



Program Progress Performance Report for University Transportation Centers

- **Federal Agency and Organization Element to which Report is Submitted**
United States Department of Transportation (USDOT), Office of the Assistant Secretary of Transportation for Research and Technology (OST-R)
- **Federal Grant or Other Identifying Number Assigned by Agency:** DTRT13-G-UTC59
- **Project Title:** University Transportation Center for Railway Safety (UTCRS)
- **Project Director (PD) Name, Title, and Contact Information**
Constantine Tarawneh, Ph.D., Director, University Transportation Center for Railway Safety;
Email: constantine.tarawneh@utrgv.edu; Phone (956) 665-2607; Fax (956) 665-8879
- **Submission Date:** October 30, 2017
- **DUNS and EIN Numbers:** DUNS: 069444511 and EIN: 465292740
- **Recipient Organization:**
The University of Texas Rio Grande Valley (UTRGV)
1201 West University Drive, Edinburg, TX 78539-2999
- **Recipient Identifying Number or Account Number:** 410000049 and 410000232
- **Project/Grant Period:** September 30, 2013 – September 30, 2018
- **Reporting Period End Date:** September 30, 2017
- **Report Term or Frequency (annual, semi-annual, quarterly, other):** Semi-annual
- **Signature of Submitting Official**

Constantine

Dr. Constantine Tarawneh, Director, University Transportation Center for Railway Safety



1. ACCOMPLISHMENTS:

What are the main goals and objectives of the program?

The UTCRS will develop knowledge, diverse human resources, and innovative technology in support of strategic safety plans for the U.S. rail transportation industry. The Center will engage and focus its partners' established expertise and leverage and expand their existing resources to establish comprehensive programs of railway safety research, education, technology transfer and implementation, and workforce development. UTCRS Strategic Research Goals aim to fundamentally improve railway safety outcomes by the following means:

- 1) Reducing fatalities and injuries at highway-rail grade crossings (HRGCs)
- 2) Reducing failures by developing more durable materials and systems
- 3) Developing advanced technology for infrastructure monitoring
- 4) Developing innovative safety assessments and decision-making tools

In working towards the overall goal of establishing comprehensive programs of railway safety research, leadership activities, education and outreach activities, and technology transfer and implementation, the following was accomplished for this reporting period:

Research Activities	Status	% Complete
Finalize Project Selection Process Under UTCRS for All Consortium Members	Complete	100%
Progress of Research Projects Under Contract for All Consortium Members	On Schedule	60%
Technology Transfer Briefs, Webinars, Symposiums, and Presentations on Research Results	On Schedule	75%
Applicable Slides, Handouts, Videos, Pictures Posted	Complete	100%
Final Reports Due & All Research Projects Completed	On Schedule	60%
Leadership Activities		
Coordination between UTCRS Director and Leadership Team	Complete	100%
Commit Remaining UTCRS Budget Funds and Finalize All Subcontracts with Consortium Members	Complete	100%
UTCRS Leadership Team Update	Complete	100%
2017 UTCRS Student Nominations for CUTC Awards	Complete	100%
2017 UTCRS Student of the Year (SOY) Selection	Complete	100%
Education & Outreach Activities		
2017 UTCRS K-12 Summer Camps	Complete	100%
2017 UTCRS Transportation Engineering Summer Enrichment Program (TESEP)	Complete	100%
2017 Research Experience for Teachers (RET) Program	Complete	100%
Selection of 2017 Research Experience for Teachers (RET) Program Participants	Complete	100%
Meetings with the Lower Rio Grande Valley Independent School District Superintendents and their Representatives	On Schedule	20%
Preparations for 2018 UTCRS K-12 Summer Camps	On Schedule	20%
Technology Transfer Activities		
2017 UTCRS K-12 STEM Teacher National Workshop	Complete	100%
Development of Elementary, Middle, and High School Transportation Related STEM Curricula Available for Use in K-12 Classrooms	Complete	100%
UTCRS Website Information Dissemination Update	Complete	100%
UTCRS Open Educational Resources Tab/Borrowing Agreement	Complete	100%
UTCRS Fall 2017 Newsletter Describing Center Activities	On Schedule	75%

UTCRS Supported Journal and Conference Publications and Presentations	On Schedule	75%
UTCRS Supported Presentations, Symposiums, Workshops, and Short Courses	On Schedule	75%
USDOT OST-R: Reporting		
UTC Program Progress Performance Reports (Quarterly)	Complete	100%
Federal Financial Reports (Quarterly)	Complete	100%
Map 21 UTC Performance Indicators Report (Annual)	Complete	100%
UTC Specific Performance Indicators Report (Annual)	Complete	100%
Update UTCRS-UTRGV Website Research Repository	Complete	100%
Posting of Newly Funded Research Projects & Descriptions (Exhibit Fs)	Complete	100%

What was accomplished under these goals?

The UTCRS continues its timely delivery of comprehensive research, education, workforce development, technology transfer, and community outreach programs in support of the USDOT mission to train and develop the next transportation workforce that is prepared to design, deploy, operate, and maintain the complex transportation systems of the future. In particular, the UTCRS offered its annual Fall Research Symposium in which all the UTRGV undergraduate and graduate research assistants presented their research projects through oral and poster presentations. The 2017 UTCRS K-12 STEM Teacher National Workshop served 100 STEM teachers that participated in a full-day hands-on workshop on the use of the UTCRS developed curricula focused on transportation engineering. The UTCRS also continued its Research Experience for Teachers (RET) Program, which featured 13 STEM teacher participants in summer of 2017, some of whom were funded by the school districts who have come to depend on the UTCRS Summer Programs for teacher professional development, and to serve their students' needs in terms of STEM education. For the fourth consecutive year, the UTCRS Summer Camps hosted more than 1000 K-12 students who were exposed to STEM curricula focused on transportation engineering with an emphasis on railway safety. Recognizing the benefits and impact of the educational programs offered by the UTCRS, community collaborations have widely expanded, which is evident by the generous financial support (\$110K) of the Independent School Districts in the Lower Rio Grande Valley (LRGV) for the 2017 UTCRS K-12 Summer Camps and STEM Teacher National Workshop. Currently, the UTCRS offers the *only* transportation related STEM summer camp for elementary students in the Rio Grande Valley (RGV).

To date, the UTCRS has funded **36** research projects aligned with the UTCRS strategic research goals in the three consortium institutions (11 at UTRGV-Lead Institution, 12 at UNL, and 13 at TAMU). The fourteen research projects initially funded as part of the inaugural 2014CY Call for Proposals have all been completed on-schedule, and the final reports have been posted on the UTCRS website and indexed on the TRID database. Three of the twenty projects selected for funding at the three consortium institutions as part of the 2015CY Call for Proposals have completed and the rest are progressing on schedule. UTRGV had a final 2017CY Call for Proposals to commit the remainder of the allotted Federal funds, and two new projects were selected for funding starting February 2017 with an end date of August 2018. External reviewers from federal, state, and local agencies whose areas of expertise align with the subject matter of the proposed research projects were involved in the proposal peer-review process. Hence, as of January 2017, all Federal Funds allotted to the UTCRS have been fully committed, and all ongoing projects are progressing on schedule and are expected to complete by no later than August 2018. The following table provides a list of all the research projects that are/were funded by the UTCRS including links to the web pages that contain full project descriptions:

RESEARCH AREAS: Addressed in Prospectus: 2014CY Call for Proposals	
Completed Projects	
A Final Report has been Indexed by TRID and Posted on the UTCRS Website (Follow Links)	
1.	Structural Integrity of Railroad Bearing Adapters with Modifications for Onboard Monitoring Applications. http://www.utrgv.edu/railwaysafety/research/mechanical/2014/modified-railroad-bearing-adapter-for-onboard-monitoring/index.htm
2.	Effects of Vapor Grown Carbon Nanofibers on Electrical and Mechanical Properties of a Thermoplastic Elastomer. http://www.utrgv.edu/railwaysafety/research/mechanical/2014/conductive-railroad-bearing-suspension-element/index.htm
3.	Modeling the Residual Useful Life of Bearing Grease. http://www.utrgv.edu/railwaysafety/research/mechanical/2014/life-of-bearing-grease/index.htm
4.	Applications of Magnetostrictive Materials for Real-Time Monitoring of Vehicle Suspension Components. http://www.utrgv.edu/railwaysafety/research/mechanical/2014/applications-of-magnetostrictive-materials/index.htm
5.	Single Bearing Test Rig with Vertical, Lateral, and Impact Load Capabilities. http://www.utrgv.edu/railwaysafety/research/mechanical/2014/single-bearing-test-rig/index.htm
6.	Improving Safety at Rural Highway-Rail Grade Crossings by Utilizing Light Detection and Ranging (LiDAR) Technology. http://www.utrgv.edu/railwaysafety/research/operations/improving-safety-at-hrgc-by-using-lidar-technology/index.htm
7.	High Speed Train Geotechnics. http://www.utrgv.edu/railwaysafety/research/infrastructure/high-speed-train-geotechnics/index.htm
8.	Development of Corridor-based Traffic Signal Preemption Strategies at Signalized Intersections near Highway Railway Grade Crossings. http://www.utrgv.edu/railwaysafety/research/operations/traffic-signal-preemption-strategies-near-hrgc/index.htm
9.	Drivers' Perceptions of Highway-Rail Grade Crossing Safety and Their Behavior. http://www.utrgv.edu/railwaysafety/research/operations/drivers-perceptions-of-hrgc/index.htm
10.	Safety Modeling of Highway Railway Grade Crossings using Intelligent Transportation System Data. http://www.utrgv.edu/railwaysafety/research/operations/modeling-of-hrgc-using-its/index.htm
11.	Rail Neutral Temperature In-Situ Evaluation. http://www.utrgv.edu/railwaysafety/research/infrastructure/evaluation-of-rail-neutral-temperature/index.htm
12.	Ultrasonic Tomography for Infrastructure Inspection. http://www.utrgv.edu/railwaysafety/research/infrastructure/ultrasonic-tomography-for-infrastructure-inspection/index.htm
13.	Optimizing Performance of Railroad Rail through Artificial Wear. http://www.utrgv.edu/railwaysafety/research/infrastructure/railroad-rail-performance/index.htm
14.	Vehicle-Bourne Autonomous Railroad Bridge Impairment Detection Systems. http://www.utrgv.edu/railwaysafety/research/infrastructure/railroad-bridge-impairment-detection-systems/index.htm
RESEARCH AREAS: Addressed in Prospectus: 2015CY Call for Proposals	
Completed Projects	
A Final Report has been Indexed by TRID and Posted on the UTCRS Website (Follow Links)	
15.	Bumps in High Speed Rails: What is Tolerable? http://www.utrgv.edu/railwaysafety/research/infrastructure/bumps-in-high-speed-rails/index.htm
16.	Method for Predicting Thermal Buckling in Rails. http://www.utrgv.edu/railwaysafety/research/infrastructure/thermal-buckling-in-rails/index.htm
17.	Multi-scale Fatigue Damage Life Assessment of Railroad Wheels.

<http://www.utrgv.edu/railwaysafety/research/infrastructure/wheel-fatigue-damage-life-assessment/index.htm>

On-going Projects

18. **The Effect of Heat Generation in the Railroad Bearing Thermoplastic Elastomer Suspension Element on the Thermal Behavior of Railroad Bearing Assembly.**
<http://www.utrgv.edu/railwaysafety/research/mechanical/2015/heat-generation-in-the-railroad-bearing-suspension-element/index.htm>
19. **Development of Predictive Models for Spall Growth in Railroad Bearing Rolling Elements.**
<http://www.utrgv.edu/railwaysafety/research/mechanical/2015/predictive-models-for-spall-growth-in-railroad-bearings/index.htm>
20. **Radiative Heat Transfer Analysis of Railroad Bearings Using a Single Bearing Test Rig for Wayside Thermal Detector Optimization.**
<http://www.utrgv.edu/railwaysafety/research/mechanical/2015/radiative-heat-transfer-analysis-of-railroad-bearings/index.htm>
21. **Demonstration of Magnetostrictive Materials for Self-Powered Monitoring of Rail Vehicle Suspension Components.**
<http://www.utrgv.edu/railwaysafety/research/mechanical/2015/energy-harvesting-applications/index.htm>
22. **A Mechanistic Investigation of Concrete Tie Degradation in the Rail Seat.**
<http://www.utrgv.edu/railwaysafety/research/infrastructure/investigation-concrete-tie-degradation/index.htm>
23. **Dynamic Live Load Effects of Railroad on Retaining Walls and Temporary Shoring.**
<http://www.utrgv.edu/railwaysafety/research/infrastructure/dynamic-live-load-effects-of-railroads-on-retaining-walls/index.htm>
24. **Estimating Bridge Span Deflections Using Data Streams from Rolling Stock.**
<http://www.utrgv.edu/railwaysafety/research/infrastructure/bridge-span-deflection-estimation/index.htm>
25. **Fatigue and Service Analysis of Railroad Eyebars Members.**
<http://www.utrgv.edu/railwaysafety/research/infrastructure/service-analysis-of-eyebars-members/index.htm>
26. **Strength and Fracture Toughness of Railroad Eyebars Members.**
<http://www.utrgv.edu/railwaysafety/research/infrastructure/fracture-of-eyebars-members/index.htm>
27. **Anti-Icing LED Light Covers for Railroad Safety.**
<http://www.utrgv.edu/railwaysafety/research/operations/anti-icing-led-light-covers-for-railroad-safety/index.htm>
28. **Heavy Truck and Bus Traversability at Highway-Rail Grade Crossings.**
<http://www.utrgv.edu/railwaysafety/research/operations/heavy-truck-traversability-at-hrgc/index.htm>
29. **Improving Crash Prediction - A More Relevant Exposure Measure than AADT for Highway-Rail Crossing Safety Models.**
<http://www.utrgv.edu/railwaysafety/research/operations/improving-crash-predictions-at-hrgc/index.htm>
30. **Best Practices for Modeling Light Rail at Intersections.**
<http://www.utrgv.edu/railwaysafety/research/operations/modeling-light-rail-intersections/index.htm>
31. **Unifying Railcar Monitoring Sensor Data, Maintenance Records, and Railcar Usage Information through Big Data Processing for Optimizing Railcar Maintenance and Safety.**
<http://www.utrgv.edu/railwaysafety/research/operations/rail-equipment-safety/index.htm>
32. **Shipments of Oil By Rail: Economic Implications for Safety and Safety-Related Investments.**
<http://www.utrgv.edu/railwaysafety/research/operations/shipments-of-oil-by-rail/index.htm>
33. **Highway-Rail Crossing Safety Improvement by Diverting Motorists to Alternate Routes.**
<http://www.utrgv.edu/railwaysafety/research/operations/highway-rail-crossing-safety-diverting-motorists/index.htm>
34. **Railyard Worker Safety through innovative Mobile Active Train Detection and Risk Localization.**
<http://www.utrgv.edu/railwaysafety/research/operations/railyard-worker-safety-mobile-active-train-detection/index.htm>

RESEARCH AREAS: Addressed in Prospectus: 2017CY Call for Proposals

New Projects

35. **Prototyping and Testing of Electrically Conductive Thermoplastic Polyurethane (TPU) Railroad Suspension Pad.**
<http://www.utrgv.edu/railwaysafety/research/mechanical/2017/prototyping-conductive-tpu-railroad-suspension-pad/index.htm>
36. **Low Power Wireless Sensors for Railroad Bearing Health Monitoring.**
<http://www.utrgv.edu/railwaysafety/research/mechanical/2017/wireless-sensors-for-railroad-bearing-health-monitoring/index.htm>

During this reporting period, the UTCRS financially supported 64 undergraduate, master’s, and doctoral students actively involved in the various UTCRS funded research projects and educational programs. As part of our commitment to transportation industry workforce development, a substantial number of research positions at the UTCRS are exclusively available for undergraduate students to experience working in a professional and research-intensive environment early in their academic careers. The majority of the UTCRS undergraduate students pursue master’s degrees upon graduation, and remain actively engaged in research, workforce development, and technology transfer activities.

