Submitted to: US Department of Transportation, Research and Innovative Technology Administration

Federal Grant No: 69A3551747131

Project Title: Safety Research Using Simulation (SAFER-SIM)

Program Director: Dawn Marshall, M.S.
Project Director/Research Manager
National Advanced Driving Simulator
2401 Oakdale Blvd
Iowa City, IA 52242
Phone: 319-335-4774
Fax: 319-335-4658
Email: dawn-marshall@uiowa.edu

Submitting Official: Same as Program Director

DUNS and EIN Nos.: UI DUNS 062761671; EIN 42-6004813

Submission Date: April 30, 2019

Recipient Organization: The University of Iowa
5 Gilmore Hall
Iowa City, IA 52242

Recipient Identifying Grant Program No.: 15701400

Project/Grant Period: 11/30/2016 – 9/30/2022

Reporting Period End Date: 3/31/2019

Report Term or Frequency: Semi-annual

Signature of Submitting Official: [Signature]
1. Accomplishments

Research

SAFER-SIM has funded 43 research projects to date under the 2016 grant. The center issued a Request for Proposals in October 2018. Funding decisions were made in March 2019. The center funded eighteen (18) new projects – seventeen (17) research, one (1) outreach. The research projects included one (1) collaboration between sites. Information about these projects can be found on the Transportation Research Board’s Research in Progress (RIP) Database (https://rip.trb.org/) and the SAFER-SIM website (http://safer.sim.nads-sc.uiowa.edu/research_new.php?searchTerm=). SAFER-SIM currently has 19 on-going projects that began prior to the current reporting period.

<table>
<thead>
<tr>
<th>Research Project Title</th>
<th>School(s)</th>
<th>Performance Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2I Infrastructure Placement and Safety Implications of CAVs in an Interconnected Network</td>
<td>UCF</td>
<td>8/8/2019-2/8/2021</td>
</tr>
<tr>
<td>Investigating the Effects of Smartphone-based P2V Warning using Driving Simulator Experiments</td>
<td>UCF</td>
<td>5/1/2019-10/31/2020</td>
</tr>
<tr>
<td>Shared Connectivity for Safer Shared Space Facilities: Improving mobility for non-motorized and vulnerable Road-Users</td>
<td>UCF</td>
<td>9/1/2019-12/31/2020</td>
</tr>
<tr>
<td>Using Simulation to Study Communication between Autonomous Vehicles and Vulnerable Road Users</td>
<td>UI</td>
<td>6/1/2019-12/31/2020</td>
</tr>
<tr>
<td>Understanding Bicyclists’ Behaviors Through Learning from Big Trip Data</td>
<td>UI</td>
<td>7/1/2019-12/31/2020</td>
</tr>
<tr>
<td>University of Iowa SAE Baja California Nationals Event</td>
<td>UI</td>
<td>5/13/2019-5/21/2019</td>
</tr>
<tr>
<td>The Influence of Unmanned Aerial Systems on Driving Performance</td>
<td>UM</td>
<td>5/1/2019-4/30/2019</td>
</tr>
<tr>
<td>Quantifying the Impacts of Situational Visual Clutter on Driving Performance Using Video Analysis and Eye Tracking</td>
<td>UM</td>
<td>9/1/2019-8/31/2020</td>
</tr>
<tr>
<td>Drivers’ Safety Assessment in Two-Lane Rural Roads Work Zones</td>
<td>UPR</td>
<td>6/1/2019-6/1/2020</td>
</tr>
</tbody>
</table>
Eight (8) research projects submitted final reports this period. Two of those projects are collaborative and are waiting on final reports from other sites.

<table>
<thead>
<tr>
<th>Completed Projects</th>
<th>School(s)</th>
<th>TRID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using Driver State Detection in Automated Driving</td>
<td>UI</td>
<td>01685329</td>
</tr>
<tr>
<td>Augmented Reality for Safer Pedestrian-Vehicle Interactions</td>
<td>UW</td>
<td>01685401</td>
</tr>
<tr>
<td>Multi-modal Distributed Simulation Combining Cars, Bicyclists, and Pedestrians*</td>
<td>UI, UW</td>
<td>01691619</td>
</tr>
<tr>
<td>Using Simulation to Assess and Reduce Conflicts between Drivers and Bicyclists*</td>
<td>UM</td>
<td>01703100</td>
</tr>
<tr>
<td>Driver360 - A Four-dimensional Scanning System to Better Understand Drivers</td>
<td>UI</td>
<td>01692019</td>
</tr>
<tr>
<td>Assessing the Impact of Smartphone Usage While Driving in Work Zones</td>
<td>UPR</td>
<td>01698918</td>
</tr>
<tr>
<td>To Trust or Not to Trust? A Simulation-based Experimental Paradigm</td>
<td>UM</td>
<td>01695284</td>
</tr>
<tr>
<td>Risk Awareness and Perception Training using Virtual Reality (RAPT-VR)</td>
<td>UM</td>
<td>Submitted</td>
</tr>
</tbody>
</table>

*Collaborative projects still expecting additional reports from other sites

Leadership Development
Developing the next generation of leaders in safety research and simulation methods is a key function of the center.

