Southeastern Transportation Center
Proposal Cover Page
O/E Grant 2017-2018

UNIVERSITY:	University of Kentucky Research Foundation	
TITLE OF PROJECT:	Technology Based Risk Mitigation Strategies To Improve Older Driver Safety	
FEDERAL FUNDS:		
Requested Amount	**Proposed Duration:12 months**	**Desired Start Date: 01/01/2017**
$50,000		
MATCHING FUNDS:		
Source 1: State Planning and Research	**Source 2:**	
$50,000	$	
DEPARTMENT SUBMITTING PROPOSAL:		
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Signature:		**Date:10/31/2016**
SUBCONTRACTING INSTITUTION:		
ADMINISTRATIVE REPRESENTATIVE AUTHORIZED TO CONDUCT NEGOTIATIONS:		
Name/Title: Kim C. Carter, Executive Director		
Address: University of Kentucky Research Foundation, 109 Kinkead Hall, Lexington, KY 40506-0057		
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Fax: 859 323 1060		
Email: ospa@email.uky.edu		
Signature: Kim C. Carter		**Date: 10/31/2016**
ADMINISTRATIVE ORGANIZATION'S REPRESENTATIVE:		
Name/Title: Deborah Bastani, Business Officer		
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Signature:		**Date: 10/31/2016**
OTHER REQUIRED SIGNATURES:		
Name/Title:		
Address:		
Phone:		
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Email:		
Signature:		**Date:**

PROBLEM STATEMENT

Older drivers present a unique challenge to transportation system in the US. Nationwide the older population of drivers is increasing with particular increases within the Southeast United States as shown in Figure 1. Studies have shown that older drivers have high rates of crashes and injuries; however, maintaining the ability to drive is very important to older persons, and the solution must balance older driver mobility and safety (Alicandri et al. 1999). The crash involvement rates for older drivers (those over the age of 65) have been increasing since the 1980's, and elderly drivers are disproportionately more at fault in crashes than other driver age groups (US DOT 2012). As the number of older persons who are licensed to drive continues to grow, there is increased concern about their risk to themselves and others on the road. Investigation of older driver crash patterns has shown that older drivers are overrepresented in certain crash types, such as left turn crashes and crashes involving complex maneuvers, than other driver age groups. Further research is required to develop countermeasures that can improve their safety level and reduce the safety threat to others, while maintaining older driver mobility. The relatively recent integration of mobile technology solutions, as the increasing familiarity of older driver population with technology, especially in younger cohorts, presents a unique toolset of potential solutions.

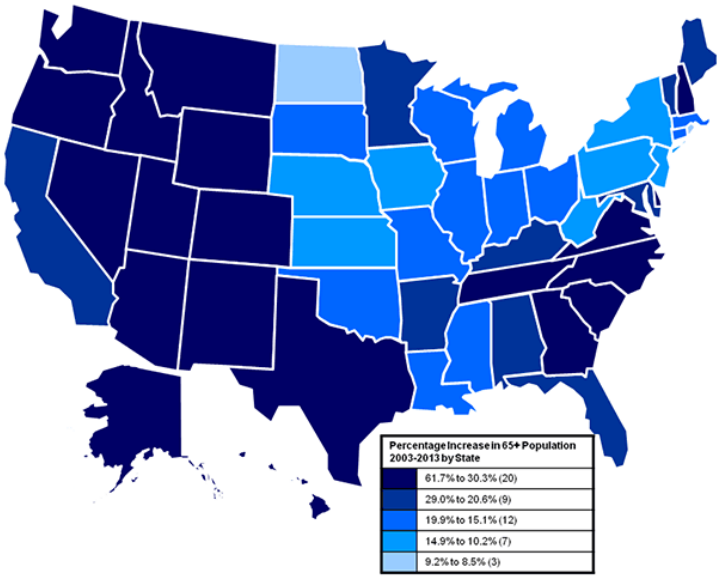

Figure 1: Older Driver Population Increase (2003-2013) (US Dept. of Health and Human Services, 2016)

RESEARCH OBJECTIVES

The objective of this research is to identify technological based methods that may be used to assist older drivers in avoiding high hazard scenarios, though increased risk assessment and guidance on route choice, time of travel and required maneuvers at intersections, in an attempt to reduce the overall crash representation of this driver population. Research has shown that older drivers have a willingness to self-regulate, avoiding perceived high hazard driving practices such as driving at night. However, drivers may not always be aware of hazardous situations, or be informed of alternatives to them. This research will identify specific traffic conditions and turning maneuvers which represent hazardous conditions for older drivers, and develop navigational routing algorithms that may be used to automate route selection and guidance. These algorithms could then be integrated into personal navigational system to develop a "safe route" as opposed to a "fastest route" solutions for older drivers. As a result this research has the potential to reduce overall older driver crashes and crash severity through avoidance of high hazard conditions by this population while maintaining personal independence and mobility.

