

AFER SEMI-ANNUAL PROGRESS REPORT FOR UNIVERSITY TRANSPORTATION CENTERS

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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 five 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 human in the loop 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

The center has funded ninety-nine (99) projects under the FAST Act. Fifteen (15) projects remain active, and eighty-four (84) projects have completed research activities. Multi-institution collaborative projects are counted separately for each institution. All project information can be found on the research tab of the <u>SAFER-SIM website</u> and active projects are listed on the Transportation Research Board's <u>Research in Progress (RIP) Database</u> though information is still being gathered for posting for a few projects.

Year	Funded/Inactive	Projects Active	Projects Complete	Total Projects
Y1	0	0	14	14
Y2	0	0	16	16
Y3	0	0	19	19
Y4	0	2	21	23
Y5	0	6	12	18
Y6	0	7	2	9
Total	0	15	84	99

Nine (9) research projects that have completed research activities have submitted reports that are still under review. These projects are finalizing revisions to reports and datasets, and final submission to TRID will follow completion of review.

Below is a summary of research performance metrics for the current performance period. Full list can be found <u>here</u>.

Performance Metric	Result
Peer-reviewed journal publications (published)	23
Book chapters	0
Edited books	0
Conference papers, posters, and symposia	12
Paper/poster awards	3
External grants related to SAFER-SIM	9

1.2.2 Leadership Development

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

SAFER-SIM researchers continued representing the center at professional meetings through invited presentations. This work shows the combined expertise of our center along with the wide range of stakeholders interested in our research including state departments and tech companies. Some invited presentation highlights include:

- Hazard anticipation training: A parent-focused, teen-driving intervention. Illinois High School & College Driver Education Association 2023 Fall Workshop, Macomb, IL, September 20, 2023. (O'Neal)
- 2. Parent's/guardian's role in teaching their novice teen driver to anticipate roadway hazards. 2023 American Driver & Traffic Safety Education Association Annual Conference, Wichita, July 18, 2023. (O'Neal)
- 3. Impaired Driving and Advanced Driver Assistance Systems Crash Research. Iowa Traffic Incident Management Conference, Ames, Sept. 26, 2023. (Reyes)
- 4. Gender in Driver Behavior. TRB AME20 Mid-Year Meeting on September 6, 2023. (Roberts)
- 5. Effectiveness of Bike Boxes in Massachusetts, MassDOT Innovation Webinar Series, April 27, 2023. [virtual] (Christofa).
- 6. Demonstration of robotic vehicle for IGNITE engineering success conference
- 7. Discussed Quantifying Autonomous Vehicle Pedestrian Interactions at Intersections project and Evolution of User Trust in Autonomous Vehicles and Characteristics of Disengagements project along with development of automated vehicle program with the City of Racine at the Smart Cities Connect conference on May 18, 2023.

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. SAFER-SIM researchers were honored by an array of awards for impactful achievements in transportation. Some exemplary awards were given to our Co-Directors and are listed below:

- 1. Higher Education Resource Services (HERS) Leadership Institute (Christofa)
- 2. Civil and Environmental Engineering (CEE) Faculty Service Award, University of Massachusetts Amherst (awarded to the whole Diversity, Equity, and Inclusion Committee) (Christofa)
- 3. Link Foundation Fellowship (Pai)
- 4. AAAM Elaine Wodzin Award (Pradhan)

Below is a summary of leadership development performance metrics. Full list can be found here.

Leadership Development Performance Metrics	Result
Invited presentations	7
Invited papers	0
Invited workshops	3
Grant review panels	5
Advisory committees	21
Journal editing	35
Leadership positions in professional organizations	20
SAFER-SIM webinars (see section 1.1.4)	3
Professional awards	4

1.2.3 Education and Workforce Development

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

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The University of Iowa actively engaged K-12 students this period through tours, events, and classroom visits with 762 students participating. The UI team focused on visiting school districts with high percentages of minority students and established relationships with new school districts while continuing existing relationships. School classroom visits present STEM concepts and provide students with information on transportation careers and present science topics supporting physics, math, psychology, and health curricula. Two in-class mini research activities are offered, distracted driving and stopping distance based on the coefficient of friction of different road conditions. Additionally, UI researchers are again involved in the organizing committee for the <u>Iowa National Transportation Summer Institute</u> (<u>INTSI</u>). The INTSI is a STEM Camp for 7-9 grade students focusing on STEM education, careers in transportation, and leadership. The program provided 16 students with challenges with two weeks of introduction to careers in aviation, maritime, and surface transportation.