Paper/poster awards – 4 awards received
- Yalda Ebadi presented preliminary results of this research during the SaferSim Symposium in November 2018. She received 1st prize for best poster presentation.
- Shannon Roberts presented preliminary results of this research during the Hybrid Session
(entitled “Intriguing Research About the Performance of Transportation Users”) during the TRB Annual Meeting in January 2019. She received 1st prize for best poster presentation.

- AND30’s 2019 Outstanding Paper Award at TRB for ‘Can Virtual Reality Headsets Be Used to Measure Accurately Drivers’ Hazard Anticipation Performance: The Promise of VR Headsets’ – awarded to authors Ganesh Pai Mangalore, Yalda Ebadi, Siby Samuel, Michael Knodler and Donald Fisher
- Nominated for the 2019 Honda Outstanding Paper Award at Driving Assessment 2019 for the paper ‘Can Virtual Reality Headsets be Used to Measure Accurately Drivers’ Anticipatory Behaviors?’ – Ganesh Pai Mangalore, Yalda Ebadi, Siby Samuel, Michael Knodler and Donald Fisher

External grants related to SAFER-SIM – 4 proposals submitted, 2 funded

Funded

- “Evaluation of Training Programs to Accelerate Hazard Anticipation Skills in Novice Teen Drivers” Dan McGehee (PI), Jodie Plumert (Co-PI), Michelle Reyes (Co-PI), Elizabeth O’Neal (Co-PI), Shaun Vecera (Co-PI), Shawn Allen (Co-PI), Neil Lerner (Co-PI), Philip Kellman (Co-PI). AAA Foundation for Traffic Safety, 2/15/18 – 8/31/19, $378,321 in total costs. Not reported previously
- “Developing Connected Simulation to Study Interactions between Drivers, Pedestrians, and Bicyclists” Dan McGehee (PI), Joseph Kearney (Co-PI), Jodie Plumert (Co-PI), Chris Schwarz (Co-PI), Stephen Baek (Co-PI). DOT Federal Highway Administration, Broad Agency Announcement for Exploratory Advanced Research Program, 9/29/17 – 9/28/19, $1,217,530 in total costs, Award No. 693JJ31750016. Not reported previously

Submitted, funding status not yet known

- Roberts, S. C. (PI), Deep Explanations to Enable Social Interactions with AI Systems, National Science Foundation – Early-concept Grants for Exploratory Research on Artificial Intelligence (AI) and Society, $300,000, 09/01/2019-08/31/2021, co PI with PI Shlomo Zilberstein and co-PI Laurel Smith-Doerr. This proposal uses the same approach, experimental design, and methods that were developed through the current SaferSim grant.
• Negrut has submitted with colleagues from the Department of Civil and Environmental Engineering (David Noyce, Sue Ahn, Jon Riehl, Madhav Chitturi) a WARF Discovery Initiative UW2020 project for investigating how computer modeling and simulation can assist with assessing the safety of autonomous vehicles. The proposal, which is due on December 3, 2018, will seek approximately $400,000 in funding to investigate topics related assessing safety via simulation.

• David Noyce, Sue Ahn, Jon Riehl, Madhav Chitturi, Radu Serban, John Lee, and Parmesh Ramanathan of UW submitted a $3 million DOT proposal in March of 2019.*

*Also reported in outputs
Previously submitted, not funded

• Rector, K. K. (PI), Joseph K Kearney (PI), J. K., Plumert, J. M. (PI) CHS: Small: Ability-Based Mobile Technology to Help Older Pedestrians Make Safe Street Crossing Decisions, submitted to the National Science Foundation ($499,954.00). SAFER-SIM project to collected pilot data.

• Roberts, S. C. (PI), What forms a mental model? Exploring how different consumer groups acquire knowledge about automated driving systems, AAA Foundation for Traffic Safety, $250,000, 01/07/2019-12/31/2019, co-PI, subcontracting to Purdue University. This proposal used the same experimental design and methods that were developed through the current SaferSim grant.

• Roberts, S. C. (PI), Human Training and Interaction with Hybrid Autonomous Transportation Systems, National Science Foundation – Smart and Autonomous Systems, $1,000,000, 02/01/2019-01/31/2022, co-PI with PI Wayne Burleson and co-PI Hossein Pishro-Nik. This proposal used the same experimental design that was developed through the current SaferSim grant.

• Roberts, S. C. (PI), From driver to passenger: discovering and transforming the relationship between humans and driving automation systems, National Science Foundation – CAREER, $615,000, 09/01/2019-08/31/2023, sole PI. The findings of the current SAFER-SIM project, as it relates to the design of warning messages for automated vehicles, was used to inform this proposal.

