIATE PRIORITY**

##### **Evaluation of Warrants for Separate Left-Turn Lanes**

**Problem Statement:** It has been shown that older drivers experience difficulties in performing turning maneuvers at intersections. One approach to simplify the complexity of urban intersections is to provide left-turn lanes and left-turn signals. The AASHTO "Policy on Geometric Design of Highways and Streets" (Green Book), states that left-turn facilities should be established on roadways where traffic volumes are high enough to warrant them. It further states that serious hazards, inconvenience and considerable loss in efficiency of operation are evident on divided highways where such lanes are not available.

Although the Green Book provides warrants (based on volume only) for left-turn lanes on two-lanes

highways, it does not provide guides and/or procedures for analyzing the need of left-turn lanes and signals on multi-lane highways.

**Research Objective:** To evaluate current AASHTO warrants for left-turn lanes on two-lane roads and develop warrants for left-turn lanes and signals on multi-lane roads in light of the needs of older drivers.

**Key Words:** Intersection design; turn lanes; turn signals; warrants.

**Urgency/Priority:** This is one of the design-related recommendations of TRB Special Report 218.

**Cost:** Unknown.

**User Community:** AASHTO

#### Delineation of Highway Curves

**Problem Statement:** Nationwide studies indicate that the older and the impaired driver need additional delineation on both horizontal and vertical curves.

**Research Objective:** To make curves safer for all drivers to negotiate, especially for the older driver, by adding delineator posts on curves.

**Key Words:** Horizontal curve, vertical curve, delineation, delineator posts, older driver.

**Related Work:** *Special Report 218: Transportation in an Aging Society*, TRB

**Urgency/Priority:** By 2020, 17 percent of the population will be 65 or over (50 million ± drivers over 65). The urgency is now.

**Cost:** \$25,000 to install delineators at curves of 3°.

**User Community:** All persons in street and highway agencies (AASHTO, FHWA).

**Implementation:** Information should be disseminated as rapidly as possible.

**Effectiveness:** We believe that all drivers will benefit by this project. This should aid in keeping drivers aligned properly as they negotiate curves.

#### Raised (Curbed) Medians--Harsher Impact on the Aged Driver

**Problem Statement:** Raised (curbed) medians are fixed objects which, when struck by a vehicle, are unforgiving. The aged driver, having poorer vision, slower physical reaction time, lower degree of awareness, and reduced ability to maneuver the vehicle, is more likely to be negatively impacted by a raised median than is the average driver. The typical curbed median often offers little to no contrast with the adjacent pavement and is difficult to reflectorize at night. Low beam headlight limitations, coupled with reduced vision of the aged driver, compounds the visibility problem. Since one purpose of a raised median is to restrict certain movements, the median, by design, causes the motorist to make abbreviated lane changes and weaving movements to position for a left- or U-turn, forces U-turn movements which can be difficult for the aged driver to master since they are performed so seldomly, and causes the driver to use a driveway, street opening, and private parking lot to turn around. Raised medians and raised corner islands, when used together, often create turning path options at complex intersections that are confusing to the average driver--let alone the aged one. Raised medians, while precluding encroachment thereupon, do not communicate passively. Failure to comply will result in an accident.

**Research Objective:** Does the aged driver magnify the need to convert raised medians to the more forgiving, self-communicating, and versatile flush median which includes continuous uni- and bi-directional left-turn lanes, as well as the striped median with left-turn pockets? Does the aged driver provide just another reason to strictly limit the continued use of raised (curbed) medians?

**Key Words:** Visual Acuity, Raised Medians, Abbreviated Lane Change and Merging, U-turns, Flush Medians.

**Related Work:** Comparisons have been researched between raised (curbed) medians and flush medians. However, little research has been done involving the impact the raised median has on safety, vehicle maneuvering, lane changing, and merging.

**Urgency/Priority:** The urgency is relatively consistent with the urgency of all aged driver research.

**Cost:** Cost is proportional to the scope.

**User Community:** AASHTO, FHWA, NHTSA, Municipal Public Works Directors, County Superintendents of Highways.

**Implementation:** Summary of findings published in trade journals, professional magazines, etc.

**Effectiveness:** The research will emphasize human limitations regarding the aged driver. If communicated effectively, it will provide another factor to be considered by the practitioner when making geometric design decisions.

### **Revised Guidelines for Left-Turn Phasing of Traffic Signals**

**Problem Statement:** Left-turn bays are provided at many channelized intersections with traffic signals. However, many such intersections provide no protected left-turn phasing. Left-turns are permissive only. Frequently, the intersecting streets are collectors or locals which accommodate many older drivers who are leaving arterials.

Traffic engineers and others use the Manual on Uniform Traffic Control Devices for all instructional material. Its companion, Traffic Control Devices Handbook, was created to augment and interpret the Manual. Section 4C of the Handbook discusses guidelines for Operational Requirements. Subsection 4-C1 discusses Controller Phasing. Reference pages 4 - 18 which set up guidelines for Left-turn Phase Criteria—"These warrants are not mandated by MUTCD and are provided here for information purposes only..." Accident statistics show that 25% of accidents involving drivers 65+ are left-turn accidents.

**Research Objectives:** TRB *Special Report 218: Transportation in an Aging Society* makes several recommendations that will prove beneficial, not only to the elderly, but to all drivers. One of the recommendations is that left-turn lanes and left-turn signals should be used to simplify the complexity of urban intersections. This proposal is to add additional guidelines for left-turn phasing criteria, one of which might be that where left-turn phasing and traffic signals already exist, that protected-permissive left-turn phasing be provided, regardless of other guidelines.

**Key Words:** Intersection, channelized, left-turn bays, traffic signals, protected and permissive left-turn, phasing guidelines.

**Related Work:** Manual on Uniform Traffic Control Devices, Traffic Control Devices Handbook

**Urgency/Priority:** Urgent

**Cost:** \$50,000

**User Community:** AASHTO, FHWA, NHTSA, all governmental agencies utilizing traffic signals

**Implementation:** A directive to users of the MUTCD and Traffic Control Devices Handbook re-emphasizing that some guidelines are not mandated and advising of further guidelines.

**Effectiveness:** Accidents and the potential for accidents should be reduced. Society as a whole, but more particularly, the ever-increasing elderly driver population will benefit.

### **ADDITIONAL PROBLEM STATEMENT**

#### **Effectiveness of Offsetting Intersection Approaches**

**Problem Statement:** Some research indicates that a reduction in accidents is noticed when minor road approaches to a major highway are offset from one another. Is there a certain level of traffic volume where this is true, or can it be said that this fact is true for nearly all offset intersections? Does this kind of intersection become more complex when, in fact, we are striving for simple designs?

**Research Objective:** To select several intersections to study and verify that offsetting approach legs should become standard design practice.