Student Researcher Classification	Number	Male	Female
Undergraduate Research Assistants	34	17	17
Masters’ Research Assistants	18	14	4
Doctoral Research Assistants	12	9	3
Totals	64	40	24

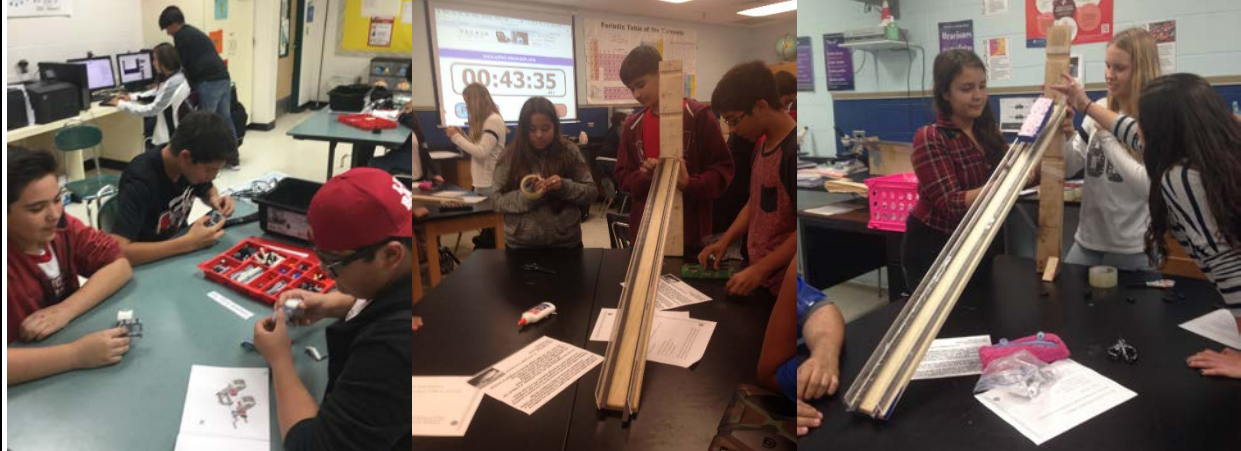
Students funded by the UTCRS are also actively involved in education and outreach efforts through on-campus and off-campus community events where they present about the different transportation careers and opportunities available to students, and talk about railway safety issues and ongoing research projects being conducted at the UTCRS. These students facilitate, on a regular basis, presentations, tours, and symposiums, and attend various community events and K-12 science fairs representing the UTCRS. This reporting period, the UTCRS experienced a significant increase in requests for tours of the UTCRS laboratory facilities. This has proven exceptionally successful in giving students professional outreach experience to promote and provide visitors with an accurate representation of the scope of railway safety research being performed at the UTCRS. The UTCRS outreach efforts reached more than 3300 community members through numerous information sessions and tours of the research facilities at UTRGV. The success of the aforementioned outreach efforts is evident in terms of participants’ recruitment for education, workforce development, and outreach programs for summer of 2017. The UTCRS had 13 STEM teachers participate in the 2017 Research Experience for Teachers (RET) Program, 100 teachers attend the 2017 STEM Teacher National Workshop, 1014 K-12 students from Lower Rio Grande Valley (LRGV) school district partners attend the 2017 UTCRS Summer Camps, and 116 middle school students attend the Roads, Rails, and Race Cars After-School Program. The following is a summary of the educational, workforce development, and outreach activities carried out over the period from April 1, 2017 to September 30, 2017:

EDUCATION & OUTREACH ACTIVITIES for period (April 1st, 2017 – September 30th, 2017)

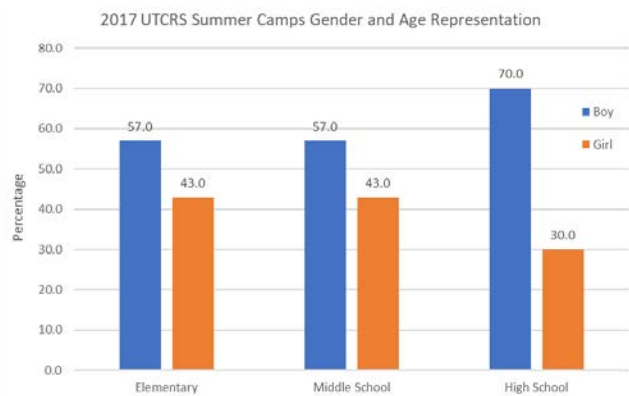
Outreach and Educational Activities aimed at Increasing Awareness of Transportation Engineering and Railway Safety Careers

Over the last four years, the Research Experience for Teachers (RET) Program engaged 37 teachers that were trained and provided the required tools to implement the UTCRS developed modules to introduce students to

STEM concepts using transportation engineering and railway safety applications. Moreover, the UTCRS STEM Teacher Workshops exposed more than 350 teachers from 26 different local school districts to the various hands-on activities associated with the UTCRS developed curricula. As a result of these professional development efforts, the transportation-related STEM modules have seen a very wide implementation in K-12 classrooms across the Rio Grande Valley. Over this reporting period, the UTCRS curriculum was implemented in four elementary classes (100 students), four middle school classes (88 students), and three high school classes (80 students).



Following three successful years of implementation of the UTCRS Summer Camps in 2014 (700 participants - 300 elementary, 300 middle school, and 100 high school), in 2015 (1000 participants - 450 elementary, 425 middle school, and 125 high school), in 2016 (1300 participants - 585 elementary, 515 middle school, and 200 high school), the 2017 UTCRS Summer Camps that were held at UTRGV from June 5th to June 30th hosted 1014 K-12 students (473 elementary, 422 middle school, and 119 high school) from local school districts in the Rio Grande Valley (RGV). The UTCRS Summer Camps, acknowledged as the largest transportation related summer camps in the nation, have become the main program to attend for K-12 RGV students who are interested in STEM activities.



Pictures of all the 2017 UTCRS Summer Camps activities can be downloaded from our Website at: <http://www.utrgv.edu/railwaysafety/news/gallery/index.htm>

Over the past four years, the UTCRS K-12 STEM Teacher Professional Development Workshops have helped train close to **400** Rio Grande Valley teachers to implement in their classrooms transportation engineering curricula and modules with an emphasis on railway safety. The 2017 STEM Teacher National Workshop (Transportation in the Classroom) held on June 3, 2017 engaged **100** educators and coordinators on the use of the UTCRS developed curricula through hands-on activities and lessons. During the workshop, participants were introduced to challenge-based instruction methodologies that they can utilize to create their own challenges and modules, and implement them in their classrooms. The main goal of the workshop is train teachers to be able to design lessons and challenges that are aligned with state and national STEM learning objectives using applications in transportation engineering with an emphasis on railway safety. Pictures from the 2017 UTCRS STEM Teacher Workshop can be accessed at: <https://www.flickr.com/photos/131769328@N02/sets/72157685098779965/>



On Thursday July 6, 2017, the UTCRS celebrated the accomplishments of the K-12 students and teachers that participated in the 2017 UTCRS Summer Camps during the closing ceremony that was held at the UTRGV campus. The closing ceremony was attended by more than 1000 community members and the keynote speaker was U.S. Representative Vicente Gonzalez (TX-15) who stressed the importance of STEM education to ensure that students are exposed to these opportunities at an early age. Santiago Navarro, manager of the Technology Transfer Program, in the U.S. Department of Transportation OST-R, also addressed the community and re-iterated the importance of these programs to K-12 students. The winning teams from the elementary, middle school, and high school final competition challenge were introduced during this ceremony. Details can be found in the article: <http://www.utrgv.edu/en-us/about-utrgv/news/press-releases/2017/july-07-aspiring-engineers-recognized-at-utrgv-railway-safety-camp-awards-ceremony/index.htm>

See: <https://www.flickr.com/photos/131769328@N02/albums/72157686183548205/with/35474431180/>



UTCRS Highlights for April 1st, 2017 – September 30th, 2017

UTCRS-UTRGV Research Group Receives “Best Paper” Honors at the 2017 ASME Joint Rail Conference

The UTCRS Research Group attended the 2017 ASME Joint Rail Conference from April 5-7 where they presented five papers on work that is performed as part of the projects funded by the UTCRS under the USDOT Grant No. DTRT13-G-UTC59. The UTCRS group consisted of five faculty and four students from UTRGV (4 faculty and 3 students) and consortium partner UNL (1 faculty and 1 student). The presentations featured four of our graduate students who were first authors and presenters at the conference. The UTCRS Research Group was the largest academic group in attendance at this conference and during the banquet held on Thursday April 6, 2017, four of our graduate students received the ASME Graduate Scholarship (3 from UTRGV and 1 from UNL). In total, there were 8 ASME graduate scholarships awarded and the UTCRS Research Group captured half of those. Moreover, one of the UTRGV graduate students (Oscar Rodriguez) received the “Best Paper” Award, which is the highest honors given in this conference. We are very proud of the accomplishments of the UTCRS Research Group! This

event provided an invaluable experience for our students to participate in a professional conference where they were able to showcase and discuss their work with their peers and other professionals in the field.



What opportunities for training and professional development has the program provided?