• John D. Lee is a CoI on a project funded by NIJ titled “Mitigating distraction for police officers” Requested more information

• John D. Lee is a PI for a project funded by Toyota tilted “Modeling driver response to takeover requests from vehicle automation” Requested more information

• John D. Lee is a PI for a project funded by NHTSA titled “Detecting drowsy drivers with naturalistic video data” Requested more information

Invited Workshops – 2 workshops
• TRB Doctoral Student Session (Knodler)
• Public Engagement Fellowship Program (Knodler)

Invited Presentations – 17 presentations
Full list of presentations here

Panels & Advisory Committees
• 2 TRB Committees Chaired by 2 individuals
• 12 TRB Committee Memberships held by 11 Individuals
• 1 TRB Task Force Memberships held by 1 Individuals
• 14 Advisory Board, Panel, and Committee positions held by 8 Individuals

Full list of committees [here](#)

Professional Journals – 11 individuals
• 2 Editors-in-Chief
• 1 Academic Editor
• 4 Associate Editors
• 18 Editorial Board Members
• 26 Journals for which we review

Full list of professional journals [here](#)

Leadership positions in professional organizations – 6 individuals, 23 positions held
Dr. Mohamed Abdel-Aty
• Department of Civil, Environmental & Construction Engineering at the University of Central Florida, Department Chair

Dr. Jaeyoung Lee
• Center for Advanced Transportation Systems Simulation at the University of Central Florida, Safety Program Director

Dawn Marshall
• Road Safety & Simulation Conference 2019, Local Organizing Committee Co-Chair
• University of Iowa Engineering Staff Advisory Council, Secretary

Jacob Heiden
• Road Safety & Simulation Conference 2019, Local Organizing Committee
• University of Iowa Engineering Staff Advisory Council, Treasurer
• University of Iowa Femineer Summit 2019, Planning Committee
• Johnson County, IA Fair STEM Day coordinator

Enid Colón
• Vice-President of the ITE UPRM Student Chapter, August 2017 to Present, Student.

Benjamín Colucci
• Member, Board of Directors of the Pan-American Academy of Engineering (PAE), 2018-2020.
• Vice-President of the Board of Trustees of the Society of Engineers of Puerto Rico, 2017-2019.
• President of the International Relations Commission of the College of Engineers and Surveyors of Puerto Rico (CIAPR), 2017-2019.
• President of the Pan-American Transport Systems Committee (UPADI), 2017-2020.
• Vice-President Caribbean Region of the Pan-American Union of Engineers in Association (UPADI), 2015-2019.
• Vice-President of the International Society for Maintenance and Rehabilitation of Transport Infrastructures (iSMARTi).
• Co-Chair of the Traffic Enforcement Committee, International Road Federation.
• UPRM Manager of the Dwight D. Eisenhower Transportation Fellowship Program for Hispanic Serving Institutions.
• Director of Abertis Chair of Puerto Rico.
• Member of the Board of Director of the College of Engineering of Surveyors of Puerto Rico-Mayaguez Chapter.
• Founder and Director of the Puerto Rico Transportation Technology Transfer Center (PR-LTAP).
• Every Day Count (EDC) Program Technical Oversight Director of Puerto Rico PRHTA and U.S. Virgin Island DPW.
• El Puente Newsletter, Puerto Rico LTAP Editor-in-Chief, 1986 to present.

Professional awards – 6 awards to 3 individuals
Dr. Mohamed Abdel-Aty
• Francis C. Turner award, ASCE, 2019. – “outstanding leadership in the field of road safety nationally and internationally”
• MetroLAB Network, Innovation of the Month, Jan. 2019.
• Korean Society of Transportation, 2018 Achievement Award, Dec. 2018. – “your many innovative ideas that changed much of the safety research and practice as one of the top safety researchers that are recognized worldwide”
• Institute of Traffic Engineering, Shanghai, 2018 Excellence in Traffic Safety Improvement Service Award. – “The award is based on your credentials as a world known traffic safety expert”

Dr. Mike Knodler
• Public Engagement Fellowship

Katerina Deliali
• Women’s Transportation Seminar Ann Hershfang Scholarship, Boston Chapter

Education and Workforce Development
SAFER-SIM is dedicated to educating the next generation of safety professionals, building the transportation workforce for tomorrow, and fostering a vibrant community of researchers. SAFER-SIM consortium members continue to engage students of all levels in transportation, safety, and STEM (science, technology, engineering, and math).

Transportation-related MA and PhD theses – 10 students obtained degrees in transportation disciplines
• Scott Castro, MSC in Transportation Management Systems - UCF
• Rezaur Rahman, MSC in Transportation Systems Engineering- UCF
• Aikaterini Deliali, MS Civil Engineering - UMass
• Francis Tainter, M.S. Civil Engineering – UMass
• Nicholas Campbell, M.S. Civil Engineering and M.S. Regional Planning – UMass
• Rajiv Nair, M.S. Industrial Engineering – UMass
• Alyssa Ryan, M.S. Civil Engineering – UMass
• Aamani Parthasarthy, M.S. Civil Engineering – UMass
• Foroogh Hajiseyedjavadi, PhD Civil Engineering
• Ricardo E. García Rosario, M.S, Civil Engineering UPRM

Curriculum modules developed – 6 modules developed
• Shannon Roberts and Jodie Plumert co-developed a boot camp on experimental design methods during the SaferSim Symposium in November 2018.
• Researchers at the University of Iowa developed 5 modules for a simulation boot camp. Simulation Boot Camp is a webinar series on using simulation technology to study transportation problems. Participation is open to individuals in academia, government, and industry who are interested in learning about how to use simulation technology in their research. This workshop will cover topics such as simulation hardware and software, scenario development, best practices for testing participants using simulation technology, and simulation data reduction and analysis. The sessions will take place in April 2019.