K-12 activities include:

- Classroom visits 140 students
- Project Lead the Way or Class tours 142 students
- STEM Night 350 students
- Job Shadows 1 student
- Workshops 9 students
- Other 120 students

Activities with collage-age students include:

• 7/7/2023 Iowa Summer Institute in Biostatistics tour of DSRI at UI - 16 students

SAFER-SIM developed an <u>online resource</u> in 2019 for Boy Scouts of America to earn the Traffic Safety merit badge. The goal of the resource is to create greater visibility and access to the merit badge. The Traffic Safety merit badge "gives Scouts 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 online resource continued making nationwide impacts this period with students this period.

In 2020, SAFER-SIM developed a similar <u>online tool</u> for the Engineering Merit Badge. Whether it is improving personal electronics, developing health care solutions, creating automated vehicles, protecting the environment or sending people to Mars, engineers are using math and science to create a better tomorrow. Earning the Engineering Merit Badge gives Scouts a better understanding of how engineers work and how to apply the engineering process to daily problems. For both badges, dome scouts work with the badge material online then obtain completion documentation locally rather than from our personnel.

Traffic Safety Merit Badge			
This Period To Date			
Started 31 1156			
Completed 33 767			
Engineering Merit Badge			

	This Period	To Date
Started	5	344
Completed	3	173

Below is a summary of education and workforce development performance metrics. Full list can be found here.

Education and Workforce Development Performance Metric	Result	
Peer-reviewed journal publications w/ student authors	18	
Book chapters w/ student authors	0	
Conference posters and papers w/ student authors	10	
Paper/poster awards w/ student authors	3	
Graduate students working on and supported by SAFER-SIM	26	
related projects		
Undergraduate students working on and supported by SAFER-	14	
SIM related projects		
Student attendance and presentations at the SAFER-SIM	0	
symposium		
Transportation-related M.A. and PhD theses	5	
Curriculum modules developed	1	
Student Internships	2	
Presentations to student groups or classes	5	
	>500	
# Schools visited and # students present	2	
	140 students	
# Career fairs visited and # of attendees	2 career fairs	
	350 attendees	
Summer institutes and programs and # of students participating	0	
	0 students	

1.2.4 Technology Transfer

SAFER-SIM-funded projects 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. SAFER-SIM uses a combination of webinars from individual project and online symposia where projects may be grouped by subject matter to allow parties interested in specific topics to interact with several researchers and projects in a single session. Attendance at presentations remain open to all transportation

professionals and the public, recorded, and posted on the SAFER-SIM YouTube channel so they are available to anyone who was not able to attend or would like to review. Three (3) individual project webinars were hosted this period:

- 1. 9/12/2023 The Gap Effect in Conditionally Automated Driving, Emily Shull, UI approx. 25
- 2. 9/19/2023 Reinforcement Learning for Optimal Speed Limit Control Over Network, Fatima Afifah, UCF 5 registrations
- 3. 9/26/2023 Investigating the safety effect of different sensors in various conditions in a connected vehicle environment a Digital Twin approach, Zijin Wang, UCF 13 registrations

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

- 1. Car crashes, alcohol consumption and vet visits: How legal recreational marijuana has ... Cleveland Plain Dealer
- 2. "SR-22 Insurance Guide." or high-risk drivers quoted Shannon Roberts Wallet Hub
- 3. The UPRM Mobile Driving Simulator was used as part of the Educational and Training Plan to be presented in the TV live show "Pégate al Mediodía" to demonstrate how to negotiate the new innovative interchange DDI open to the public during the summer of 2023. Pégate al Mediodía

Lab tours included government representatives and their staff, professionals in the transportation industry, corporations, local interest groups, Our center offered 11 facility tours:

- 1. 3/3/2023 Siqi Liu (Iowa Writers' Workshop) (Plumert & Kearney)
- 2. 6/12/2023 lab tour for ~60 high school students in the Summer Engineering Institute (Roberts)
- 3. 8/3/2023 lab tour for ~15 high school students in the Massenberg Summer Institute on (Roberts)
- 4. (no date provided) tour of the driving simulator lab to prospective UMass undergraduate students during the Engineering Open House (Roberts)
- 5. 7/27/2023 The project team showed the Lieutenant Governor of Wisconsin, Sara Rodriguez, the automated vehicle and took her for a test drive.
- 6. 4/27/2023 Findley Elementary, Des Moines, IA toured DSRI facilities at UI, 54 K-12 students
- 7. 5/11/2023 US DOT Site Visit
- 8. 5/21/2023 Brownie Girl Scout Troup toured DSRI facilities at UI, Iowa City, IA , 10 K-12 students
- 9. 6/27/2023 Iowa National Summer Transportation Institute toured DSRI facilities at UI, 20 K-12 students
- 10. 7/7/2023 Iowa Summer Institute in Biostatistics toured DSRI facilities at UI, 16 college students
- 11. 7/12/2023 Trail Trekkers Group toured DSRI facilities at UI, 27 K-12 students
- 12. 7/13/2023 Perry Research Scholars toured DSRI facilities at UI, 15 K-12 students

Below is a summary of our technology transfer plan performance metrics with the full list accessible <u>here</u> and more detail provided in <u>Section 3</u> below.

