



**SEMI-ANNUAL PROGRESS REPORT FOR
UNIVERSITY TRANSPORTATION CENTERS**

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Signature of Submitting Official: 

1. Accomplishments

1.1 What are the major goals of the program?

1.1.1 Research

Safety Research Using Simulation (SAFER-SIM) is a Tier 1 University Transportation Center (UTC) with a research priority of promoting safety. The UTC includes 5 institutions: University of Iowa (lead), University of Wisconsin Madison, University of Massachusetts Amherst, University of Central Florida, and University of Puerto Rico Mayaguez. SAFER-SIM leverages research from a range of disciplines to study how road users, roadway infrastructure, and new vehicle technologies interact and interface with each other. The center uses microsimulation and state-of-the-art driving, bicycling, pedestrian simulators to develop solutions for safer transportation in the US and globally.

SAFER-SIM works to promote safety by addressing these research topic areas:

- Automated Vehicles Technology
- Connected Vehicles Technology
- Vulnerable Road Users
- Roadway Infrastructure Design
- Distributed Simulation Technology

1.1.2 Leadership Development

SAFER-SIM sites are recognized nationally and internationally as leaders in transportation safety research with a distinction in applying simulation to safety problems. Developing the next generation of leaders in safety research and simulation is a key function of our work. Our center will accomplish this using seminars, symposia, web-based discussions, and other opportunities to share our expertise.

1.1.3 Education and Workforce Development

SAFER-SIM will educate the next generation of safety professionals, building the transportation workforce for tomorrow, and fostering a vibrant community of researchers.

1.1.4 Technology Transfer

SAFER-SIM will establish and promote opportunities for research collaboration with industry, state and local governments, and other organizations with an interest in transportation safety. The center will promote commercialization activities and will provide highly-trained scientists for the industrial work force

1.1.5 Collaboration

Strong collaboration efforts will take place across consortium sites, within consortium sites, and with government agencies and industry partners. Collaboration plays an important role in reaching goals in all areas at our center.

1.1.6 Diversity

SAFER-SIM is committed to promoting diversity through student involvement on research

projects and to reaching underrepresented populations in community outreach.

1.2 What was accomplished under these goals?

1.2.1 Research

SAFER-SIM has funded 43 projects – 42 research and 1 outreach – under the FAST Act. 26 projects remain active and 17 are complete. Information about these projects can be found on the Transportation Research Board’s [Research in Progress \(RIP\) Database](#) and the [SAFER-SIM website](#).

Year	Projects Active	Projects Complete	Total Projects
Y1	2	7	9
Y2	7	9	16
Y3	17	1	18
Total	26	17	43

SAFER-SIM completed 8 research projects this period. These projects have submitted final reports to required entities and have uploaded final datasets in our [Harvard Dataverse](#).

Projects Completed this Period	TRID
Risk Awareness and Perception Training using VR Headsets: The Validation of VR Headsets to Measure Hazard Anticipation Behaviors *Reported last period but wasn’t on TRID	01706588
Driver Behavior and Performance with In-Vehicle Display Based on Speed Compliance	01712414
Enhancing School Zone Safety: Case Studies in Puerto Rico using Driving Simulation	01712409
Dissecting the Safety Benefits of Protected Intersection Design Features	01714363
Developing an Open-Source Multi-Agent Simulation Environment for Connected Autonomous Vehicles	01712411
Safely and Effectively Communicating Non-Connected Vehicle Information to Connected Vehicles through Field- and Driving-Simulator-Based Research	01713096
Evaluation of Safety Enhancements in School Zones with Familiar and Unfamiliar Drivers	01712413
Evaluation of Managed Lane Facilities in a Connected Vehicle Environment	01717787

Findings from a [SAFER-SIM project](#) helped the University of Central Florida receive an external grant from the National Science Foundation for \$210,000 for the project *Predicting Real-time Population Behavior during Hurricanes Synthesizing Data from Transportation Systems and Social Media*. Traffic data analysis done under the SAFER-

SIM project significantly helped understand certain aspects of hurricane evacuation that will be investigated in the above NSF-funded project.

Below is a summary of research performance metrics for the current performance period. Full list can be found [here](#).