Student internships related to SAFER-SIM – 2 internships by 1 individual
• Areen Alsaid completed two internships at Ford Motor Company to apply skills gained through a SAFER-SIM project to their automated vehicles development research (UW)

Graduating student placement - 3 students found full time employment, 1 undergraduate student was accepted into a graduate program
• Shiwen Zhou will join the PhD program in Engineering Psychology, Georgia Tech
• Foroogh Hajiseyedjavadi, Post-Doc, University of Leeds
• Ricardo E. García Rosario, Master of Science in Civil Engineering, Federal Highway Administration, Sterling, VA.

Presentations to student groups or classes – 18 presentations, over 1650 students
• STEM Festivals/events – 7 events; 1288 students
• Engineering@Iowa – 3 events; 145 students
• AAA Teen Driver Workshop – 50 teens from local drivers education
• Horn Elementary School – 76 students
• Iowa Mennonite School – 60 students
• Belchertown High School – 30 students
• Shannon Roberts presented concepts on Industrial Engineering and Human Factors to prospective UMass freshmen in February 2019. The students were also given a tour of the lab facilities, including the driving simulator.
• Ganesh Mangalore – Presentation to Virtual Reality Group at UMass
• Five technical presentations by the research team to civil engineering students enrolled in the Undergraduate Research Course entitled “Driving Simulation for Geometric Design and Highway Safety Analysis”. (UPRM)
• Negrut (March 21, 2019) presented in his “High Performance Computing for Applications in Engineering” class a segment on AV simulation. The presentation drew on SAFER-SIM work and its purpose was to recruit two or three students interested in independent studies related to AV modeling and simulation. (UW)

Schools visited and students present – 6 colleges/universities, 171 students
• University of California, San Diego (October, 2018): 40 students present (department seminar)
Jet Propulsion Lab (Cal Tech) (October, 2018): no students present, only technical staff (department seminar)
University of California, Berkeley (October, 2018): 6 students present
Georgia Tech (November, 2018): 40 students present (department seminar)
MIT (November, 2018): 8 students present
Des Moines Area Community College – Boone: 77 students

Summer institutes
- None this period

Diversity – 1 event with 40 individuals, 16 projects involving 18 diverse/underrepresented students
SAFER-SIM is committed to promoting diversity by supporting minority participation throughout our work and community outreach. A SAFER-SIM consortium member, the University of Puerto Rico – Mayaguez is a minority serving institution. In addition, minority students make up one-third of the student population at the University of Central Florida. SAFER-SIM projects supported diverse students and interacted with diverse populations through community outreach. This period the center participated in 1 event focused on diversity and interacted with 40 underrepresented/minority individuals:
  - Girls Tech Career Day – 40 girls in grades 5-8

Sixteen (16) research projects in the center involve 18 total underrepresented/minority students.

<table>
<thead>
<tr>
<th>Research Project Title</th>
<th>Site</th>
<th># Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessing the Effectiveness of Connected Vehicle Technologies based on Driving Simulator Experiments</td>
<td>UCF</td>
<td>1</td>
</tr>
<tr>
<td>Using Driver State in Automated Driving</td>
<td>UI</td>
<td>0.5</td>
</tr>
<tr>
<td>Human-Machine Interfaces to Convey Feedback in Automated Vehicles</td>
<td>UI</td>
<td>0.5</td>
</tr>
<tr>
<td>Using Simulation to Assess and Reduce Conflicts between Drivers and Bicyclists</td>
<td>UI</td>
<td>1</td>
</tr>
<tr>
<td>Mobile Applications to Help Older Adults Make Safe Street-Crossing Decisions</td>
<td>UI</td>
<td>1</td>
</tr>
<tr>
<td>Extended Evaluation of Training Programs to Accelerate Hazard Anticipation Skills in Novice Teen Drivers</td>
<td>UI</td>
<td>3</td>
</tr>
<tr>
<td>Safely and Effectively Communicating Non-Connected Vehicle Information to Connected Vehicles through Field- and Driving Simulator-Based Research</td>
<td>UW</td>
<td>1</td>
</tr>
<tr>
<td>Enhancing School Zone and School Bus Safety</td>
<td>UPR</td>
<td>1</td>
</tr>
<tr>
<td>Assessing the Impact of Smartphone Usage While Driving in Work Zones</td>
<td>UPR</td>
<td>1</td>
</tr>
<tr>
<td>Evaluation of Safety Enhancements in School Zones with Familiar and Unfamiliar Drivers</td>
<td>UM, UPR</td>
<td>1</td>
</tr>
</tbody>
</table>
Result dissemination – 8 final reports, 8 summaries, 6 webinars, 11 news digests to 338 individuals, 2212 community members engaged

In addition to the 8 technical reports submitted this period, research projects are required to submit 2-page summaries and prepare online webinar presentations about their results which are shared with contacts in academia, industry, and government. These summaries and webinars focus on recommendations, specifications, and guidelines for practitioners. Webinars for research projects completing are being scheduled for next reporting period. The final reports, summaries, and webinars can all be accessed through the research projects on the center’s webpage here: http://safersim.nads-sc.uiowa.edu/research_new.php?searchTerm.

Center’s biweekly news digest reaches 338 subscribers from industry, government, and academia. The center shares content featuring SAFER-SIM news, webinars, final reports, and other transportation news and career opportunities. Eleven (11) news digests were sent this period.

Center’s outreach efforts reached 2212 community members of all ages this period.