UTCRS remains committed to developing a professionally trained transportation workforce by focusing on graduating a highly-skilled and experienced cadre of graduate and undergraduate students. Students hired as research assistants by the UTCRS are required to perform at the highest level of research competence and to develop and maintain a professional-level skill set required to succeed in day-to-day research operations. To ensure research assistants' responsibilities are being met, the UTRGV Railroad Research Group provides its research assistants with quarterly mandatory trainings in which the students learn to: (1) enforce safety operational protocols, (2) maintain testing equipment and facilities, (3) disassemble and assemble bearings and testing rigs, (4) design and fabricate testing fixtures, which includes machining, milling, welding, and constructing a variety of testing components, (5) perform periodic bearing teardowns and inspections, (6) troubleshoot mechanical systems, and (7) prepare technical progress update reports that summarize the work accomplished and provide the main conclusions and steps moving forward. During this reporting period, the UTCRS conducted **six** mandatory trainings attended by research assistants; namely: (1) Data Acquisition and Analysis Training, provided by Dr. Constantine Tarawneh; (2) Mechanical Sensors Training, provided by Dr. Tarawneh and Dr. Stephen Crown; (3) Bearing Test Rig Setup and Maintenance Procedures Training, provided by Dr. Tarawneh, (4) Preparing Well-Drafted Technical Briefs and Reports Training, provided by Dr. Tarawneh, (5) Performing test axle disassembly and complete railroad bearing tear down and inspection, provided by Dr. Tarawneh, and (6) Laboratory Safety Training, provided by the UTRGV Environmental Health, Safety and Risk Management Office.

The UTCRS also continued their practice of holding a bi-weekly seminar series in which students presented research findings and progress. UTCRS Director, Dr. Constantine Tarawneh, and the faculty who have research projects funded through the center give students feedback and discuss future tasks to be completed during these meetings. This practice guarantees that work stays on schedule and that progress and research needs are being met; improves verbal communication skills; builds confidence; and addresses issues before problems arise. At the same time, undergraduate and graduate students involved in funded research are expected to help create a professional and encouraging environment of support and accountability. To ensure that all UTCRS students reach their fullest potential, they are asked to serve as primary mentors for new research assistants. In this way, students are responsible for passing down knowledge, skills, and work habits before transitioning research responsibilities to a successor.

Several research assistants who have been funded by the UTCRS for more than two semesters have participated in national conferences alongside professors with whom they collaborate. Supervising professors provide support, guidance, knowledge, and wisdom allowing students the opportunity to develop a professional network, and become recognized by their future peers in the transportation industry. A recent success story in this area involves three UTRGV and one UNL graduate students who received ASME Scholarships, which were awarded during the 2017 ASME Joint Rail Conference, held in

Philadelphia, PA. UTCRS students, Oscar Rodriguez, Arthur Mealer, Nancy De Los Santos of UTRGV, and Subharthi Banerjee of UNL, submitted papers summarizing their initial findings and results as part of the work performed under their UTCRS funded projects. Following this success, four graduate and three undergraduate students from UTRGV are co-authoring with UTCRS faculty four more papers to be presented at the 2018 ASME Joint Rail Conference to be held in Pittsburgh, PA.

The UTCRS has placed student researchers in a leadership role by allowing them to represent the UTCRS in science fairs' judging panels, providing laboratory tours, presenting to K-12 students, mentoring high school students, and interacting with high profile visitors during university and community engagement events. One example of UTCRS students taking on leadership roles is a group of students from the UTRGV Curriculum and Instruction Department who participated as interns through the UTeach program collaboration. After being trained by the UTCRS faculty to implement the K-12 STEM curricula during the 2017 UTCRS Summer Camps, the group of students applied the UTCRS-developed STEM lessons at local elementary and middle school classrooms. These interns also presented posters at national conferences.

How have you disseminated your results?

The progress and results of the 36 research projects funded by the UTCRS are published in the UTCRS website (<http://railwaysafety.utrgv.edu>) with further dissemination including academic publications, national and international conference presentations, local and national symposiums, theses and dissertations, products, UTC meetings, local community engagement and outreach events, and project poster presentations. The UTCRS will also release the second semi-annual newsletter this fall to further disseminate results, news, and highlights of the center. This newsletter will be distributed by email to all collaborating faculty, students, UTC counterparts, industry contacts, and K-12 educators and program coordinators, and will be posted on social media for the general public.

What do you plan to do during the next reporting period to accomplish the goals and objectives?

1. Implementation and completion of research activities as outlined in the table above for all research, education, workforce development, technology transfer, and community engagement projects.
2. Continue to update the UTCRS website on a regular basis to reflect all new progress.
3. Continue the bi-weekly research meetings between faculty and student research assistants to address UTCRS goals and objectives, and identify tasks needed to meet project deliverables.
4. Continue to develop student experience and leadership skills through mentoring and engagement in professional scholarly work with the UTCRS faculty.
5. Keep promoting UTCRS STEM Curricula to be implemented in local, state, and national classrooms.
6. Continue to leverage the partnership with the local independent school districts and the community at large to grow and expand our existing community outreach and educational programs.
7. Continue to track and follow the academic and professional careers of students that are participating/have participated in UTCRS programs and activities to measure longitudinal impact.

2. PRODUCTS:

Publications, conference papers, and presentations:

The UTCRS sponsored projects have resulted in a number of journal, symposium, and conference publications and presentations in relevant national and international arenas, as follows:

Journal Publications:

1. Chen, Y. and Rilett, L., "A Train Data Collection and Arrival Time Prediction System for Highway-Rail Grade Crossings," *Transportation Research Records: Journal of the Transportation Research Board*, No. 2608, 2017, DOI: 10.3141/2608-05.

2. Kiani, M. and Fry, G., "Fatigue Analysis of Railway Wheel Using a Multiaxial Strain-Based Critical Plane Index," *Fatigue & Fracture of Engineering Materials & Structures*, pp. 1–13, August 2017. <https://doi.org/10.1111/ffe.12697>.

Conference Publications:

1. Banerjee, S., Hempel, M., and Sharif, H., "A Review of Workspace Challenges and Wearable Solutions in Railroads and Construction," *13th International Wireless Communications and Mobile Computing Conference (IWCMC)*, Valencia, Spain, pp. 91-96, 2017, DOI: 10.1109/IWCMC.2017.7986268.
2. Banerjee, S., Hempel, M., and Sharif, H., "A Survey of Railyard Worker Protection Approaches and System Design Considerations," *Proceedings of the 2017 ASME/IEEE Joint Rail Conference*, Philadelphia, PA, April 4-7, 2017, DOI: 10.1115/JRC2017-2246.
3. Mealer, A., Tarawneh, C., and Crown, S. W., "Radiative Heat Transfer Analysis of Railroad Bearings for Wayside Hot-Box Detector Optimization," *Proceedings of the 2017 ASME/IEEE Joint Rail Conference*, Philadelphia, PA, April 4-7, 2017.
4. De Los Santos, N., Jones, R., Tarawneh, C., Fuentes, A. A., and Villarreal, A., "Development of Prognostic Techniques for Surface Defect Growth in Railroad Bearing Rolling Elements," *Proceedings of the 2017 ASME/IEEE Joint Rail Conference*, Philadelphia, PA, April 4-7, 2017.
5. Rodriguez, O., Fuentes, A. A., Tarawneh, C., and Jones, R., "Hysteresis Heating of Railroad Bearing Thermoplastic Elastomer Suspension Element," *Proceedings of the 2017 ASME Joint Rail Conference*, Philadelphia, PA, April 4-7, 2017. **[Received Best Paper Award]**
6. Timmer, D., Tarawneh, C. and Jones, R., "Models for the Residual Life of Railroad Bearing Grease in Laboratory and Industry Applications," *Proceedings of the 2017 ASME Joint Rail Conference*, Philadelphia, PA, April 4-7, 2017.
7. Fry, G., and Tangtragulwong, P., "Analysis of Rail Grinding as a Means to Optimize Rail Head Fatigue Life under Heavy Axle Loads," *Proceedings of the 11th International Heavy Haul Association Conference*, Cape Town, South Africa, September 2-6, 2017.
8. Allen, D.H. and Fry, G.T., "A Model for Predicting Lateral Buckling in Rails," *Proceedings of the 11th International Heavy Haul Association Conference*, Cape Town, South Africa, September 2-6, 2017.