Performance Metric	Result
Peer-reviewed journal publications (published)	9
Book chapters	3
Edited books	NA
Conference papers, posters, and symposia	7
Paper/poster awards	2
External grants related to SAFER-SIM	2

1.2.2 Leadership Development

Researchers and students gained and shared valuable experience through SAFER-SIM work this period.

A major accomplishment for our center is the development and presentation of the Simulation Boot Camp. The boot camp was a 5-part webinar series developed by the collective simulation expertise within our consortium. SAFER-SIM researchers presented materials every Tuesday in April 2019 and covered the following topics: Overview of Simulation; Experimental Design; Scenario Design, Development, and Testing; Conducting Simulator Studies; and Data Analysis. The series was open to individuals in academia, government, and industry who were interested in learning how to use simulation technology in their research. The boot camp had 195 registrants – 146 from academia, 43 from industry, and 6 from government. The [archived boot camp videos on YouTube](#) have 387 views since posting.

SAFER-SIM researchers continued representing the center at professional meetings. Some center highlights include:

- Dr. Mohamed Abdel-Aty from UCF provided the Francis C. Turner distinguished lecture at the ASCE banquet in Alexandria, VA on the *Application of Big Data Analytics and Visualization in Pro-Active Traffic Safety Management*.
- Dr. Aty also gave a keynote speech titled *Assessing the Safety Benefits of Connected and Low Level Automated Vehicles* at the 7th International Symposium on Transportation in Shanghai.
- Drs. Jodie Plumert and Joe Kearney from UI represented the American Psychological Association and the Federation of Associations in Behavioral and Brain Sciences at the Coalition for Health Funding Public Health Fair in Washington DC. With lawmakers and staff in attendance, they showcased their innovative work that uses virtual reality to study child pedestrian and bike safety.

SAFER-SIM contributed to the advancement of simulation and road safety through other

leadership development activities this period. Researchers actively participated on grant review panels, advisory committees, professional organizations, and other scholarly endeavors. The leadership of individuals in our center has been recognized by other organizations leading to the following highlighted awards this period:

- Benjamín Colucci (UPR), 2019 ITE’s Wilbur S. Smith Distinguished Transportation Educator Award
- Eleni Christofa (UM), Barbara H. and Joseph I Goldstein Outstanding Junior Faculty Award, College of Engineering, University of Massachusetts Amherst, 2019
- Katerina Deliali (UM), American Road & Transportation Builder Association “The Future Industry Spotlight Award”, 2019
- Mohamed Abdel-Aty (UCF), Transportation Safety Council Edmund R. Ricker Individual Award, Institute of Transportation Engineering (ITE), July 2019
- Mohamed Abdel-Aty and his UCF team, Stage II winners of USDOT Solving for Safety Visualization Challenge for their project *Real-time crash risk visualization using integrated tools for traffic safety evaluation and management*
- Mohamed Abdel-Aty and his UCF team, Green Cross for Safety Award Excellence finalist. National Safety Council award that “recognizes those who have made a significant impact on safety by raising awareness and bringing about change”

Below is a summary of leadership development performance metrics. Full list can be found [here](#).

Performance Metric	Result
Invited presentations	27
Invited papers	NA
Invited workshops	2
Grant review panels	8
Advisory committees	27
Journal editing	29
Leadership positions in professional organizations	19
SAFER-SIM webinars	6
Professional awards	10

1.2.3 Education and Workforce Development

Consortium members continue engaging students of all levels this period in transportation, safety, and STEM (science, technology, engineering, and math).

SAFER-SIM funded an outreach project in year 3 by sponsoring the University of Iowa’s SAE Baja Team. The sponsorship supported the team’s trip to the California Nationals Event in May 2019. At this event, teams designed and built off-road vehicles capable of traversing difficult obstacles on tracks specifically designed to test their car. 14 undergraduate engineering students went to the competition, and 3 of those students have

since graduated and found full-time engineering positions in the workforce. The UI Baja team placed 14th overall this year, the best finish in team history. A full description of the student development project can be found in this [outreach project's final report](#).