Plans for next reporting period

Research
13 research projects will complete next period. Seventeen (17) recently funded projects will begin. Researchers at the University of Iowa will lead a 5-week simulation boot camp, and regular webinar presentations will return through the summer and fall.

Symposium
Planning for the SAFER-SIM Symposium will be held October 13, 2019 at the University of Iowa in conjunction with the 2019 Road Safety and Simulation conference. The agenda is still being determined, yet is expected to include campus and research facility tours, speakers, workshops, meetings and technical sessions.
Outreach
SAFER-SIM consortium members will continue to engage students of all levels and community members in transportation, safety, and STEM (science, technology, engineering, and math). Plans are underway for a summer STEM festival at the Johnson County Fair, and we expect to exhibit at the Iowa State Fair.

2. Participants & Collaborating Organizations
Collaboration plays an important role in our center’s work. All five consortium sites collaborate regularly through director calls, meetings, and research. Five (5) research projects are collaborative with more than one site involved. Additionally, the center has entered a collaborative agreement with the AAA Foundation for Traffic Safety. SAFER-SIM and AAAFTS have provided funds and researchers to address research questions on How do driver knowledge, attitudes and beliefs of automated systems impact safety, performance, driver behaviors, trust and acceptance of these technologies? The collaborative agreement includes 2 years of funding and a 2 phase research project with UI, UM, and AAAFTS.

Other collaborators or contacts involved – 5 collaborative projects between sites, 6 projects with interdepartmental collaboration
A main focus of SAFER-SIM UTC is collaboration, both within consortium sites and across disciplines. Consortium members engage in regular web conferencing, teleconferences, and email communications, as well as face-to-face interactions via site visits and time set aside during symposia. Site directors participate in a conference call once a month to share information about the progress at each university.

SAFER-SIM researchers have a diverse range of professional backgrounds that span across many colleges throughout the universities. The variety of expertise within the consortium creates a collaborative environment to address safety issues from different perspectives. Some backgrounds include Civil Engineering, Industrial Engineering, Computer Science, Psychology & Brain Sciences, Public Health, Management Sciences and Urban and Regional Planning.

Partner Organizations – 6 partner organizations

| SAFER-SIM Project                              | Using Driver State Detection in Automated Driving |
| Organization Name:                            | Aisin Technical Center of America                |
| Location of organization:                     | Northville, MI                                  |
| Partner’s contribution:                       | Financial support - $27,000                     |

<p>| SAFER-SIM Project                              | Extended Evaluation of Training Programs to Accelerate Hazard Anticipation Skills in Novice Teen Drivers |
| Organization Name:                            | AAA Foundation for Traffic Safety               |
| Location of organization:                     | Washington D.C.                                 |</p>
<table>
<thead>
<tr>
<th>Partner’s contribution:</th>
<th>Financial support - $378,321</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFER-SIM Project</td>
<td>Extended Evaluation of Training Programs to Accelerate Hazard Anticipation Skills in Novice Teen Drivers</td>
</tr>
<tr>
<td>Organization Name:</td>
<td>InSight Learning Technologies (Subcontractor)</td>
</tr>
<tr>
<td>Location of organization:</td>
<td>Pacific Palisades, CA</td>
</tr>
<tr>
<td>Partner’s contribution:</td>
<td>- Tech support   - Personnel exchange</td>
</tr>
<tr>
<td>SAFER-SIM Project</td>
<td>Extended Evaluation of Training Programs to Accelerate Hazard Anticipation Skills in Novice Teen Drivers</td>
</tr>
<tr>
<td>Organization Name:</td>
<td>Neil Lerner (Subcontractor)</td>
</tr>
<tr>
<td>Location of organization:</td>
<td>Maryland</td>
</tr>
<tr>
<td>Partner’s contribution:</td>
<td>- Personnel exchange   - Collaborative research</td>
</tr>
<tr>
<td>SAFER-SIM Project:</td>
<td>Developing an Open Source Multi-Agent Simulation Environment for Connected Autonomous Vehicles (CAVs)</td>
</tr>
<tr>
<td>Organization Name:</td>
<td>Mandli Communications Inc.</td>
</tr>
<tr>
<td>Location of organization:</td>
<td>Madison, WI</td>
</tr>
<tr>
<td>Partner’s contribution:</td>
<td>- In-kind support Facilities   - Collaborative research   - Provided LiDAR data</td>
</tr>
<tr>
<td></td>
<td>Mandli Communications Inc., is a company specialized in highway data collection and the integration of 3D pavement technology, mobile LiDAR, and geospatial data collection equipment. Our collaboration focuses in using Mandli’s high-resolution LiDAR scans to obtain accurate visualization and collision meshes for simulation, as well as detailed road and lane information.</td>
</tr>
<tr>
<td>SAFER-SIM Project:</td>
<td>Developing an Open Source Multi-Agent Simulation Environment for Connected Autonomous Vehicles (CAVs)</td>
</tr>
<tr>
<td>Organization Name:</td>
<td>Continental Mapping Consultants Inc.</td>
</tr>
<tr>
<td>Location of organization:</td>
<td>Madison, WI</td>
</tr>
<tr>
<td>Partner’s contribution:</td>
<td>- In-kind support Facilities   - Collaborative research</td>
</tr>
<tr>
<td></td>
<td>Continental Mapping Consultants, Inc. is a company specialized in providing comprehensive geospatial services and technologies for collecting, processing, curating and analyzing geospatial data. We are currently incorporating 3D meshes generated by Continental Mapping into our virtual environment.</td>
</tr>
</tbody>
</table>