Theses and Dissertations:

9. Allard, A. J., "Vehicle Bourne Autonomous Railroad Bridge Impairment Detection Systems," Doctoral Dissertation, Zachry Department of Civil Engineering, Texas A&M University, College Station, TX, May 2017.
10. Renteria, D., "Discrete Element Analysis of SCB Variability – Asphalt Mixtures," Master's Thesis, Department of Mechanical Engineering, University of Texas Rio Grande Valley, Edinburg, TX, May 2017.
11. Perales, G., "An Empirical Analysis on Longitudinal and Lateral Tire-Pavement Friction," Master's Thesis, Department of Civil Engineering, University of Nebraska-Lincoln, Lincoln, NE, August 2017.

Professional Presentations:

12. Tarawneh, C. Radiative Heat Transfer Analysis of Railroad Bearings for Wayside Hot-Box Detector Optimization. 2017 ASME/IEEE Joint Rail Conference, Philadelphia, PA, April 4-7, 2017.
13. De Los Santos, N. Development of Prognostic Techniques for Surface Defect Growth in Railroad Bearing Rolling Elements. 2017 ASME/IEEE Joint Rail Conference, Philadelphia, PA, April 4-7, 2017.
14. Rodriguez, O. Hysteresis Heating of Railroad Bearing Thermoplastic Elastomer Suspension Element. 2017 ASME/IEEE Joint Rail Conference, Philadelphia, PA, April 4-7, 2017. **[Received Best Paper Award]**
15. Jones, R. Models for the Residual Life of Railroad Bearing Grease in Laboratory and Industry Applications. 2017 ASME/IEEE Joint Rail Conference, Philadelphia, PA, April 4-7, 2017.

16. Banerjee, S. A Survey of Railyard Worker Protection Approaches and System Design Considerations. 2017 ASME/IEEE Joint Rail Conference, Philadelphia, PA, April 4-7, 2017.
17. Murru, P., Grasley, Z., Rajagopal, K.R., and Alagappan, P. Damage in Concrete in Terms of Microscopic Density Changes. 8th Advances in Cement-Based Materials, Atlanta, GA, June 28, 2017.
18. Micro-Simulation Calibration Using Intelligent Transportation Systems Data: Lessons Learned. School of Information Engineering, Chang'An University, Xian, China, July 3, 2017. Sponsor: Chang'An University.
19. Critical Civil Infrastructure Systems: Challenges and Opportunities. Invited Talk, Tsingua University, Department of Civil Engineering, Beijing, China, July 5, 2017.
20. Multidisciplinary Safety Research. Invited Plenary Speaker, COTA International Conference of Transportation Professionals, CICTP 2017, Shanghai, China, July 8, 2017. Sponsor: CICTP 2017*.
21. Fry, G. Analysis of Rail Grinding as a Means to Optimize Rail Head Fatigue Life under Heavy Axle Loads. 11th International Heavy Haul Association Conference, Cape Town, South Africa, September 2-6, 2017.
22. Allen, D.H. A Model for Predicting Lateral Buckling in Rails. 11th International Heavy Haul Association Conference, Cape Town, South Africa, September 2-6, 2017.

Technical Reports:

23. Allen, D.H., Fry, G.T. and Davis, D., "Development of a Model for Describing Nonlinear Lateral Resistance of Track Ballast," Technology Digest, TD-16-029, 2016.
24. Allen, D.H. and Fry, G.T., "Analysis of a Rail Subjected to Mechanical and Thermal Loading," Center for Railway Research, Texas A&M University, CRR-2016-01, 2016.
25. Allen, D.H. and Fry, G.T., "Finite Element Formulation for Thermal Buckling of Rails," Center for Railway Research, Texas A&M University, CRR-2016-02, 2016.
26. Allen, D.H. and Fry, G.T., "Predicting Lateral Buckling in Rails," RT&S Magazine, 2017.

Technical Committees, Conference Session Chairs, and Panels:

27. Zachary Grasely, Professor of Civil Engineering, ACI Committee 236 Materials Science of Concrete, Secretary.
28. Hamid Sharif, IEEE Conference on Research and Development (SCORed 2016).
29. Hamid Sharif, International Workshop on Design and Performance of Networks on Chip (DPNoC 2016).
30. Hamid Sharif, Advanced Research in Electrical and Electronic Engineering Technology (ARiET 2017).
31. Hamid Sharif, Communication Track Chair, IEEE International Conference on Electro Information Technology (EIT 2017)
32. Aemal Khattak, TRB Standing Committee on Highway/Rail Grade Crossings (AHB60).
33. Jennifer Schmidt, Research Assistant Professor, TRB AFB20 Committee Member.
34. Ronald K. Faller, MwRSF Director and Research Associate Professor, TRB AFB20 Committee Member.
35. Ronald K. Faller, MwRSF Director and Research Associate Professor, International Roadside Safety Conference Chair, 2015 - Present, Event: June 11 -15, 2017.
36. Hamid Sharif, 13th International Wireless Communications and Mobile Computing Conference (IWCMC 2017), Session Chair.
37. Hamid Sharif, Tutorial, Wireless Communications Challenges in Surface Transportation, IEEE International Conference on Communications (ICC 2017).

Editorial Boards:

38. Constantine Tarawneh, Fourth International Conference on Railway Technology: Research, Development, and Maintenance (Railways 2018), Editorial Board.
39. Constantine Tarawneh, Transport Research Arena 2018, Editorial Board.
40. Zachary Grasley, Journal of Materials: Civil Engineering, Associate Editor.

41. Laurence Rilett, Journal of Intelligent Transportation Systems: Technology, Planning and Operations, Editorial Board, 2005 – Present.
42. Laurence Rilett, Journal of Transportation Engineering, Managing Editor, 2007 – Present.
43. Laurence Rilett, Journal of Transportation Engineering, Textbook Editor, 2010 – Present.
44. Hamid Sharif, Wiley Security and Communications Networks (SCN) Journal, Co-Editor-in-Chief.
45. Ronald K. Faller, MwRSF Director and Research Associate Professor, International Roadside Safety Conference, e-Circular Editorial Board.
46. Aemal Khattak, Area Editor, Journal of Transportation Safety and Security
47. Dennis Alexander, Multiscale and Multidisciplinary Modeling, Experiments, and Design, Associate Editor.
48. Editorial Board Member, Journal of Transportation Research Forum.

Website or other Internet Material:

The UTCRS website (<http://railwaysafety.utrgv.edu>), hosted by UTRGV, is being maintained on a regular basis to reflect the full spectrum of research, education, workforce development, technology transfer, outreach activities, trainings, and student opportunities and programs available at UTCRS. The goal is to have a complete repository of photo galleries, videos, and news articles that carefully document the UTCRS operations and activities over the past four years.

Technologies or techniques:

- a. The research sponsored by the UTCRS investigates the buildup of ice on railroad and highway traffic signals as a result of using low thermal emitting LED light bulbs. The goal of this research is to (1) femtosecond laser process (FLSP) a hard die material that could be used as a die to stamp micro and nanoscale surfaces on railroad crossing lenses, and (2) directly process the railroad crossing lens with a femtosecond laser to produce super-hydrophobic surfaces. To this end, a surface structure was imprinted to the Polycarbonate, which is always used as the railway traffic signal lens material. The material used as the die is tungsten carbide (WC). FLSP is used to produce the micro/nano-structured surface structures shown in **Fig. 1**. The FLSP WC's roughness (peak to valley height) is $63 \pm 7 \mu\text{m}$. Using this die, the railroad lens, which is a polycarbonate (PC) sample, is stamped by providing large loads under various temperature. The FLSP mounds penetrated into the PC to produce the negative surface.

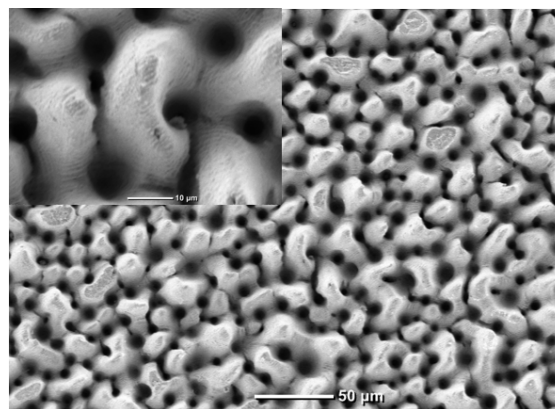


Figure 1. SEM image from the die's micro/nano-structure, which is Femtosecond Laser Surface Processed (FLSP). The die's material is Tungsten Carbide.