BACKGROUND

The United States population is aging, and by 2030, one in five Americans will be 65 or older (Ortman et al. 2014). Clearly, the demographic of older drivers is rapidly growing, and they bring with them special challenges for traffic safety. As people age, they become more susceptible to any injuries, including injuries sustained in a crash (Khattak et al. 2002). In fact, many of the same factors that increase the likelihood of injury in elderly drivers have also been found to lead to a higher crash-causing propensity (Stamatiadis et al. 1991; Villalba et al 2001). Older drivers may experience a decline in physical and mental facilities that lead to or cause unsafe driving behaviors. Some of these obstacles include the "deterioration of sight and hearing, the onset of muscle, joint, and skeletal disorders, and deterioration of mental and physical response times" (Khattak et al. 2002). The higher crash propensity of older drivers is often attributed to typical aging related deterioration, which affects three functions important to safe and carefree driving: sensory (visual), cognitive and psychomotor (Deacon, 1988). It is estimated that 90 percent of the input that a driver receives is visual (Bailey and Sheedy, 1988). This makes vision the primary sensory function used for driving. The deterioration of visual ability does not only reduce the capability to operate an automobile but it also causes the driver difficulty in judging distances between vehicles which in turn can lead to crash involvement. Loss of peripheral vision to observe approaching vehicles from the sides is also critical (Baxter et al., 1990). While crash survivability undoubtedly plays a large role in the safety problem facing older drivers, just as much of an issue is crash avoidance (TRB 2004). If measures can be taken to reduce the likelihood that elderly drivers will even be involved in a crash, then some of the impediments facing older driver can be overcome.

Several studies have found that older drivers have a higher crash frequency at intersections as compared to younger drivers (Chandraratna and Stamatiadis 2003; Tenfelde and Stamatiadis, 2002; Staplin et al. 1997). Older drivers have particularly high rates of involvement in intersection crashes when they are turning, and even more so when they are turning left. Moreover, older drivers are more likely than younger drivers to have been at fault in these situations, typically because they failed to yield the right-of-way, disregarded the traffic signal, or committed some other traffic violation (Chandraratna and Stamatiadis 2003). Studies also suggest that the extent of over-involvement of older drivers in certain types of crashes generally increases with advancing age (Stamatiadis and Deacon 1995; Villalba et al. 2001). However, most of the studies cannot identify whether these changes are due to changing travel patterns associated with aging, or physical or cognitive impairments related to the aging process.

A more detailed analysis of the crash propensities and their perception by older drivers has validated the concept that older drivers have specific crash-related problems and they also perceive these as critical issues for their safety (Chandraratna et al. 2002). The study examined four crash types: 1) left turns against oncoming traffic, 2) gap acceptance for crossing non-limited access highways, 3) high speed lane changes on limited-access highways, and 4) merging and weaving on limited-access highways at ramps using older and younger drivers' crash propensities form Kentucky crash data. In addition, older drivers participated in a survey where they were asked to evaluate driving scenarios related to these four crash types and indicate their perceived level of difficulty in completing the required maneuver. The survey results indicated that older drivers are having difficulties merging on access controlled highways, changing lanes, driving at night, and turning left. The survey results

also showed that the presence of other drivers on the road seemed to be the most significant factor in the left turning maneuvers and that the addition of a signal at the intersection did not alter the ranking difficulty of the left turn maneuver. The study concluded that this was a significant result that should be considered more in depth because a number of past studies indicate that more signals would aid older drivers; it did not seem to make a difference here.

Many mitigating factors have been introduced with the goal of decreasing crashes among older drivers: those targeting the vehicle, the roadway and the driver (Dellinger et al. 2002). Most of these, however, are focused primarily on the design aspects of vehicles and the roadway. The results of deeper passenger research may determine that more effort should be placed on the driver through awareness and education.

RESEARCH APPROACH TASKS

Task 1: Literature Review

A comprehensive literature review will be conducted to identify situations (including maneuvers), traffic and roadway characteristics that increase the likelihood of crashes for older drivers. As identified in the background section several maneuvers have been identified, such as left turns, and high levels of congestion as contributing more to older driver crashes. Studies will be sought which have identified relative performance of older drivers for each of these maneuvers that can be used in the development of quantitative or qualitative risk assessments for turning maneuvers and roadway choices for use in the development of a route selection algorithm.

The Kentucky Transportation Center has a state-of-the-art transportation research library that maintains current information relating to all aspects of transportation. The library possesses copies of most general transportation journals and articles. The KTC library has access to national information services (TRIS, Transport, NTIS, Dialog, etc.) and the Center employs a full-time research librarian to assist with all literature search activities. These resources will help the team obtain the latest research information.