3. Outputs

Journal publications – 3 publications, 2 under review

Book chapters: – 2 chapters
• “A Connected Autonomous Vehicle Emulator (CAVE) for testing multi-agent, conventional/autonomous mixed-vehicle traffic scenarios” Dan Negrut, Asher Elmquist, Dylan Hatch, Parmesh Ramanathan and Radu Serban – under second review, ASME’s Advances in Computers and Information in Engineering Research

Other publications, conference papers and presentations:
• 3 conference presentations
• 9 symposium presentations

Full list of other publications, conference papers, and presentations here

Technology Transfer Plan Output Performance Measures
SAFER-SIM Webinars: 6 webinars, 308 registrants, 217 archived views

<table>
<thead>
<tr>
<th>Webinar</th>
<th>Date</th>
<th>Site</th>
<th>Registrants</th>
<th>Archived Views</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using Driver State Detection in Automated Driving</td>
<td>10/30/2018</td>
<td>UI</td>
<td>52</td>
<td>57</td>
</tr>
<tr>
<td>Connected Vehicles (CV) Transition and Market Penetration</td>
<td>11/13/2018</td>
<td>UCF</td>
<td>28</td>
<td>34</td>
</tr>
<tr>
<td>Augmented Reality for Safer Pedestrian-Vehicle Interaction</td>
<td>1/29/2019</td>
<td>UW</td>
<td>78</td>
<td>39</td>
</tr>
<tr>
<td>Geographically Distributed and Multi-Agent Driving Simulation Using the Unity Game Engine</td>
<td>2/12/2019</td>
<td>UW, UI</td>
<td>44</td>
<td>42</td>
</tr>
</tbody>
</table>
Tours of Facilities – 26 tours, over 725 attendees

Full list of tours here

Website - 715 website users, 6 YouTube videos, 9 datasets (this period)
Center’s website http://safersim.nads-sc.uiowa.edu/ - containing descriptions of research projects and final reports, news articles about our work, contact information, and other important information related to the center. Traffic measures from this period are below:

- 715 total users (692 of those being new)
- 1107 sessions
- 3421 page views

Center’s YouTube channel https://www.youtube.com/channel/UCE8CN3JX8_mkAf8d8-UPzKQ - containing webinar presentations and other videos related to our work including a virtual symposium, and scenario creation playlist. Metrics from videos this period are below:

- 6 videos
- 728 views
- +6 subscribers

Center’s data repository https://dataverse.harvard.edu/dataverse/safersim - containing final data from research projects.

- 9 datasets

Patents filed

- Nothing to report this period

Press releases for SAFER-SIM related research

- Nothing to report this period

DOT requests for presentations or proposals related to SAFER-SIM – 1 DOT proposal

- David Noyce, Sue Ahn, Jon Riehl, Madhav Chitturi, Radu Serban, John Lee, and Parmesh Ramanathan of UW submitted a $3 million DOT proposal in March of 2019

Media requests – 14 media requests

Full list of media requests here

Practitioner Attendance at events – 161 individuals attending 2 events

- 2018 Forum: Impact of Vehicle Technologies & Automation on Users, co-hosted by the AAA Foundation for Traffic Safety and The University of Iowa
97 individuals attended (25 from UI, 11 from AAA or AAAFTS, 10 speakers, 51 from industry and other institutions)

- Gathering of representatives and experts from the research community, government and industry to continue discussion on the impact of vehicle technologies and automation with a focus on the impact to vulnerable road users and on driver behavior and performance. Key research gaps and direction were identified via interactive discussion and exchanges with experts and stakeholders.


- **UMass Symposium November 16-18, 2018**
  - 64 registrations, 3 keynote speakers
  - **Deb Bruce from NTSB** on the first fatal crash involving an autonomous vehicle and the investigation that followed.
  - **Shannon Bliven from ValleyBike** presented the new electric-assist bike share which had just launched in Western Massachusetts. Segways and Oxboards (i.e. hoverboards) were also demonstrated with discussion about how these alternative modes would integrate into the transportation system and potential challenges. After the presentation, attendees experienced the e-bikes, Segways and Oxboards.
  - **Don Fisher from the Volpe Lab** provided an address on the range of simulation research he had conducted throughout his career.
  - Small-group tours of the UMass campus, simulation facilities, including the full-scale driving simulator, mini simulator, and air traffic control simulator.
  - Professional development activity - a light-hearted skit on proper interactions during poster sessions.
  - “Transportation mini-camps” – four topics over two days chosen by attendees, were using virtual reality for driving simulation, the impact of e-scooters on mobility and the application of drones in transportation, and curbside AAA Forum Panel

Tour of Human Performance Lab at UMass
management. During each mini-camp, there was open discussion along with short structured activities to stimulate conversation.

- Experimental design boot camp led by Dr. Shannon Roberts from UMass and Dr. Jodie Plumert from UI.
- Virtual poster session - Students who were working on a SaferSim project presented their posters on large video monitors in an integrated classroom. Other students and attendees visited the posters and voted for the best presentation. Yalda Ebaldi from UMass was awarded ‘Best Poster’ for her research on “Development and Testing of an In-Vehicle Interface for Use in Automated Driving Contexts”.