The parameters used to obtain the results in **Fig. 1** are: sample size is $2 \times 2 \text{ cm}^2$, FLSP WC sample's size is $1 \times 1 \text{ cm}^2$, the applied load is 100 MPa, the temperature is 120°C , and after imprinting, the surface wetting properties were tested. The stamped PC sample shows the negative surface of the FLSP WC. The roughness of the imprinted surface is $17 \pm 2 \mu\text{m}$, peak to valley height. (See **Fig. 2**)

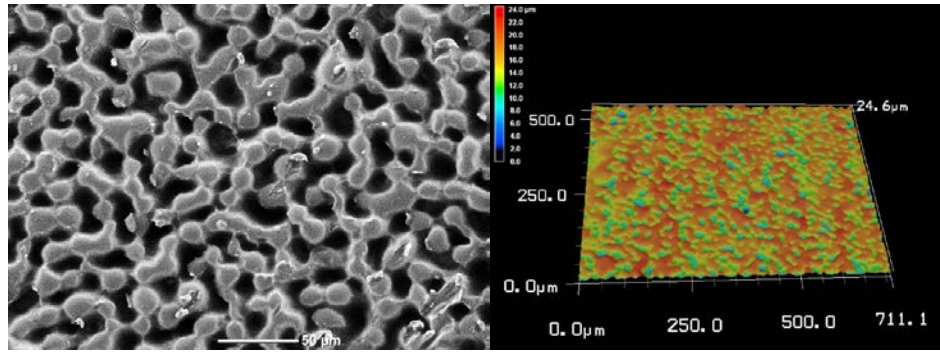


Figure 2. a) SEM image from the imprinted PC's surface; b) 3D image from the imprinted PC, the peak to valley height is .

Before imprint is carried out on the PC sample, the contact angle is $97.8^\circ \pm 5.5^\circ$. After imprinting, the contact angle is $130.5^\circ \pm 7.4^\circ$, as can be seen in **Fig. 3**. The results show that negative FLSP surface by imprinting does alter the hydrophobicity of the railroad lens. Currently, the direct writing of FLSP surfaces on the polycarbonate light cover on railroad signals is being investigated. Observations of the FLSP surface reveal a 159° contact angle, a very low droplet roll off angle, and the formation of plastron on the surface when submerged in water which qualify the FLSP surface as superhydrophobic. Shown in **Fig. 4** are the FLSP surface images on a cube of an actual railroad lens that has been cut into small squares, the plastron present on the surface, and a surface scan using a confocal microscope laser microscope. The laser processing roughens the surface on the micro-nanoscale, which typically result in superhydrophobic surfaces that are, in general, icephobic surfaces. An icephobic polycarbonate surface is of interest because if implemented on traffic and railroad signals, they could resist snow and ice buildup resulting in better visibility of these signals. The potential for FLSP-engineered surfaces to produce icephobic properties is promising, however, some important characteristics of the FLSP on polycarbonate surfaces need to be taken into consideration for this application, most notably transparency and durability. Further research into engineering FLSP surfaces on polycarbonate is necessary to maximize their icephobic properties and investigate if the process is effective and scalable.

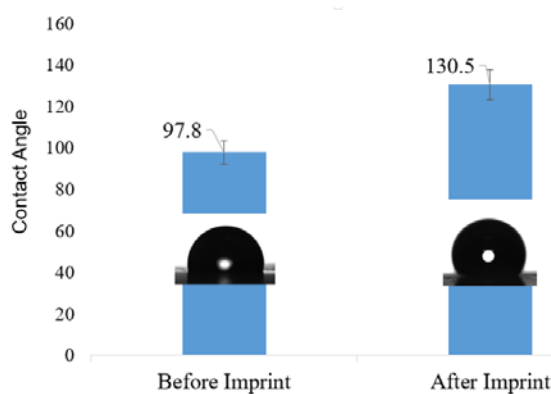


Figure 3. PC surface becomes more hydrophobic after imprint according to the droplets test.

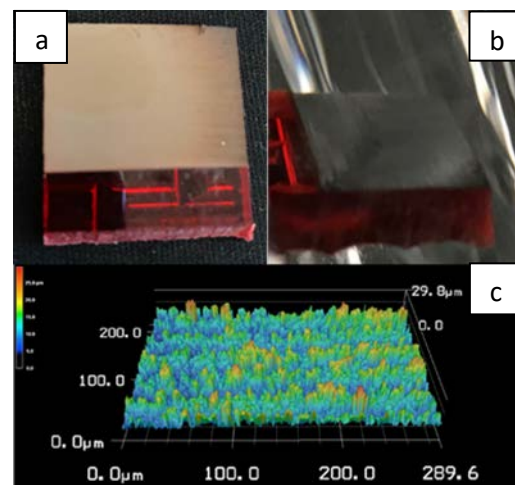


Figure 4. a) Picture of an FLSP on the polycarbonate signal cover ($\sim 20 \times 22$ cm), b) image of plastron on surface of FLSP surface, and c) confocal laser microscope scan of surface structuring

- b. A technique was developed to map existing rail grade crossing sites. High-fidelity laser profilometry was conducted to map real-world existing rail grade crossing sites to evaluate slopes, obstacles, and features affecting rail grade crossings (e.g., roadway intersections adjacent to railroad tracks). The technique uses laser scanning of a site without interfering with the railroad right-of-way. Profilometry data will be used during computer simulation efforts to investigate large truck and trailer crossings using vehicle and trailer dynamics investigation.

Inventions, patent applications, and/or licenses:

Nothing to report at this time.

Other products:

The new design for the four railroad bearing test rig that has been fabricated at UTRGV continues to be heavily utilized to perform testing for the various UTCRS funded projects at UTRGV.

3. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS:

What individuals, organizations, or collaborators have worked on the program?

During the current reporting period, the following individuals, organizations, and collaborators listed below have been an integral part of the various research, education, workforce development, technology transfer, and outreach activities of the UTCRS.

NAME	ORGANIZATION NAME	RELATION	GENDER
State			
Acton, Jessica	Texas Higher Education Coordinating Board (THECB)	Education	Female
Crown, Stephen, PhD	Director of UTRGV Texas Pre-Freshman Program (TexPrep)	Education	Male
Mahmoud, Enad	Texas Department of Transportation (TxDOT)	Governmental	Male
Parra, Nayeli	Texas Department of Transportation (TxDOT)	Governmental	Female
Local			
Dr. Roni Rentfro	Brownsville ISD	Community	Female
Dr. Alda Benavides	La Joya ISD	Community	Female
Kelly Watson	Donna ISD	Community	Male
Sandra Tovar	Harlingen CISD	Community	Female
Cynthia Torres	La Feria ISD	Community	Female
Rey Villarreal	La Feria ISD	Community	Male
Dr. Jose A. Gonzalez	McAllen ISD	Community	Male
Dr. Sharon Roberts	Mission CISD	Community	Female
Dr. Daniel P. King	Pharr-San Juan-Alamo ISD	Community	Male
Dr. Robert O’Conner	Sharyland ISD	Community	Male
Dr. Richard Rivera	Edcouch Elsa ISD	Community	Male
Dr. Rene Gutierrez	Edinburg CISD	Community	Male
Ramiro Balderas	Valley View ISD	Community	Male
Robert L. Olivarez	Vanguard Academy	Community	Male
Jorge Chipres	IDEA ISD	Community	Male
Jimmy McDonough	Los Fresnos ISD	Community	Male
Brenda DeHoyos	Hidalgo ISD	Community	Female
Olivia Almanza	Monte Alto ISD	Community	Female
Dr. Adrian Vega	San Benito CISD	Community	Male
Maria J. Chavez	Santa Maria ISD	Community	Female
Martin Cuellar	Progreso ISD	Community	Male
Yulia Molina	Progreso ISD	Community	Female