Technology Transfer Performance Metric	Result
SAFER-SIM webinars	3
Registrations for webinars	43

Views of archived webinar content	3178 this period
	56,187 lifetime
Press releases for SAFER-SIM related research	0
Media requests	3
Tours of facilities	12
Website traffic	Total Users: 1361
	New Users: 1355
	Sessions: 2019
	Page Views: 3182
Patents filed	0
DOT requests for presentations or proposals related to	1
SAFER-SIM	
Practitioner attendance at events	0 from industry
	0 from government
Number of improved or new simulation technologies,	1
software, methods, or processes	

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.

SAFER-SIM and the AAA Foundation for Traffic Safety continue collaboration for the fourth year. Two additional research projects were created and funded this year. Researchers from AAAFTS, the University of Massachusetts-Amherst, and the University of Iowa are collaborating to further understanding of advanced vehicle technologies.

Identifying outcome measures to evaluate effectiveness of consumer education and training for vehicle automation (AAAFTS Year 4) – **University of Massachusetts, Lead** This project has the primary objective to identify outcome measures that can be used to assess effectiveness of training and education for advanced vehicle technologies. This research will be focused on understanding drivers' knowledge in the context of vehicle technologies that are currently deployed and available (Level 1 & 2 as per SAE J3016 (SAE, 2018) definitions). Specifically, adaptive cruise control (ACC) and lane keeping assist (LKA) or lane centering technologies will be considered, whether they function independently or in combination. A secondary objective of this proposed research is a discussion of the implications of these identified outcome measures in the context of higher levels of automation.

Mapping comprehension of ADAS across different driving and road user populations (AAAFTS Year 4) – **University of Iowa, Lead** This project will survey drivers and other road users regarding their knowledge of different vehicle technologies, providing significant insight into how understanding varies across populations, defined by age, gender and individual differences. This research will also identify those groups of individuals who are lacking the necessary understanding but who feel confident, nonetheless. The outcomes of this research will (1) inform the development of education and training approaches for specific populations, and (2) characterize those individuals with miscalibrated confidence in their understanding of advanced vehicle technologies.

Below is a summary of collaboration performance metrics. Full list can be found <u>here</u>.

Collaboration Performance Metric	Result
Attendance at the SAFER-SIM symposia	0
Interdisciplinary research projects within and across sites	1
Collaborative research projects across SAFER-SIM or other UTC sites	2
Collaborations with industry partners and government agencies	7
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 and University of Central Florida are minority serving institutions. Twenty-eight (28) students from historically excluded groups were involved in 25 SAFER-SIM projects this period. Individuals from historically excluded groups contribute to SAFER-SIM at all levels including the directors, advisory board, principal investigators, and students.

Three students from underrepresented or minority groups graduated this period.

- 1. Jaheen Malik, Apple Computer
- 2. Leila Cesic graduated with a BSc in Civil Engineering at UMass, started as an MS Student at UMass in Fall 2023.
- 3. Emily Shull, NHTSA

Below is a summary of diversity performance metrics. Full list can be found <u>here</u>.

Diversity Performance Metric	Result
# SAFER-SIM projects involving underrepresented/minority (U/M) students	25
# U/M events attended	2
# U/M students at attended events	36
Graduating U/M student placement	3

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

SAFER-SIM provides opportunities for training and professional development in numerous 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 and share their knowledge with others in the transportation industry.

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 two-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.

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

The center will continue progressing toward final reports from projects. Sites and administration teams have re-organized project timelines after receiving a 12-month no-cost extension. Project symposia, education and outreach will continue as normal.

2. Participants & Collaborating Organizations

2.1 What organizations have been involved as partners?

The following organizations have been involved as SAFER-SIM partners during this reporting period:

Organization Name	Location	Contribution
1. AAA Foundation for Traffic Safety	Washington D.C.	Financial support Collaborative research
2. Grinnell College	Grinnell, IA	Collaborative Research with Ryan Miller & 2 undergraduate students
3. UI Injury Prevention Research Center and the Iowa Initiative for Artificial Intelligence	University of Iowa	Financial support and Collaborative research
4. Recreative Association of Sport Buenaventura	Mayagüez, Puerto Rico	Provided facilities at low cost to perform data collection activities for the project.
5. Mayagüez Bureau of Highway Patrol	Mayagüez, Puerto Rico	The Mayaguez Bureau of Highway Patrol provided Equipment and experienced police officers to measure BAC during the project data collection.