SAFER-SIM developed an [online resource](#) for Scouts across the country to earn the Traffic Safety merit badge. The goal of the resource was to create greater visibility and access to the merit badge. The Traffic Safety merit badge “gives Scouts some crucial tools to stay safer when driving a car on a highway, riding a bike across town, or jogging across a busy street.” By completing the Traffic Safety merit badge, Scouts learn about transportation safety, careers, and research at an opportune time. The Traffic Safety merit badge not only educates users of the transportation system, but it sparks the interest of the next generation of researchers and professionals to study crucial questions in the transportation field. The online resource became available in August 2019. Since then 137 Scouts have started the materials and 32 have completed the requirements.

The University of Iowa attended the World Scout Jamboree from July 22 - August 2, 2019 with over 30,000 Scouts in attendance from across the world. The center launched an online process of earning the Traffic Safety merit badge (describe above) while attending. Additionally, transportation safety demonstrations were provided to attendees using a portable driving simulator. Presenters interacted with 1854 scouts from 51 countries and 40 states.

7 students from Northwest Junior High School in Iowa City visited the National Advanced Driving Simulator in preparation for a trip to the National TEAMS (Tests of Engineering Aptitude, Mathematics and Science) competition. They submitted an entry for the Digital Media Competition where their challenge was to create informative and persuasive digital media promoting the advantages of autonomous vehicles. They spoke with researcher Chris Schwarz who shared insights into automation and gave a lab tour. The team placed 2nd overall at the nationals with the following video: [Autonomous Cars TSA Nationals](#)

Below is a summary of leadership development performance metrics. Full list can be found [here](#).

Performance Metric	Result
Peer-reviewed journal publications w/ student authors	3
Book chapters w/ student authors	1
Conference posters and papers w/ student authors	12
Paper/poster awards w/ student authors	2
Graduate students working on and supported by SAFER-SIM related projects	38
Undergraduate students working on and supported by SAFER-SIM related projects	22
Student attendance and presentations at the SAFER-SIMposium	NA
Transportation-related M.A. and PhD theses	4

Curriculum modules developed	3
Student Internships	6
Presentations to student groups or classes	10 presentations 1972 students
# Schools visited and # students present	10 schools 435 students
# Career fairs visited and # of attendees	3 fairs 752 attendees
Summer institutes and programs and # of students participating	7 institutes 159 students

1.2.4 Technology Transfer

Projects funded by SAFER-SIM work toward technology transfer goals from the beginning through completion. State DOTs, industry partners, and other agencies work with researchers by using their expertise or findings to inform decisions that guide future research and projects.

A main aspect of our technology transfer activities involves webinars. Research projects are required to present webinars about their results which are shared with contacts in academia, industry, and government. The presentations focus on findings, recommendations, specifications, and guidelines. The center hosted 6 webinars this period with 237 registrants – 180 from academia, 43 from industry, and 14 from government.

Webinar	Date	Registrants	Archived Views
Driver360: A Four Dimensional Scanning System to Better Understand Drivers	5/22/2019	43	30
Risk Awareness and Perception Training using Virtual Reality (RAPT-VR)	6/6/2019	55	56
Open Source Multi Agent Simulation Environment for Connected Autonomous Vehicles	6/20/2019	33	32
Dissecting the Safety Benefits of Protected Intersection Design Features	8/30/2019	25	13
Safely and Effectively Communicating Non-Connected Vehicle Information to Connected Vehicles	9/10/2019	19	11
Human-Machine Interfaces to Convey Feedback in Automated Vehicles	9/24/2019	62	20
		237	162

Our center has been successful at receiving media attention from our work. Some highlights of SAFER-SIM sites in the media this period include:

- [Iowa Senate approves autonomous vehicle regulations](#) –*KMA Land*
- [NSC Announces 2019 Green Cross for Safety Award Finalists](#) – *National Safety Council*
- [University of Iowa awarded \\$7 million from US DOT to test driverless technologies](#) – *The Gazette*

Sharing our work with stakeholders has led to site tours from government and industry. Individuals from the following organizations visited this period:

- Iowa Federal Legislative district staff
- Governor’s Empower Rural Iowa Initiative
- Racine County (WI) Mayor and City of Racine Engineers
- Federal Highway Administration
- National Highway Traffic Safety Administration
- National Transportation Safety Board
- Seoul Institute of Technology
- Toyota
- Aisin
- Harmon

Below is a summary of our technology transfer plan performance metrics with the full list accessible [here](#) with more detail provided in section 3 below.