Task 2: Algorithm Development

Based on the findings of Task 1, this task will develop a safety hazard or risk algorithm for route based decision making. Depending upon the quality and consistency found in existing datasets, the algorithm will be developed using quantitative or qualitative ratings that can evaluate relative risk associated with multiple routing decisions. This may include:

- Turning maneuvers
- Route length
- Route congestion
- Number of traffic control devices

The algorithm will be developed based upon characteristics commonly found in state maintained geographically oriented databases or maintained by third party route navigation applications, such as Garmin, Google or Apple Maps navigation services. This will allow for the development of a meaningful risk algorithm that can be readily applied. If research shows the need for increased data resolution for such an application, data needs will be identified and summarized.

Task 3: Testing and Evaluation
This task will conduct a pilot test to validate the route choice algorithm developed in the previous task. Route summaries obtained from previous surveys on older driver patterns conducted by the research team will be reviewed and GIS based routing solutions will be identified and used to evaluate alternative route choices. Alternative routes from origin to destination and origin return will be evaluated through manual application of the alternative as a proof of concept for the risk based routing decisions.

Task 4: Results and Recommendations
The product of this project will be a document that outlines the risk based routing algorithm and summarizes the general results of the application overview. This is a crucial step for the safety initiative as we embark into the next generation of vehicle and infrastructure technology and begin to understanding how we may leverage information to better serve individual driving populations which may experience unusual travel risk factors.

RESEARCH DURATION AND COST

It is anticipated that this project will take 12 months to complete for a total budget of $100,000. The majority of the efforts involved in this effort will be data collection and numerical model development efforts which can be executed concurrently with other ongoing research projects currently underway at the Kentucky Transportation Center. A 50/50 match of the STC Grant is proposed.

QUALIFICATION OF RESEARCH TEAM

The Kentucky Transportation Center team members have extensive experience in operations and safety. Team members have not only worked with the datasets being utilized in the study but have also worked with the controlling agencies to refine and improve the datasets and technology deployments in questions. The Universities of Kentucky also offers well established civil engineering department that focus on transportation research from which to draw knowledgeable and interested graduate and undergraduate students.

Dr. Adam Kirk, PE, PTOE, is a Principal Research Associate at the Kentucky Transportation Center at the University of Kentucky and will serve as the Principal Investigator for this research. Dr. Kirk leads the research team within the Center for Advanced Traffic Solutions Laboratory (CATSLab; catslab.ukytc.com), which focuses on advances within traffic signal systems and practices. In this role he has lead efforts within Lexington and Louisville Kentucky to implement and evaluate adaptive traffic control systems to ease high levels of congestion and associated safety problems. Dr. Kirk also has extensive safety experience, having utilized similar modeling efforts to develop surrogate safety performance measures for innovative intersection applications through his PhD research.

Dr. Stamatiadis is a Professor of Civil Engineering at the University of Kentucky. He joined UK as an Assistant Professor in 1990 from Michigan State University, where he completed his graduate studies obtaining a Ph.D. in Civil Engineering with emphasis in traffic safety and the older driver. Dr. Stamatiadis teaches several transportation courses at UK both at the graduate and undergraduate level and he has developed and taught workshops on the Highway Capacity Manual, traffic signals,

and traffic networks. Dr. Stamatiadis has been actively involved in establishing a strong traffic and transportation teaching and research program at UK. His research interests include issues on traffic safety, highway design and capacity, measures of congestion mitigation, transportation planning, and public transportation. He has completed research grants on safety issues of the elderly, truck safety, highway cost allocation, congestion management, license renewal alternatives, access management, speed management, effects of design element choices on roadway safety, impacts of inconsistencies between design and operating speeds, and safety consequences of design elements trade-offs. He is currently conducting research dealing with evaluation of means to affect driver operating speeds, intersection design, and practical design and solutions.

Kyriakos Amiridis is a new graduate student at the Department of Civil Engineering at UK and he will commence his studies in fall 2015. He has a strong interest on traffic safety issues and he will be working on a project dealing with intersection design and safety aspects that is funded by the Kentucky Transportation Cabinet.

Full resumes for the project team are provided at the end of the proposal.

TECHNOLOGY TRANSFER

The results of this research have the potential to be disseminated widely among the transportation community. This research will develop the methodology and algorithms and validation that may be used by others to develop time-based route choice selection and guidance for older driver populations. In addition, the methodology developed may also be adapted in the future to benefit other driving populations which demonstrate poor performance under certain driving conditions. It is anticipated that journal articles will be published based on the findings of this safety and operations research. Additionally, the results of the proposed study may also be presented at conference venues, like the Annual Transportation Research Board Meeting and be shared with state and local engineers during workshops accessible to transportation professionals. The results of this research will also be readily incorporated into the education and professional training courses regularly delivered by the researchers. Finally, the findings will also be available online at the Southeastern Transportation Center website and a special effort will be made to disseminate the results to federal and state agencies, policy makers as well as to relevant private sector. This research will be critical in harnessing personal and automotive technological advances with the coming increase in the older driver population.