6. City of Racine	Racine, WI	Financial support to help with the purchase of AV. In- kind support facilities to operate the AV shuttle in Racine.
7. Gateway Technical College	Racine, WI	In-kind support facilities to house and operate the shuttle in Racine.

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 Engineering
- Industrial & Systems Engineering
- Computer Science
- Psychology & Brain Sciences
- Public Health
- Management Sciences
- Urban and Regional Planning

Our advisory board currently includes 11 individuals from industry, government, and academia.

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

Rebecca Burkel	Wisconsin DOT	
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3. Outputs

Below is a summary of our technology transfer plan output performance metrics. Further description can be found in <u>Section 1.2.4</u> Technology Transfer Accomplishments with the full list accessible <u>here</u>.

Performance Metric	Target	Result	Target Next Period
SAFER-SIM webinars	10	3	10
Registrations for	100	43	200
webinars			
Views of archived	200	3178	3500
webinar content			
Press releases related to	1	0	1
SAFER-SIM			
Media requests	5	2	5
Tours of facilities	15	12	15
Website traffic	3,000 users	1361 users	1500 users
	3,000 sessions	2019 sessions	22500 sessions
	7,000 pageviews	3182 page views	3500 pageviews
Patents filed	1	0	1
DOT requests for	1 per year	1	1 per year
presentations or			
proposals related to			
SAFER-SIM			
Practitioner attendance	100	0	25
at events			
Number of improved or	1	1	1
new simulation			
technologies, software,			
methods, or processes			

3.1 Publications, conference papers, and presentations

Journal Publications

- 1. Gaspar, J. G., Carney, C., Shull, E., & Horrey, W. J. (2021). Mapping drivers' mental models of adaptive cruise control to performance. Transportation research part F: traffic psychology and behaviour, 81, 622-638.
- 2. Subramanian, L. D., O'Neal E. O., Kim, N. Y., Noonan, M., Plumert, J. M., & Kearney, J. K. Deciding when to cross in front of an autonomous vehicle: How child and adult pedestrian respond to eHMI timing and vehicle kinematics. Manuscript submitted for publication.
- 3. Kim, N. Y., Plumert, J. M., Kearney, J. K., Clark, L. A., Dindo, L. & O'Neal E. O. Longitudinal and concurrent effortful control as predictors of risky bicycling in adolescence: Moderating effects of age and gender. Manuscript submitted for publication.