Performance Metric	Result
SAFER-SIM webinars	6
Registrations for webinars	237
Views of archived webinar content	162
Press releases for SAFER-SIM related research	NA
Media requests	21
Tours of facilities	14
Website traffic	2736 users 4461 sessions 8406 page views
Patents filed	NA
DOT requests for presentations or proposals related to SAFER-SIM	1
Practitioner attendance at events	43
Number of improved or new simulation technologies, software, methods, or processes	4

1.2.5 Collaboration

Collaboration drives our consortium in all aspects of our work. Our collaboration is

described further in section 2 of this report.

Below is a summary of collaboration performance metrics. Full list can be found [here](#).

Performance Metric	Result
Attendance at the SAFER-SIMposium	NA
Interdisciplinary research projects within and across sites	4
Collaborative research projects across SAFER-SIM or other UTC sites	5
Collaborations with industry partners and government agencies	5
Collaborative peer-reviewed journal publications	0
Collaborative book chapters	0
Student exchanges with other SAFER-SIM sites	0
Students pursuing advanced degrees at other SAFER-SIM sites	0
Programs involving community colleges	0
Graduates hired at other SAFER-SIM or UTC sites	0

1.2.6 Diversity

Diversity continues to play an important part in our research and outreach. 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. 20 diverse students were involved in 28 SAFER-SIM projects this period. A former student involved in SAFER-SIM research at UPR found a job after graduating in June 2019. Enid Colon Torres now works in Nashville, TN at the Federal Highway Administration.

Along with the direct student research involvement, SAFER-SIM sites are leaders in promoting diversity in a number of ways. Some selected highlights include:

- John D. Lee (UW) received the Equity and Diversity Faculty Award, a Faculty Recognition Award in 2019
- In June 2019, UW-Madison hosted a group of 75 high school girls as part of an event organized by the Society of Women Engineers as part of the Engineering Tomorrow's Career Camp. The group visited the driving simulator and learned about transportation safety.
- Shannon Roberts of University of Massachusetts served on a panel focused on Women in Science for undergraduate female students in April 2019. She and her student Yalda Ebadi also presented transportation safety information during the Girls, Inc. Eureka Program in July 2019 to 18 middle school females.
- Advancing Women in Transportation – three members of SAFER-SIM attended WTS – Iowa Chapter Inaugural Event. WTS is an international organization dedicated to building the future of transportation through the global advancement of women with over 6,500 members, including both women and men.
- The University of Iowa hosted a Femineers Summit in May 2019. SAFER-SIM program coordinator Jacob Heiden helped organize the event as part of the

planning committee. The Femineers program provides K-12 students with project based learning, undergraduate women engineering student mentors, and opportunities to visit UI's campus. 31 students participated in the summit.

Performance Metric	Result
# SAFER-SIM projects involving underrepresented/minority (U/M) students	28
# U/M events attended	5
# U/M students at attended events	124
Graduating U/M student placement	1

1.3 What opportunities for training and professional development have been provided?

SAFER-SIM provides opportunities for training and professional development in a number of ways. Students gain direct training from faculty and research staff from involvement in research projects. Researchers and students are encouraged to attend conferences to share their work and continually develop their professional skills.

The Simulation Boot Camp organized by our center trained both professionals and students on using simulation in their research. The boot camp had 146 participants from academia, 43 from industry, and 6 from government. The presentations are now available online and will be accessible into the future for new individuals interested in simulation research. The boot camp will also be presented as an in-person workshop at the Road Safety & Simulation conference in October 2019 for more hands-on training with the materials.

1.4 How have the results been disseminated?

Final reports and datasets are posted on all required repositories after completion. Additionally, 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. Researchers and students also share their work at meetings, conferences, and with the public.

While most of our outreach work is related to students, our center believes it's important to share our work with the general public to enhance safety information and interest in the transportation field. SAFER-SIM attended the Iowa State Fair with all members of the public and the Fall Prevention Awareness, Health and Resource Fair focused on the older population. The center promoted safety and transportation careers to 926 individuals at these 2 events.

1.5 What do you plan to do next reporting period to accomplish these goals?

SAFER-SIM sent out a Request for Proposals for Year 4 projects in September this period. Proposals are due in December 2019 with award decisions made in March of 2020. Year 4

projects will begin summer or fall 2020.