Dr. Priscilla Canales	Weslaco ISD	Community	Female
Scott Amdahl	Weslaco ISD	Community	Male
Sarah Leal-Mendez	RGV Homeschool Cooperative Resource	Community	Female
Stacey Proctor	2017 RET Program Participant – PSJA ISD	District Level	Male
Beatriz Valenzuela	2017 RET Program Participant – La Joya ISD	District Level	Female
San Juanita Maldonado	2017 RET Program Participant – La Joya ISD	District Level	Female
Imelda Dumalaog	2017 RET Program Participant – La Joya ISD	District Level	Female
Maria Isabel	2017 RET Program Participant – La Joya ISD	District Level	Female
Andres Benitez	2014-2017 RET Program Participant - Sharyland ISD	District Level	Male
Rene Garcia	2014-2017 RET Program Participant - PSJA ISD	District Level	Male
Teresa Ochoa	2015-2016 RET Program Participant - La Joya ISD	District Level	Female
Stephanie Soto	2017 RET Program Participant – UTeach Program	UTRGV	Female
Erica Hinojosa	2017 RET Program Participant – UTeach Program	UTRGV	Female
Lizbeth Morales	2017 RET Program Participant – UTeach Program	UTRGV	Female
Private			
Wilson, Brent, PhD	Director of Research and Development, Amsted Rail	Advisory Board	Male
Connell, David	Vice President – Engineering Union Pacific Railroad Co.	Advisory Board	Male
Kalay, Semih	Vice President – Research and Development, Transportation Technology Center, Inc. (TTCI)	Advisory Board	Male
Staplin, David	Deputy Chief Engineer – Amtrak	Advisory Board	Male
Consortium			
Tarawneh, Constantine, PhD	UTCRC – Director Professor, Mechanical Engineering, UTRGV 1201 West University Drive, Edinburg, TX 78539-2999	Researcher/ Executive Committee	Male
Allen, David, PhD, PE	UTCRC – TAMU Associate Director Professor, Civil Engineering, TAMU 3135 TAMU, College Station, TX 77843-3135	Researcher/ Executive Committee	Male
Rilett, Laurence, PhD, PE	UTCRC – UNL Associate Director Professor, Civil Engineering, UNL 262D Whittier Research Center P.O. Box 830851, Lincoln, NE 68583-0851	Researcher/ Executive Committee	Male
Freeman, Robert, PhD	UTCRC – UTRGV Associate Director Professor and Chair, Mechanical Engineering, UTRGV	Executive Committee	Male
Chapman, Angela, PhD	UTCRC – Education and Diversity Coordinator Assistant Professor, Curriculum & Instruction, UTRGV	Researcher/ Executive Committee	Female
Ley-Martinez, Brenda	UTCRC – UTRGV Program Assistant	Staff	Female
Dove, Russell	Web Designer II, Internet Services, UTRGV	Institutional	Male
Pelton, Amanda	Program Coordinator, Center for Railway Research, Texas A&M Transportation Institute (TTI)	Staff	Female
Bret, Evert	Business Associate I, Nebraska Transportation Center, UNL 2200 Vine Street, Lincoln, NE 68583-0815	Staff	Male
Foltz, Heinrich, PhD, PE	Professor, Electrical Engineering, UTRGV	Researcher	Male
Fuentes, Arturo, PhD	Professor, Mechanical Engineering, UTRGV	Researcher	Male
Jones, Robert, PhD	Professor, Mechanical Engineering, UTRGV	Researcher	Male
Fry, Gary, PhD, PE	Associate Professor, Civil Engineering, TAMU	Researcher	Male
Hurlebaus, Stefan, PhD	Assistant Professor, Civil Engineering, TAMU	Researcher	Male
Briaud, Jean-Louis, PhD	Assistant Professor, Civil Engineering, TAMU	Researcher	Male
Aubeny, Charles, PhD	Professor, Civil Engineering, TAMU	Researcher	Male
Keating, Peter, PhD	Associate Professor, Civil Engineering, TAMU	Researcher	Male

Grasley, Zachary, PhD	Associate Professor, Civil Engineering, TAMU	Researcher	Male
Alexander, Dennis, PhD	Professor, Kingery Engineering, UNL	Researcher	Male
Zuhlke, Craig, PhD	Research Assistant Professor, UNL	Researcher	Male
Schmidt, Jennifer, PhD	Research Assistant Professor, MWRSF, UNL	Researcher	Female
Stolle, Cody, PhD	Research Assistant Professor, MME, UNL	Researcher	Male
Faller, Ronald, PhD	Associate Research Professor, Civil Engineering, UNL	Researcher	Male
Sangster, John, PhD, PE	Assistant Professor, Civil Engineering, UNL	Researcher	Male
Khattak, Aemal, PhD	Associate Professor, Civil Engineering, UNL	Researcher	Male
Sharif, Hamid, PhD	Professor, Telecommunication and Computer Engr., UNL	Researcher	Male
Hempel, Michael, PhD	Research Assistant Professor, Elect. and Comp. Eng., UNL	Researcher	Male
Thompson, Eric, PhD	Associate Professor, Economics, UNL	Researcher	Male
Contreras, Roger, PhD	Co-director, UTRGV UTeach Program	Institutional	Male
Gonzales, Veronica	VP for Governmental and Community Relations, UTRGV	Institutional	Female
Garza, Barbara	Director, Office of P-16 Initiatives, UTRGV	Institutional	Female
De Los Santos, Nancy	Society of Automotive Engineers (SAE)	Institutional	Female
Villarreal, Domingo	MiniBaja Student Organization (SAE)	Institutional	Male
Capitanachi, Dulce	Society of Women Engineers (SWE)	Institutional	Female
Mendoza, Atilano	Society of Hispanic Professional Engineers (SHPE)	Institutional	Male
Gutierrez, Jacob	American Society of Mechanical Engineers (ASME)	Institutional	Male
Resendez, Erika	American Society of Civil Engineers (ASCE)	Institutional	Female

4. IMPACT:

What is the impact on the development of the principal discipline(s) of the program?

The UTCRS is able to report various indicators of impact, including:

- A clear pathway to graduate studies between the three consortium institutions has been established providing students with several options to pursue their postgraduate studies on mechanical, operations, and infrastructure railway research. To date, 26 of the 35 REU students are either already enrolled or have been accepted into graduate programs at the three consortium institutions pursuing Master's degrees in transportation-related fields. The UTCRS 74% admission to graduate programs as a result of participation in an REU Program is well above the national average for these programs. Three of these REUs are currently pursuing their doctoral degrees, which is a remarkable accomplishment and success for the UTCRS in such a short period. More importantly, these students come from mechanical, civil, electrical, manufacturing, and computer engineering majors; a fact that demonstrates the impact of the UTCRS on several engineering programs.
- The UTCRS has been successful in attracting a large percentage of minorities, typically underrepresented in transportation engineering fields, to the discipline. These groups are receiving rigorous hands-on training through active engagement in railway safety research applications that are vital for the railroad industry.
- Training of a critical mass of engineering students on hands-on skills that include welding, machining, design specifications, assembly, testing fixtures, and the use of hydraulic machinery.
- Twenty graduate and sixteen undergraduate students have gained invaluable technical writing and oral presentation experience by co-authoring paper publications, writing and defending theses, and presenting at national and international conferences relevant to the rail transportation industry.
- Students also gained experience in using complex mathematical and statistical modeling and state-of-art engineering software tools and packages such as SolidWorks, Algor, MatLab and Labview.
- The success of the UTCRS REU Program has highlighted the need for a Master's Program in Civil Engineering at UTRGV. Based on that, a proposal to establish a Master's of Science in Civil Engineering Program with an emphasis on transportation was submitted and approved by the University of Texas

System and is awaiting final approval by The Higher Education Coordinating Board (THECB) in January of 2018. The department has already hired one faculty with expertise in transportation systems, and will be requesting two more faculty in the upcoming recruitment cycle.

- The new transportation systems faculty that has been hired in the Civil Engineering Department at UTRGV has set up a new Surface Transportation Operations and Safety (STOpS) Laboratory that will be used to devise and develop efficient traffic flow models for cities and municipalities.

What is the impact on other disciplines?

The UTCRS continues to emphasize the interdisciplinary nature of the transportation industry in all research and educational programs the center develops. To this end, the UTCRS activities are developed as college and university wide initiatives rather than a single department or unit. Hence, the UTCRS activities span across the mechanical, electrical, civil, manufacturing, computer engineering, and computer science from the college of engineering and computer science, as well as the department of curriculum and instruction from the college of education and P-16 integration. Faculty, staff, and students from these different disciplines are working in unison towards promoting transportation engineering, improving railway safety, and raising awareness and interest in the transportation field.

The impact of the UTCRS Summer Camps is not limited to K-12 students as these camps have provided preservice teachers in the UTeach program, a secondary math and science educator preparation program, the opportunity to engage in teaching and research. These students have been working as paid interns to gain teaching experience and conduct education research related to improving participation of Hispanic students in STEM. Many of these students have been recognized by international STEM scholars for their work. For example, nine students presented their research findings at the 2017 Understanding Interventions that Broaden Participation in Science Conference in San Antonio, Texas. These students have been investigating how gender and family culture influence K-12 student participation in the summer camps. Under the supervision of Dr. Angela Chapman, one manuscript is under review in the Journal of Women and Minorities in Science and Engineering while another manuscript is in preparation. In addition, the nine students were invited to deliver a plenary session at the 2018 Understanding Interventions Conference in Baltimore. Working in the UTCRS Summer Camps has helped to prepare prospective teachers as critical STEM educators who can connect theory to practice. Many of these students are in the first few years of teaching in local school districts and are being recognized as exemplary educators and rising stars by their administration.