- 4. Subramanian, L. D., Sherony, R., Kearney, J. K., Plumert, J. M., & O'Neal E. O. (in press). How do bicyclists respond to vehicles with adaptive headlamp systems? A nighttime study in an immersive virtual environment. Journal of Safety Research.
- 5. Malik, J., Kim, N. Y., Parr, M. D. N., Kearney, J. K., Plumert, J. M., & Rector, K. (2023). Do simulated augmented reality overlays influence street-crossing decisions in non-mobility-impaired older and younger adults? Human Factors. https://doi.org/10.1177/00187208231151280
- Di Napoli Parr, M. D. N, O'Neal, E. O., Zhou, S., Williams, B., Butler, K. M., Chen, A., Kearney, J. K., & Plumert, J. M. (2023). How children judge affordances when walking and bicycling across virtual roads: Does mode of locomotion matter? Developmental Psychology, 59(6), 1098–1108. https://dx.doi.org/10.1037/dev0001520.
- Ghanbari, A., Hamann, C., Jansson, S., Reyes, M., Faust, K., Cavanaugh, J., Askelson, N. and Peek-Asa, C. (2023). Predictors of rural driver self-reported passing behaviors when interacting with farm equipment on the roadway, *Transportation Research Interdisciplinary Perspectives* 22. <u>https://doi.org/10.1016/j.trip.2023.100926</u>
- O'Neal, E. E., Wendt, L., Hamann, C., Reyes, M.L., Yang, J., and Peek-Asa, C. (2023). Rates and Predictors of Teen Driver Crash Culpability. *Journal of Safety Research 86*, 185-190. Available online: <u>https://doi.org/10.1016/j.jsr.2023.05.009</u>
- 9. Subramanian, L.D., Sherony, R., Plumert, J.M., Kearney, J.K. & O'Neal, E.E. (in press). How Do Bicyclists Respond to Vehicles with Adaptive Headlamp Systems? A Nighttime Study in an Immersive Virtual Environment.
- Peek-Asa, C., Zhang, L., Hamann, C., O'Neal, E.E., Yang, J., (2023). Direct medical charges of all parties in teen-involved vehicle crashes by culpability. *Injury Prevention*. Advance online publication. <u>http://dx.doi.org/10.1136/ip-2022-044841</u>
- 11. Carney, C., Gaspar, J. & Horrey, W. (accepted), Longer-Term Exposure vs. Training: Their Effect on Drivers' Mental Models of ADAS Technology, Transportation Research Part F.
- Z. Wang, O. Zheng, L. Li, M. Abdel-Aty, C. Cruz-Neira and Z. Islam, "Towards Next Generation of Pedestrian and Connected Vehicle In-the-Loop Research: A Digital Twin Co-Simulation Framework," in IEEE Transactions on Intelligent Vehicles, vol. 8, no. 4, pp. 2674-2683, April 2023, doi: 10.1109/TIV.2023.3250353.
- 13. Z. Wang, M. Abdel-Aty, L. Yue, J. Zhu, O. Zheng and M. H. Zaki, "Investigating the Effects of Human-Machine Interface on Cooperative Driving Using a Multi-Driver Co-Simulation Platform," in IEEE Transactions on Intelligent Vehicles, doi: 10.1109/TIV.2023.3296678.
- 14. Pai, G., Zhang, F., Hungund, A. P., Pamarthi, J., Roberts, S. C., Horrey, W. J., & Pradhan, A. K. (2023). Frequency and Quality of Exposure to Adaptive Cruise Control and Impact on Trust, Workload, and Mental Models. Accident Analysis & Prevention, 190, 107130. https://doi.org/10.1016/j.aap.2023.107130
- 15. Pradhan, A.K., Roberts, S.C., Pai, G., Zhang, F. & Horrey, W.J. (2023). Change in Mental Models of ADAS in Relation to Quantity and Quality of Exposure (Technical Report). Washington, D.C.: AAA Foundation for Traffic Safety.
- 16. Zhang, Q., Esterwood, C., Pradhan, A. K., Tilbury, D., Yang, X. J., & Robert, L. P. (2023). The Impact of Modality, Technology Suspicion, and NDRT Engagement on the Effectiveness of AV Explanations. IEEE Access, vol. 11, pp. 81981-81994, 2023, doi: 10.1109/ACCESS.2023.3302261.
- 17. Wang, M., Parker, J., Wong, N. Mehrotra, S., Roberts, S. C., Kim, W., Romo, A., & Horrey, W. J. (under revision). The Effect of Human-Machine Interface Design on Driver Performance and

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Behavior While Using Vehicle Automation. Accident Analysis & Prevention.

- Cesic, L., Christofa, E., and Knodler, M. 2024. Infrastructure and Driver Attitudes: Impact on Escooter and Bicyclist Safety. Submitted to the Transportation Research Record: Journal of the Transportation Research Board.
- Christofa, E., C. Ai, Deliali, A., Tainter, F., Cesic, L., Hannon, T., and Kostopoulou, E. 2023. Bicyclist and Motorist Behavior at Bike Boxes. Transportation Research Record: Journal of the Transportation Research Board. DOI: 10.1177/03611981231179473.
- 20. Pai, G., Zhang, F., Hungund, A. P., Pamarthi, J., Roberts, S. C., Horrey, W. J., & Pradhan, A. K. (2023). Frequency and Quality of Exposure to Adaptive Cruise Control and Impact on Trust, Workload, and Mental Models. Accident Analysis & Prevention, 190, 107130. https://doi.org/10.1016/j.aap.2023.107130
- 21. Figueroa-Medina, D. Valdés, B. Colucci, N. Cardona & A. Chamorro. 2022. Analysis of Walking Speeds and Success Rates on Mid-Block Crossings using Virtual Reality Simulation. Accident Analysis and Prevention Journal. Elsevier. February 2023.
- 22. Schwarz, C., Gaspar, J., & Yousefian, R. (2023). Multi-sensor driver monitoring for drowsiness prediction. Traffic Injury Prevention, 24(sup1), S100-S104.
- 23. Schwarz, C., Ahmad, O., Brown, T., Gaspar, J., Wagner, G., & McGehee, D. V. (2023). The long and winding road: 25 years of the national advanced driving simulator. IEEE computer graphics and applications, 43(4), 121-128.