A cooperative agreement between AAA Foundation for Traffic Safety (AAAFTS) and SAFER-SIM will continue for a second year. A proposal for a year-2 project “The Impact of Driver’s Mental Models of Advanced Vehicle Technologies on Safety and Performance” will build on the first year project was developed collectively with AAAFTS researchers and will be presented to the AAAFTS advisory board in October. This project is a true collaboration between the two partners in that there is active interaction throughout the project between AAAFTS and SAFER-SIM researchers. Both partners have committed \$150,000 in funding and four SAFER-SIM institutions will be involved.

SAFER-SIM hosts regular symposia at consortium institutions for students, staff, and faculty to focus on leadership development, education and workforce development, and collaboration. The next symposium is scheduled in October 2019 at the University of Iowa. It will be held in conjunction with the 2019 Road Safety & Simulation conference also held at the University of Iowa. The RSS conference provides a bi-annual platform for researchers and professionals from various disciplines to share expertise and the latest insights in the field of road safety and simulation.

2. Participants & Collaborating Organizations

2.1 What organizations have been involved as partners?

The following organizations have been involved as SAFER-SIM partners:

<i>Organization Name</i>	<i>Location</i>	<i>Contribution</i>
Aisin Technical Center of America	Northville, MI	Financial support
AAA Foundation for Traffic Safety	Washington D.C.	Financial support Collaborative research
InSight Learning Technologies	Pacific Palisades, CA	Personnel exchange
Mandli Communications Inc.	Madison, WI	In-kind support Facilities Collaborative Research
Continental Mapping Consultants Inc	Madison, WI	In-kind support Facilities Collaborative Research
Council of University Transportation Centers New this period	Washington D.C	Financial support

2.2 Have other collaborators or contacts been involved?

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 backgrounds that span many colleges throughout the universities. The variety of expertise within the consortium creates a collaborative environment to take a wholistic approach on safety issues. The backgrounds of our researchers include:

- Civil, Environmental, & Construction Engineering
- Mechanical, Industrial, & Systems Engineering
- Computer Science
- Psychology & Brain Sciences
- Public Health
- Management Sciences
- Urban and Regional Planning

Our advisory board currently includes 10 individuals from industry, government, and academia. A new member from the state of Wisconsin is expected in October 2019.

William Horrey	AAA Foundation for Traffic Safety
Patrick Hoye	Iowa Governors Traffic Safety Bureau
Rich Romano	University of Leeds
Lisa Schletzbaum	Massachusetts DOT
Gary Huttman	MetroPlan Orlando
Chuck Green	Industry consultant (formerly GM)
Elizabeth Pulver	State Farm
Don Fisher	Volpe
John Corbin	USDOT
Linda Boyle	University of Washington

3. Outputs

Below is a summary of our technology transfer plan output performance metrics. Further description can be found in Section 1.2.4 Technology Transfer Accomplishments with the full list accessible [here](#).

Performance Metric	Target	Result	Target Next Period
SAFER-SIM webinars	6	6	6
Registrations for webinars	150	237	250
Views of archived webinar content	100	162	200
Press releases related to SAFER-SIM	1	None to report	1

Media requests	20	21	20
Tours of facilities	10	14	10
Website traffic	1000 users 3000 sessions 6000 page views	2736 users 4461 sessions 8406 page views	3000 users 5000 sessions 8500 page views
Patents filed	1	None to report	1
DOT requests for presentations or proposals related to SAFER-SIM	1 per year	1	1 per year
Practitioner attendance at events	50	20 Government 86 Industry	100
Number of improved or new simulation technologies, software, methods, or processes	5	4	5