Number of improved or new simulation technologies, software, methods or processes – 5 items

- **Three simulator scenarios**, each embedded with 14 potential hazards that can be compared across the three scenarios, were created for the project. These have potential for use in future experiments by this and other research teams. This project is establishing a new methodology to conduct linked simulator experiments.
- Through this project, Yalda Ebadi has become more familiar with the Altia Design software that is used to create the warning interface in our driving simulator. As a result, Yalda Ebadi, along with other graduate students, have developed a [guide for users of the Altia Design software](#) and it has been shared amongst students in the lab.
- **Prototype of simulated environment** to understand interplay between autonomous and connected vehicles and agents, where sensing, physics, and communication all contribute to inter-agent decision making. Current simulation progress includes 1) an initial test of a scene generated in partnership with Continental Mapping that replicates a corridor along Park St. In Madison, Wisconsin; 2) multiple CAVs including sedans and vans; 3) GPS and LiDAR sensors mounted on vehicles for path following and collision prevention; 4) broadcasting of MAP messages from connected intersections for connected vehicles to use in intersection navigation.

4. Outcomes

Number of improved or new technologies, software, methods, or processes adopted

<table>
<thead>
<tr>
<th>Project</th>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhancing School Zone Safety (UPR)</td>
<td>1</td>
<td>Propose a new overhead sign to the FHWA to be incorporated in the MUTCD Part 7 Traffic Control for School Areas. This sign will be applicable to urban arterial corridors with high Average Annual Daily Traffic. This new sign provides positive guidance to the driver in order to comply with the school zone speed limit.</td>
</tr>
<tr>
<td>Evaluation of Safety Enhancements in School Zones with Familiar and Unfamiliar Drivers (UPR)</td>
<td>1</td>
<td>Propose a new overhead sign to the FHWA to be incorporated in the MUTCD Part 7 Traffic Control for School Areas. This sign will be applicable to urban arterial corridors with high Average Annual Daily Traffic. This new sign provides positive guidance to the familiar drivers in order to comply with the school zone speed limit.</td>
</tr>
</tbody>
</table>
limit. However, this new sign does not provide similar compliance for unfamiliar first-time drivers. This finding might be indicative of the consideration for use of symbols rather than text (i.e., legend) messages in areas with propensity for unfamiliar drivers on the road.

### Assessing the Impact of Smartphone Usage While Driving in Work Zones (UPR)

Amendments to the FHWA MUTCD typical applications associated with Temporary Traffic Control in work zones. This recommendation based on our research findings, will strengthen the use of protection barriers in work zones where exits are closed. This new policy would provide workers positive protection from a potential driver’s decision to encroach on the workspace due to GPS instruction.

### Augmented Reality for Safer Pedestrian-Vehicle Interactions (UW)

Nothing completed yet. However, lessons learned from the project will be used to create a new interface to emulate augmented reality interfaces in the simulator which will make it possible for the research team to move away from proprietary tools used create virtual dashboards in the vehicle cabin.

### Multi-modal Distributed Simulation Combining Cars, Bicyclists, and Pedestrians (UW)

Some of the software tools created as part of this project continue to be improved as planning for upcoming projects is underway.

### A Machine Vision Approach for Estimating Motion Discomfort in Simulators and in Self-Driving Vehicles (UW)

1  

We hope we will be able to develop a recommendation for the seat positioning of drivers to reduce the number of motion sick drivers.

---

### Stakeholders who adopt, implement or deploy SAFER-SIM research findings or technologies through policy, practice, regulation, rulemaking or legislation

<table>
<thead>
<tr>
<th>Project</th>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessing the Impact of Smartphone Usage While Driving in Work Zones</td>
<td></td>
<td>Local transportation authorities are potential stakeholders that should coordinate with GPS companies to provide adequate signage and warnings as well as improve visual and voice messages to inform users of current road conditions during O/M activities.</td>
</tr>
<tr>
<td>(UPR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Machine Vision Approach for Estimating Motion Discomfort in Simulators and in Self-Driving Vehicles (UW)</td>
<td>&gt;100</td>
<td>We think that our findings will help many institutions in better calibrating driving simulator to reduce motion sickness.</td>
</tr>
</tbody>
</table>
5. Impacts

*Expected reductions in crashes from implemented policy, practice, regulation, rulemaking, or legislation*