Conference papers and presentations

- 1. Benson, A., But, J., Gaspar, J., Carney, C., & Horrey, W. J. (2021, September). Advanced vehicle technology: mapping mental model accuracy and system exposure to driver behavior. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 65, No. 1, pp. 1072-1076). Sage CA: Los Angeles, CA: SAGE Publications.
- 2. Plumert, J. M., O'Neal, E. O., & Kim, N-Y. (2023, March). Parental scaffolding of children's prospective control in a dynamic perception-action task. In J. Plumert (Chair), Broadening the lens on parent-child interaction as a mechanism of developmental change in children's skills. Symposium at the 2023 Biennial Meeting of the Society for Research in Child Development, Salt Lake City, UT.
- O'Neal, E. E., Subramanian, L.D., Noonan, M., Wang, J., Kim, N.Y., Kearney, J. K., and Plumert, J. M. (April, 2023). How do children respond to autonomous vehicle external human-machine interface cues? Paper presented at the Biennial Meeting of the Society for Advancement of Violence and Injury Research, Denver, CO.
- 4. Kruse, C., Brown, T. L., Schmitt, R., Gaffney, G., Milavetz, G., & Berka, C. (2024). Effects of Cannabis on Highway Driving Transportation Research Board Annual Meeting, Washington, DC.
- 5. Miller, R., Hodson, S., Le, T., & Brown, T. (2024). Detection of Cannabis Impaired Driving from Vehicle-based Inputs using Machine Learning Methods. Transportation Research Board Annual Meeting, Washington, DC.
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- 8. Lenneman, J.K., Hungund, A.P., Pamarthi, J., Pradhan, A.K., (2023, pre-press) Enhancing ADAS Knowledge and Trust Through Consumer Education. *Proceedings of 2023 FAST-zero conference*.
- 9. Pamarthi, J., Hungund, A. P., Wang, M., Sayer, T. B., Hallman, J. J., Roberts, S. C., & Pradhan, A. K. (2023). Risk-ATTEND (Risk Anticipation Training to Enhance Novice Driving): Pilot Evaluation of a Risk Anticipation Training Program for Teen Drivers. 67th International Annual Meeting of the Human Factors and Ergonomics Society.
- Valdés, D., Figueroa-Medina, A, Perelló, C., Sierra-Betancur, C. L, Mori-Vargas, A. and Concepción-Carrasco, E., Use of Driving Simulation to Improve Safety on Innovative Intersection Designs: A Diverging Diamond Interchange Implementation. XXII Pan American Congress on Transport and Logistics (PANAM), Guayaquil, Ecuador, 2023
- 11. Ramos-López, I., Valdés, D., Development of Innovative Strategies to Improve Drivers and Workers Safety in Freeway Work Zones (Title in Spanish: Desarrollo de Medidas Innovadoras para Mejorar la Seguridad de Conductores y Trabajadores en Zonas de Trabajo en Autopistas.) XXII Pan American Congress on Transport and Logistics (PANAM), Guayaquil, Ecuador, 2023
- Valdés, D., Figueroa-Medina, A, Perelló, C., Solano, A., Velasquez, G. A., and Concepción-Carrasco, E., Driving Simulation Study of the First Diverging Diamond Interchange in Puerto Rico (PR-30 & PR-189 in Gurabo). Plaza Las Americas Educational Activity, San Juan, PR, June 2023.

Books or other non-periodical, one-time publications Nothing to report.

3.2 Policy Papers

Nothing to report.

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

<u>SAFER-SIM website</u> - 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 are below:

Metric	This Period	Lifetime
Total Users	1361	Not reported
New Users	1355	Not reported
Sessions	2019	Not reported
Page Views	3182	Not reported

<u>SAFER-SIM YouTube Channel</u> - 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	1	120
Views	3178	56,187
Subscribers	249	na

<u>SAFER-SIM Twitter Account</u> – the Twitter account has been abandoned due to very low number of interactions.

Metric	This Period	Lifetime
Tweets	na	394
Tweet Impressions	na	82,600
Followers	na	170

SAFER-SIM Dataverse - data repository containing final data from research projects.

Metric	This Period	Lifetime
Datasets	0	44
File Downloads	na	19,444

3.4 New methodologies, technologies, or techniques

- 1. Evaluation of Driver Workload and Training Strategies on a Diverging Diamond Interchange
 - a. SaferSim contributed to demonstrating the importance of driving simulation and evaluating the best instruments to carry out DDI's education and training processes for the public. The generated and tested instruments were then implemented as part of the educational campaigns that were carried out to educate potential users before opening the project for public use. The improved process was the final design of an innovative intersection implemented for the first time in Puerto Rico. A series of experiments were conducted using the driving simulator in three phases. Several changes were recommended after the first phase of the study. These changes were incorporated into the design, and another round of experiments was carried out in the second phase with better results than those obtained with the original design. Given new recommendations, the design was adjusted, and a final design was reached, which was finally implemented. Before opening the project, the third phase included a series of events held as part of the educational campaign to use this type of innovative intersection. The events included presentations at professional activities such as the annual convention of the Institute of Civil Engineers of the College of Engineers and Surveyors of Puerto Rico (CIAPR, for its acronym in Spanish), presentation on a television program broadcast throughout Puerto Rico, presentation for a radio program widely broadcast throughout PR and educational activities in two shopping centers of high impact in the metropolitan area that are Plaza Las Américas in San Juan and Las Catalinas Mall in Caguas.