3.1 Publications, conference papers, and presentations

Journal Publications

1. Pai Mangalore, G., Ebadi, Y., Samuel, S., Knodler, M. A., & Fisher, D. L. (2019). The Promise of Virtual Reality Headsets: Can They be Used to Measure Accurately Drivers' Hazard Anticipation Performance?. *Transportation Research Record*, <https://doi.org/10.1177%2F0361198119847612>
2. Zhang, F., Mehrotra, S., Roberts, S. C. (2019). Driving distracted with friends: Effect of passengers and driver distraction on young drivers' behavior. *Accident Analysis & Prevention*, 132. <https://doi.org/10.1016/j.aap.2019.07.022>
3. Ebadi, Y., Fisher, D., & Roberts, S. C. (2019). Impact of cognitive distractions on drivers' hazard anticipation behavior in complex scenarios. *Transportation Research Record*. <https://doi.org/10.1177%2F0361198119846463>
4. Hamann, C., Schwab-Reese, L. O'Neal, E.E., Butcher, B., Yang, J., & Peek-Asa C. (2019). Family communication patterns and teen driving intervention effectiveness. *American Journal of Health Behavior*, 43(5), 963-974. <https://doi.org/10.5993/AJHB.43.5.8>
5. O'Neal, E. E., & Plumert, J. M. (2019). Do mother-child conversations about safety differ in middle- and low-income families? *Journal of Injury and Violence Research*, 11,171-178. <https://doi.org/10.5249/jivr.v11i2.1093>
6. O'Neal, E. E., Jiang, Y., Brown, K., Kearney, J. K., & Plumert, J. M. (2019). How does crossing roads with friends impact risk taking in young adolescents and adults? *Journal of Pediatric Psychology*, 44(6), 726-735. <https://doi.org/10.1093/jpepsy/jsz020> Jiang, Y., O'Neal, E. E., Rahimian, P., Yon, J.P., Plumert, J. M., & Kearney, J. K. (2019). Joint action in a virtual environment: Crossing roads with risky vs. safe human and agent partners. *IEEE Transactions on Visualization and Graphics*, 25, 2886-2895. <https://doi.org/10.1109/TVCG.2018.2865945>

7. Rahimian, P., O’Neal, E., Plumert, J. M., and Kearney, J. K. (2018). Harnessing vehicle-to-pedestrian (V2P) communication technology: Sending traffic warnings to texting pedestrians. *Human Factors*, 60 (6), 833-843.
<https://doi.org/10.1177%2F0018720818781365>
8. O’Neal, E. E., Jiang, Y., Franzen, L. J., Rahimian, P., Yon, J. P., Kearney, J. K., & Plumert, J. M. (2018). Changes in perception–action tuning over long time scales: How children and adults perceive and act on dynamic affordances when crossing roads. *Journal of Experimental Psychology: Human Perception and Performance*, 44, 18-26. <https://psycnet.apa.org/doi/10.1037/xhp0000378>
9. Rahman, M. H., Abdel-Aty, M., Lee, J., & Rahman, M. S. (2019). Enhancing traffic safety at school zones by operation and engineering countermeasures: A microscopic simulation approach. *Simulation Modelling Practice and Theory*, 94, 334-348. <https://doi.org/10.1016/j.simpat.2019.04.001>

Conference papers and presentations

1. A. Elmquist, E. Brandt, and D. Negrut, “Virtual Sensing for Simulating Autonomous Behavior”, *Computing in Engineering Forum*, 2019
2. Safely and Effectively Communicating Non-Connected Vehicle Information to Connected Vehicles. August 22, 2019. 2019 Mid-Continent Transportation Research Symposium. Iowa State University. Ames, IA
3. Valdés, D., Colucci, B., Figueroa-Medina, A., Colón, E., Rojas, M., García, R., Taveras, Y., Ramos, I., Arroyo, C. (2019). “Operational Analysis of School Zones Using a Driving Simulator”. *American Society of Civil Engineers: International Conference on Transportation & Development*, Alexandria, VA.
4. Qin, L., Flockhart, P., Lapets, A., Jansen, F., Bab, K., Varia, M., Roberts, S. C., & Globus-Harris, I. (2019). From usability to secure computing and back again. In *Proceedings of the 15th Symposium on Usable Privacy and Security (SOUPS)* (pp. 191-210). Santa Clara, CA: Usenix Association.
5. O’Neal, E. E. & Plumert, J. M. (April, 2019). Peer influences on risk taking when crossing roads. Oral Presentation given at the biennial meeting of the Society for Advancement of Violence and Injury Research, Cincinnati, OH.
6. Moatz Saad, Mohamed Abdel-Aty, Jaeyoung Lee, Yina Wu, and Md Sharikur Rahman. *International Conference on Transportation and Development 2019: Smarter and Safer Mobility and Cities*. Reston, VA: American Society of Civil Engineers. “Safety Analysis of Managed Toll Lanes Considering Connected Vehicles.”
7. Deliali, A., Christofa, E., Knodler, M., Tainter, F., Campbell, N., 2019. Assessing the impact of protected bicycle infrastructure on driver behavior. *ASCE International Conference on Transportation and Development*, June 9-12, Arlington, VA.