What is the impact on the development of transportation workforce development?

Since its inception in the fall of 2013, the UTCRS has engaged over 220 undergraduate and graduate students in its various research, education, technology transfer, professional development, and community outreach activities. These students are mentored by a team of highly qualified and dedicated faculty who are committed to providing a well-rounded education and research experience in the transportation engineering field. Students develop valuable skill-sets through hands-on projects relevant to the railroad industry, preparing technical reports and briefs on work accomplished, co-authorship of journal and conference papers, presentation at local and national symposiums and conferences, and writing and defending theses and dissertations, making these students workforce ready upon graduation.

In addition to developing well-rounded transportation engineering workforce skills in research students, the UTCRS educates and provides development opportunities for a largely Hispanic student population that is statistically underrepresented in the professional transportation field (as reported by the Department of Labor Statistics of 2014). Moreover, of the 220 UTCRS students that were engaged in the various center activities, **37.5%** of them are **female**, which more than doubles the national average of 15.7% female in Professional Transportation and Materials Moving Occupations. In fact, the three UTCRS

REU participants that are now pursuing their doctoral degrees in transportation engineering fields are females who were not previously considering pursuing their graduate education.

The UTCRS K-12 education outreach and workforce development efforts are led by a highly dedicated group of faculty and students. This group has facilitated a number of hands-on STEM workshops for educators, offered to develop the skill-sets required to teach transportation engineering concepts in their classroom, and to expose educators to the use of appropriate pedagogy to engage students in STEM fields. Since 2014, the UTCRS has engaged and trained more than **400** teachers, program coordinators, counselors, and administrators on how to implement the UTCRS Curricula in diverse educational settings. The latter has enabled teachers and educators to interactively deliver age-appropriate STEM concepts, related to transportation engineering with an emphasis on railway safety, in their classrooms, while also promoting STEM career fields. The skill-sets gained by these educators helped them boost their CVs.

What is the impact on physical, institutional, and information resources at the university or other partner institutions?

The community outreach activities of the UTCRS have strengthened institutional collaborations between UTRGV and more than **26** school districts that collaborated with the UTCRS in the organization of the 2017 Railway Safety Summer Camps. Of particular importance is the establishment of interlocal cooperative contract agreements between UTRGV and these school districts, which have facilitated partnership on current and future education and workforce development initiatives. In fact, the school districts funded the majority of the expenses incurred for the 2017 UTCRS Summer Camps as these school districts have come to depend on the UTCRS for their STEM camps at the elementary level, since they are the only STEM camps offered at that level in the lower Rio Grande Valley. More importantly, the UTCRS outreach efforts and educational programs are very well-aligned with UTRGV's institutional mission and educational goals of encouraging K-12 students to attend college and pursue degrees and careers in STEM fields.

The advanced research conducted by the UTCRS has generated national and international institutional visibility for the three consortium universities. In particular, UTRGV has benefited from the high-caliber publications produced by the UTCRS, as well as the national and international exposure of its research in conferences. The aforementioned is in-line with the overall institutional research goal of becoming a Tier 1 Research Institution. Furthermore, the effective collaboration among the consortium institutions has provided students accessibility to resources available at all three institutions. Through the UTCRS REU Program, the consortium has facilitated pathways for undergraduate and graduate students from UTRGV to enroll in graduate and doctoral programs with strong emphasis on transportation engineering. This reporting period, five more REU participants have enrolled in graduate programs at all three consortium institutions, with more expected to follow suit once they complete their undergraduate degrees.

What is the impact on technology transfer?

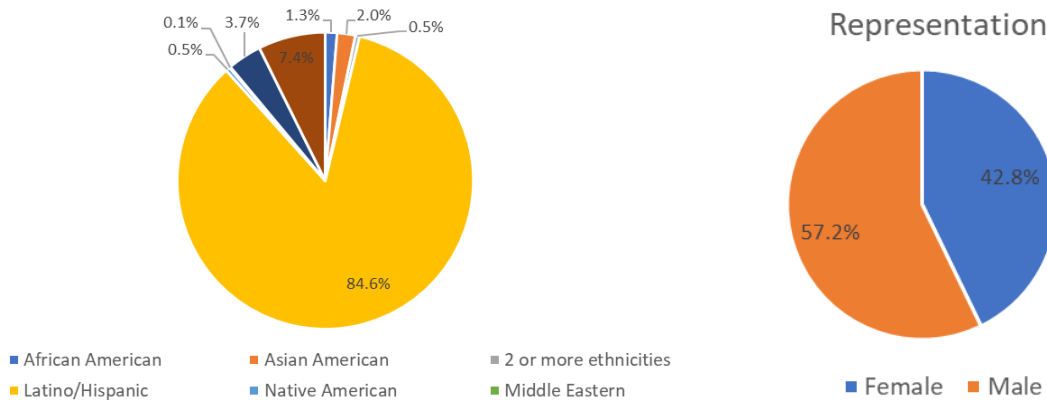
Technology transfer activities include publication of theses and research papers, presentations at national conferences and symposiums, trainings, field testing, and deployment. For this reporting period, the UTCRS technology transfer activities included two doctoral dissertations, four Master's theses, thirteen conference papers, two journal articles, six research symposiums, eight technical reports, and twenty professional presentations. Moreover, three projects that were funded through the 2015-2016CY call for proposals have completed during this reporting period. As part of the grant reporting requirements, final project reports have been posted on the UTCRS web site and are available for download. Exhibit F forms have been completed and posted on the UTCRS web site and are available for immediate download.

What is the impact on society beyond science and technology?

The UTCRS serves a population that is 90% Hispanic, of which approximately 85% are of Mexican descent, and 50% earn incomes that are significantly below the state average. The UTCRS education and outreach

efforts in the Rio Grande Valley (RGV) have promoted STEM education and facilitated many opportunities for the community that will otherwise not be possible. One specific impact this reporting period is the success of the UTCRS efforts that were focused on increasing female participation in the summer camps, especially for high school students. Previous years (2013-2016) have consistently shown that elementary (grades 3-5) boys and girls are equally likely to participate in the summer camps. However, female participation decreases during middle school and high school. For example, during 2016 elementary participation was approximately equal for boys and girls (50%/50%). By middle school, the distribution changed to 60%/40%, and by high school 79%/21%. During the 2017 UTCRS summer camps, 57% of the elementary participants were male and 43% were female. In the middle school robotics camps, 57% of the participants were male and 43% of the participants were female. In the high school camps (combined MagLev and robotics), 70% of the participants were male and 30% were female. This demonstrates a 43% increase in high school female participation, a finding that is statistically significant. One possible explanation for this increase is our strong collaborations with our local school districts that have led to important discussions about recruitment efforts. Through the strong collaborative partnership that has been established between the UTCRS and the local school districts, these educational summer camps are available to students at no charge to them, thus, affording them the same opportunities as those available to students whose parents are not financially challenged. The impact of these camps becomes apparent when considering that more than 60% of parents in the RGV did not attend college, and that these camps are the first exposure to a university setting for their kids. Moreover, the UTCRS offers the necessary teaching tools, experiences, trainings, and professional development opportunities to K-12 students and teachers at no cost to them, which, in some cases, is the only way that some of the poorer school districts can afford these experiences for their students and teachers. Most teachers involved in the UTCRS RET Program have been able to advance their professional careers through the work experience they gained by working with UTCRS faculty and Staff. These teachers continue to engage with the UTCRS regularly.

2017 UTCRS Summer Camps Ethnicity and Racial Representation 2017 UTCRS Summer Camps Gender Representation



Videos and photographs highlighting the various UTCRS activities during this reporting period can be found at: <http://www.utrgv.edu/railwaysafety/index.htm>

Community Outreach: <http://www.utrgv.edu/railwaysafety/education/community/index.htm>

News and Events: <http://www.utrgv.edu/railwaysafety/news/index.htm>

5. CHANGES/PROBLEMS:

Nothing to report

6. SPECIAL REPORTING REQUIREMENTS:

Nothing to report.