3.5 Inventions, patent, and/or licenses

Nothing to report.

3.6 Other products

Simulation Boot Camp Videos – A webinar series developed by the collective expertise of SAFER-SIM to train researchers on using simulation as a research tool. The boot camp was translated into an in-person workshop at the Road Safety & Simulation conference. The five videos in this playlist have 631 views.

Metric	This Period	Lifetime	
requirements. More information	n in <u>Section 1.2.3.</u>		
Onnie Traine Salety Ment Da	$\frac{1}{20} = 1100$ Scouts have started t	ine materials and 707 nave	completed i

Online	e Traffic	Safety	Merit I	Badge –	1156 Sc	outs hav	e started	the ma	terials a	and 767	have	complet	ed the
requir	ements.	More in	nformat	tion in S	Section 1	.2.3.						_	

Metric	This Period	Lifetime
Scouts Started	31	1156
Scouts Completed	33	767

SAFER-SIM PROGRESS REPORT

Metric	This Period	Lifetime
Scouts Started	5	344
Scouts Completed	3	183

<u>Online Engineering Merit Badge</u> – 344 Scouts have started the materials and 173 have completed the requirements. More information in <u>Section 1.2.3.</u>

<u>Two-page Project Summaries</u> – 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 "<u>Research</u>" tab of our website within specific project information.

Biweekly News Digest – The email campaigns serve to provide information about SAFER-SIM webinars, final reports, conferences, news articles, and job opportunities. Metrics from the news digest are below:

Metric	This Period	Lifetime
Subscribers	308	variable
Campaigns Sent	16	171
# Opens	1,178	12,499

4. Outcomes

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

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

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

 Evaluation of Driver Workload and Training Strategies on a Diverging Diamond Interchange -SaferSim contributed to demonstrating the importance of driving simulation and evaluating the best instruments to carry out DDI's education and training processes for the public. The generated and tested instruments were then implemented as part of the educational campaigns that were carried out to educate potential users before opening the project for public use. The improved process was the final design of an innovative intersection implemented for the first time in Puerto Rico. A series of experiments were conducted using the driving simulator in three phases. Several changes were recommended after the first phase of the study. These changes were incorporated into the design, and another round of experiments was carried out in the second phase with better results than those obtained with the original design. Given new recommendations, the design was adjusted, and a final design was reached, which was finally implemented. Before opening the project, the third phase included a series of events held as part of the educational campaign to use this type of innovative intersection. The events included presentations at professional activities such as the annual convention of the Institute of Civil Engineers of the College of Engineers and Surveyors of Puerto Rico (CIAPR, for its acronym in Spanish), presentation on a television program broadcast throughout Puerto Rico, presentation for a radio program widely broadcast throughout PR and educational activities in two shopping centers of high impact in the metropolitan area that are Plaza Las Américas in San Juan and Las Catalinas Mall in Caguas.

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

1. Evaluation of Driver Workload and Training Strategies on a Diverging Diamond Interchange - The Puerto Rico office of the Federal Highway Administration (FHWA) and the Puerto Rico Highways and Transportation Authority (PRHTA) decided to integrate driving simulation into the design process for implementing innovative intersections in Puerto Rico. The case in which this new process was implemented is the first Diverging Diamond Interchange (DDI) built at the intersection of highways PR-30 and PR-189 in Gurabo, PR. The agencies in charge of implementing transportation projects decided that in the case of the first implementation in PR of a DDI, the simulation could contribute to fine-tuning the design to benefit users. Thanks to SaferSim and the previous projects presented in PR, the decision-makers found it helpful to do a series of experiments to review the final design being built.

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

Nothing to report.

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, and presentations at conferences, meetings, and other avenues. Full list <u>here</u>.

4.4 Improved processes, technologies, techniques and skills in addressing transportation issues Highlighted in <u>Section 1.2.4</u> and in <u>Section 4</u>.