Books or other non-periodical, one-time publications

1. D. Negrut, A. Elmquist, D. Hatch, P. Ramanathan, R. Serban, “A Connected Autonomous Vehicle Emulator (CAVE) for testing multi-agent, conventional-

autonomous mixed traffic scenarios.” Advances in Computers and Information in Engineering Research, 2019

2. Christofa, E., Esentehr, S., Pollitt, K., 2019. Chapter 16: Incorporating Health Impacts in Transportation Project Decision Making, Transport and Health, Elsevier.
3. Roberts, S. C., Smith-Doerr, L., Zilberstein, S., Renski, H., Branch, E. H., & Wilkerson, T. (in press). Automation, work, and racial equity: How human systems engineering can shape the future of work. In R. D. Roscoe, E. K. Chiou, & A. R. Wooldridge (Eds.), Advancing Diversity, Inclusion, and Social Justice through Human Systems Engineering. Boca Raton, FL: CRC Press.

3.2 Policy Papers

Nothing to report

3.3 Websites(s) or other Internet site(s)

[SAFER-SIM website](#) - contains descriptions of research projects and final reports, news articles about our work, contact information, and other important information related to the center. The website is updated regularly with news stories and outreach events. Traffic measures from the website this period are below:

Metric	This Period	Lifetime
Total Users	2736	5630
New Users	2710	5630
Sessions	4461	9400
Page Views	8406	27,704

[SAFER-SIM YouTube Channel](#) - contains webinars, virtual symposium presentations, simulation boot camp, and online traffic safety merit badge videos. Metrics from those videos are below:

Metric	This Period	Lifetime
Uploaded videos	18	66
Views	2881	6718
Subscribers	22	70

[SAFER-SIM Dataverse](#) - data repository containing final data from research projects.

Metric	This Period	Lifetime
Datasets	8	17
File Downloads	622	1930

3.4 New methodologies, technologies or techniques

Projects funded by SAFER-SIM developed or improved on the following technologies this period:

1. Chrono::Sensors module – the project focuses on establishing a library of sensors that is open source and publicly available. For most of it, it’s based off the race-

- tracing package called OptiX.
2. Virtual world representation framework – a simulation technology with the goal to establish an infrastructure that allows one to generate virtual worlds that work hand-in-hand with the sensor library being developed.
 3. New approach to defining, identifying, and designing scenarios to examine driver behaviors in driving simulation to assess errors and mental models.
 4. We developed a simple way to simulate the regenerative braking levels observed in the Tesla. Future work would be to more completely model the dynamics of the Tesla vehicle and powertrain.

3.5 Inventions, patent, and/or licenses

Nothing to report

3.6 Other products

[Simulation Boot Camp Videos](#) – described in Section 1.2.2

[Online Traffic Safety Merit Badge](#) – described in Section 1.2.3

Two-page Project Summaries – Each research project is required to submit a 2-page summary of the research for a quick overview and takeaways from the work. The summaries focus on recommended practices for transportation professionals providing easier access to key information than the technical report and are available on the “Research” tab of our website within specific project information.

4. Outcomes

SAFER-SIM included 3 performance measures related to outcomes in our technology transfer plan:

Performance Measure	Target	Result	Target Next Period
Number of improved or new technologies, software, methods, or processes adopted	5	6	5
Stakeholders who adopt, implement or deploy SAFER-SIM research findings or technologies through policy, practice, regulation, rulemaking or legislation	5	4	2
Number of projects that reach adoption, implementation or deployment	1	0	1

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

1. New Chrono::Sensors module - The project focuses on establishing a library of sensors that is open source and publicly available. For most of it, it’s based off the race-tracing package called OptiX.
2. Virtual world representation framework. For the second simulation technology, the goal is to establish an infrastructure that allows one to generate virtual worlds that

- work hand-in-hand with the sensor library being developed.
3. Findings from project will guide recommendations for the seat positioning of drivers to reduce the number of motion sick drivers.
 4. 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.
 5. New approach to defining, identifying, and designing scenarios to examine driver behaviors in driving simulation to assess errors and mental models.
 6. We developed a simple way to simulate the regenerative braking levels observed in the Tesla. Future work would be to more completely model the dynamics of the Tesla vehicle and powertrain.