<table>
<thead>
<tr>
<th>Project</th>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using Simulation to Assess and Reduce Conflicts between Drivers and Bicyclists (UCF)</td>
<td>40 per year</td>
<td>This study is to study the bike crash at intersections. The identified factors are about the bike lane and shared path etc. The crashes related to the identified factors are more likely to be sideswipe crashes between vehicles and bikes. With the available data source, there are around 40 sideswipe bike crashes per year at intersection in Florida. Hence, the study could help deal with 40 bike crashes in Florida. There is no sufficient data to analyze other states.</td>
</tr>
<tr>
<td>Connected Vehicles (CV) Transition and Market Penetration (UCF)</td>
<td>14 per year</td>
<td>The estimate effectiveness of Connected Vehicle technology for fog-related crash is around 34.6%. In Florida, around 40 fatal crashes happened each year during fog. Thus, around 14 (40 *34.6%=14) fatal crashes are expected to benefit from the technology.</td>
</tr>
<tr>
<td>Using Simulation to Assess and Reduce Conflicts between Drivers and Bicyclists (UI)</td>
<td></td>
<td>We expect that the results of this project will inform policy to implement road infrastructure designs that reduce car-bicycle crashes.</td>
</tr>
<tr>
<td>Using Simulation to Assess and Reduce Conflicts between Drivers and Bicyclists (UM)</td>
<td></td>
<td>The results of this project can be used to guide decisions on bicycle infrastructure implementation both at the intersection and the segment level for safer multimodal operations.</td>
</tr>
<tr>
<td>Protected Intersection Design for Safer Cycling (UM)</td>
<td></td>
<td>The results of this project can be used to develop guidelines for protected intersection design to ensure safe multimodal operations.</td>
</tr>
<tr>
<td>Evaluation of Safety Enhancements in School Zones with Familiar and Unfamiliar Drivers (UM)</td>
<td></td>
<td>With the focus of this project having an emphasis on school zones, there is an anticipated understanding that increasing speed compliance for both familiar and unfamiliar drivers will lead to a reduction in crashes. Given the TCDs evaluated herein, there is optimism that driver compliance may be improved given a flashing overhead beacon as compared to existing minimal school zone signage standards.</td>
</tr>
<tr>
<td>Assessing the Impact of Smartphone Usage While Driving in Work Zones (UPR)</td>
<td>16% of drivers</td>
<td>It is expected that by providing the updated information of the road conditions via GPS and by implementing different protection barriers in work zones near exits, 16% of the drivers will be prevented from encroaching the workspace.</td>
</tr>
</tbody>
</table>
Therefore, the potential effects include reducing crashes in work zones and increasing workers’ safety.

A Machine Vision Approach for Estimating Motion Discomfort in Simulators and in Self-Driving Vehicles (UW)  

>1000  

We are not sure how transferrable our results from simulators to actual vehicles are. But we expect that our results will guide the development of automated vehicles, and hence, can make the driver generally more comfortable in automated vehicles and better prepared to take over when necessary.

Developing an Open Source Multi-Agent Simulation Environment for Connected Autonomous Vehicles (CAVs)  

Virtual testing and simulation of autonomous and connected vehicles allows safe and cost-effective testing of autonomous vehicles and algorithms before physical testing and before deployment.

---

**Expected reduction in congestion and traffic conflicts from implemented policy, practice, regulation, rulemaking or legislation**

<table>
<thead>
<tr>
<th>Project</th>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using Simulation to Assess and Reduce Conflicts between Drivers and Bicyclists (UM)</td>
<td></td>
<td>The results of this project can be used to guide decisions on bicycle infrastructure implementation both at the intersection and the segment level for safer and more efficient multimodal operations.</td>
</tr>
<tr>
<td>Protected Intersection Design for Safer Cycling (UM)</td>
<td></td>
<td>The results of this project can be used to develop guidelines for protected intersection design to reduce conflicts and ensure efficient multimodal operations.</td>
</tr>
<tr>
<td>Evaluation of Safety Enhancements in School Zones with Familiar and Unfamiliar Drivers (UM)</td>
<td></td>
<td>Again, the anticipated reduction in traffic conflicts and crashes weighs on the implementation of better signage in school zones, which in turn will potentially lead to an increase in driver compliance.</td>
</tr>
<tr>
<td>Enhancing School Zone Safety (UPR)</td>
<td>28% improvement in speed compliance for familiar drivers</td>
<td>It is expected that speed compliance will improve by 28%, depending upon the presence of pedestrians or the traffic level. In addition, it is expected that by providing additional information through overhead sign, drivers will reduce their average running speed.</td>
</tr>
<tr>
<td>Evaluation of Safety Enhancements in School Zones with Familiar and Unfamiliar Drivers (UPR)</td>
<td>17% improvement in speed compliance for unfamiliar drivers</td>
<td>It is expected that speed compliance for familiar drivers will improve by 28%, depending upon the presence of pedestrians or the traffic level. The expected speed compliance for unfamiliar drivers will improve by 17%. In addition, it is expected that by providing additional information through overhead sign, familiar drivers will...</td>
</tr>
<tr>
<td>Developing an Open Source Multi-Agent Simulation Environment for Connected Autonomous Vehicles (CAVs)</td>
<td>Virtual testing and simulation of autonomous and connected vehicles allows safe and cost-effective testing of autonomous vehicles and algorithms before physical testing and before deployment.</td>
<td></td>
</tr>
</tbody>
</table>

6. Changes/Problems

*Actual or anticipated problems or delays and actions or plans to resolve them*

Two projects from University of Massachusetts are past their proposed end date. The PI and site director have been notified and are in the process of completing projects and submitting final reports. Two sites in a collaborative project received no-cost extensions and have a new end date of 12/31/2018. The collaborative project is *Using Simulation to Assess and Reduce Conflicts between Drivers and Bicyclists*. University of Iowa and University of Massachusetts Amherst received the no-cost extension. University of Central Florida completed their portion of the collaborative project on time.

*Changes that have a significant impact on expenditures*

Nothing to report.

*Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards*

Nothing to report

*Change of primary performance site location from that originally proposed*

Nothing to report

7. Special Reporting Requirements

Nothing to report