4.5 Enlargement of the pool of trained transportation professionals

Our center supports the development of trained transportation professionals in numerous ways. College students directly involved in research will graduate and join the workforce as members of industry,

academia, 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 recorded webinars and 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 two performance measures related to impacts in our technology transfer plan:

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

Expected reductions in crashes from implemented policy, practice, regulation, rulemaking or legislation. 1. Reinforcement Learning for Optimal Speed Limit Control Over Network

- a. This project is expected to reduce the crash risks by dynamically selecting optimal speed limits. Metrics will be available when case studies are finished.
- 2. Driver Attitudes and Behavior in the Presence of E-Scooters versus Bicyclists
 - a. This research is expected to set the stage for determining factors and infrastructure design affecting e-scooter safety and understanding how attitudes towards e-scooter riders compare with those towards bicyclists.
- 3. Evaluation of Driver Workload and Training Strategies on a Diverging Diamond Interchange
 - a. The reduction in crash potential obtained in the simulation is notable. In the case of direct maneuvers, representing the most remarkable geometric change, the number of instances with critical errors was reduced from (8/48) 17% to (1/48) 2% of the maneuvers performed by the subjects in the study. Potential crashes are associated with critical errors in the different maneuvers performed at the intersection. Critical errors include steering against traffic, stopping in the middle of the road, reversing when realizing a wrong maneuver was made, going off the road, and crashing with curbs or concrete barriers. Moreover, the main impact generated by this project is the reduction in the construction costs of the DDI project. In reviewing the design using the driving simulator, important changes were made to the geometry, pavement marking, and signage. New safety features and overhead signs were included that required the installation of structural support for the new signage. These changes were detected in time, avoiding costly interventions that would have been necessary once the intersection was opened to the public. Likewise, the drivers' safety when traveling through this intersection was increased, and, above all, the public's confidence in implementing innovations to reduce congestion and improve safety. All this was achieved thanks to the simulation experiments done before implementation.

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

- 1. Driver Attitudes and Behavior in the Presence of E-Scooters versus Bicyclists
 - a. Reduction of traffic conflicts is expected from implementation of infrastructure treatments and regulations for e-scooter riding that improve safety. Improved safety for e-scooters could motivate increased e-scooter mode share which would consequently reduce congestion.
- 2. Evaluation of Driver Workload and Training Strategies on a Diverging Diamond Interchange
 - a. The reduction in congestion, in this case, is mainly due to the implementation of the innovative intersection itself. It is unclear how much congestion was reduced because of the changes generated by the implementation of the SaferSim project and the design process integrating driving simulation to fine-tune the detailed design. However, it was clear that reducing crashes would reduce the non-recurrent congestion generated by such events. In addition, clearer signage and pavement markings made the transition process more straightforward from a Conventional Diamond Interchange (CDI) to a Diverging Diamond Interchange (DDI), reducing congestion.

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 <u>Section 1</u> and <u>Section 3</u>

5.4 Impact on transportation workforce development

Highlighted in Section 1

6. Changes/Problems

6.1 Changes in approach and reasons for change

The center requested a no-cost extension to extend the performance period until September 30, 2024. A no-cost extension was necessary to complete ongoing research projects and to meet our student commitments. Progress on the funded projects was slowed considerably during the COVID-19 pandemic, as all labs were shut down for 6-12 months. Even when labs were re-opened, recruitment of subjects was much slower than before the pandemic. These delays hit the SAFER-SIM UTC particularly hard because the projects involved in-person studies carried out in close quarters in virtual environments (e.g., driving and pedestrian simulators, VR headsets). Unlike other kinds of research during the pandemic, it was not possible to move SAFER-SIM studies to an online format. This resulted in at least a 12-month delay in collecting data for in-person SAFER-SIM studies and a 12-month backlog of projects in the pipeline awaiting completion.

Additional time was needed to meet our commitments to the students supported by funds from the SAFER-SIM UTC. The delayed SAFER-SIM projects form the basis for many on-going student theses, which need to be finished in order for students to complete their graduate degrees. We had made commitments to fund these students for the coming year, which is necessary for them to make good progress on their SAFER-SIM research projects. All of these students experienced many disruptions to their research during the COVID-19 pandemic and we want to provide them with the financial support necessary to get back on track. We also noted that the University of Puerto Rico – Mayaguez experienced further delays due to Hurricane Fiona, which made landfall in Puerto Rico on September 18, 2022, and caused the interruption of the electric system on the whole island and no access to the Civil Engineering Building for approximately a month.

We are working with PIs to complete all projects and finalize all deliverables and reporting materials within the new grant performance period.

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

No problems or delays are anticipated.

6.3 Changes that have a significant impact on expenditures

No changes have had a significant impact on expenditures.

6.4 Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards No significant changes in use or care of human subjects, vertebrate animals, and/or biohazards have occurred.

7. Special Reporting Requirements

Nothing to report.