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

1. Findings from our project will help many institutions (100s) in better calibrating driving simulator to reduce motion sickness.
2. 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 (AADT). This new sign provides positive guidance to the driver in order to comply with the school zone speed limit.
3. 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. 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.
4. 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.

Number of projects that reach adoption, implementation or deployment

Nothing to report

4.1 Increased understanding and awareness of transportation issues

SAFER-SIM makes efforts to reach all stakeholders with our research and outreach.

Researchers and students share work at conferences, meetings, and with the general public to promote safety and bring awareness to transportation issues.

4.2 Passage of new policies, regulation, rulemaking, or legislation

The Governor of Iowa Kim Reynolds approved [Senate File 302](#) in May of 2019. Senate File 302 is an Act relating to motor vehicles operated by an automated driving system, and making penalties applicable. When speaking about the bill, State Senator Chris Cournoyer said “Iowa is at the forefront of developing and testing new technology for self-driving vehicles” and referenced the University of Iowa’s National Advanced Driving Simulator.

4.3 Increases in the body of knowledge

SAFER-SIM research continues to build on the knowledge of transportation safety and simulation through final reports, summaries, journal articles, book chapters, and presentations at conferences, meetings, and other avenues.

4.4 Improved processes, technologies, techniques and skills in addressing transportation issues

Highlighted in technology transfer outputs above.

4.5 Enlargement of the pool of trained transportation professionals

Our center supports the development of trained transportation professional in numerous ways. College students directly involved in research will graduate and join the workforce as members of industry or government. Outreach efforts focused on middle school and high school students will spark the interest of some to study and join the transportation field. The Simulation Boot Camp presented by researchers in our consortium trained individuals from industry, academia, and government. The recorded presentations from the boot camp continue to draw interest online.

4.6 Adoption of new technologies, techniques or practices

Nothing to report

5. Impacts

SAFER-SIM included 3 performance measures related to impacts in our technology transfer plan:

Performance Measure	Target	Result
Expected reductions in crashes from implemented policy, practice, regulation, rulemaking or legislation	Not yet determined	Not yet realized
Expected reductions in congestion and traffic conflicts implemented policy, practice, regulation, rulemaking or legislation	Not yet determined	Not yet realized

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

1. Virtual testing and simulation of autonomous and connected vehicles allow safe

and cost-effective testing of autonomous vehicles and algorithms before physical testing and before deployment. Furthermore, accurate models and simulation of the various sensors present on autonomous vehicles as well as accurate virtual representation of the environment enable effective development of autonomous driving systems.

2. 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.
3. 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. Therefore, the potential effects include reducing crashes in work zones and increasing workers' safety.
4. 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.
5. Provide insights on the impacts of different V2I infrastructure locations on network safety.

Expected reductions in congestion and traffic conflicts implemented policy, practice, regulation, rulemaking or legislation

1. Virtual testing and assessment allow safe evaluation of current and proposed autonomous in various environments and scenarios and can be used to inform policy, regulations, and legislation.
2. 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 reduce their average running speed.
3. 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.
4. Optimal deployment of V2I infrastructure over network for maximizing mobility.

5.1 Impact on the effectiveness of the transportation system

SAFER-SIM's approach to understanding the role that humans play in a complex, ever-changing transportation environment will lead to improved safety and effectiveness of the transportation system. Our research will lead to a safer roadway environment that encourages multiple modes of transportation, thereby also reducing traffic congestion and preserving the environment.

5.2 Impact on the adoption of new practices, or instances where research outcomes have led to the initiation of a start-up company

Nothing to report

5.3 Impact on the body of scientific knowledge

Highlighted in Sections 1 and 3

5.4 Impact on transportation workforce development

Highlighted in Section 1

6. Changes/Problems

6.1 Changes in approach and reasons for change

Nothing to report

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

Nothing to report

6.3 Changes that have a significant impact on expenditures

Nothing to report

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

Nothing to report

7. Special Reporting Requirements

A final research report is embargoed from posting on the SAFER-SIM website and TRID until journal article stemming from the [project](#) has been accepted. Our grant manager Robin Klein has been notified of this delay on report submission.