STC Research Schedule/Timeline

Task / Month	1	2	3	4	5	6	7	8	9	10	11	12
Task 1:												
Task 2.												
Task 3:												
Task 4:												

STC Research Project Description

Project Title: Technology Based Risk Mitigation Strategies To Improve Older Driver Safety
Principal Investigator: Adam Kirk
University: University of Kentucky
Telephone: 859-257-7310 **Email Address:** adam.kirk@uky.edu

External Project Contact (if applicable):
Address Street:
City: **State:** **Zip:**
Telephone: **Email Address:**

Project Start Date: 01/01/2017 **End Date:** 12/31/2017

Other Milestones, Dates:
Literature Review (March 31, 2017)
Algorithm Development (July 31, 2017)
Validation (September 30, 2016)
Final Report (December 31, 2017)

Project #:

Project Objective:

This research will identify specific traffic conditions and turning maneuvers which represent hazardous conditions for older drivers, and develop navigational routing algorithms that may be used to automate route selection and guidance.

Project Abstract:

This research will identify develop older driver performance based algorithms that may be integrated into personal navigational system to develop a "safe route" solutions for older drivers. This will be achieved by identifying high hazard scenarios, though increased risk assessment and guidance on route choice, time of travel and required maneuvers at intersections, in an attempt to reduce the overall crash representation of this driver population. As a result this research has the potential to reduce overall older driver crashes and crash severity through avoidance of high hazard conditions by this population while maintaining personal independence and mobility

Task Description:

Task 1: Research and Practice Review
Task 2: Algorithm Development
Task 3: Model Validation
Task 4: Final Report

Total Budget: $ 100,000

Student Involvement (Thesis, Assistantships, Paid Employment):

This research will support 1 graduate student in their current employment as research assistances at the Kentucky Transportation Center. In addition, the data and analysis of this project may be used in the completion of additional master and PhD level projects and theses.

Relationship to Other Projects:

This project builds on the current efforts at KTC, developing Safety Performance Functions for Kentucky, and a SHRP2 project analyzing roadway segment data.

Technology Transfer Activities:

It is anticipated that the results of this research will be disseminated through existing publications of the STC, University c
University of Tennessee, as well as submitted for inclusion in other application journals and presentations.

Potential Benefits of Project: Benefits include decreased crashes, crash severity and increased personal mobility for older drivers, through improved information and decision making.

TRB Keywords: Older Drivers, Connected Vehicles, Route Choice, Safety Performance

PEER REVIEW FORM

Peer Reviewer #1

Name:	
Organization/University Affiliation:	
Address:	
Phone #:	
Fax #:	
Email address:	
Please submit a brief overview of why this individual is qualified to review the material.	
Qualifications of reviewer:	

Peer Reviewer #2

Name:	
Organization/University Affiliation:	
Address:	
Phone #:	
Fax #:	
Email address:	
Please submit a brief overview of why this individual is qualified to review the material.	
Qualifications of reviewer:	

Peer Reviewer #3

Name:	
Organization/University Affiliation:	
Address:	
Phone #:	
Fax #:	
Email address:	
Please submit a brief overview of why this individual is qualified to review the material.	
Qualifications of reviewer:	

*Two peer reviewers will be selected for each final report. Other appropriate reviewers may be selected at the discretion of the STC.

Southeastern Transportation Center
Proposed Budget
O/E Grant 2016-2017

Title: Technology Based Risk Mitigation Strategies To Improve Older Driver Safety

University: **University of Kentucky**

	Federal Funds	Matching Funds
Salaries:		
Faculty		
Administrative Staff		
Other Staff	27200	27200
Graduate Student Salaries/Stipends	5500	5500
Undergraduate Student Salaries/Stipends	5500	5500
Total Salaries/Stipends	38200	38200
Benefits (including student health insurance)	0	0
Total Salaries and Benefits	**38200**	**38200**
Other Direct Costs:		
Permanent Equipment		
Expendable Equipment and Supplies		
Computer Costs		
Non-salary Education Costs – tuition/fees		
Other Costs: (specify)		
Printing / duplication		
Postal expense		
Communication		
Conference Registration / Fees		
Travel	1482.54	1482.54
Computer Costs		
Other miscellaneous costs:		
Total Other Direct Costs	**1482.54**	**1482.54**
Indirect Costs at 26%	**10317.46**	**10317.46**
TOTAL COSTS	**50,000**	**50,000**