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**
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- **Submission Date:** April 30, 2018

- **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 – December 31, 2018

- **Reporting Period End Date:** March 31, 2018

- **Report Term or Frequency (annual, semi-annual, quarterly, other):** Semi-annual

- **Signature of Submitting Official**

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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**	**80%**
Technology Transfer Briefs, Webinars, Symposiums, and Presentations on Research Results	**On Schedule**	**80%**
Applicable Slides, Handouts, Videos, Pictures Posted	**Complete**	**100%**
Final Reports Due & All Research Projects Completed	**On Schedule**	**75%**
Leadership Activities		
Coordination between UTCRS Director and Leadership Team	**Complete**	**100%**
UTCRS Leadership Team Update	**Complete**	**100%**
Finalize the distinguished guests list for the 2018 UTCRS Summer Camps Closing Ceremony to be held on July 6, 2018 in the UTRGV campus	**Complete**	**100%**
Education & Outreach Activities		
Meetings with the Lower Rio Grande Valley Independent School District Superintendents and their Representatives	**Complete**	**100%**
Call for 2018 Research Experience for Teachers (RET) Program	**Complete**	**100%**
Selection of 2018 Research Experience for Teachers (RET) Program Participants	**Complete**	**100%**
Preparations for the 2018 UTCRS K-12 STEM Summer Camps	**On Schedule**	**85%**
Technology Transfer Activities		
Preparations for 2018 UTCRS K-12 STEM Teacher National Workshop	**On Schedule**	**90%**
Development of New High School Transportation Related STEM Curriculum Featuring MakeBlock Robotics Kits and Arduino Board Programming	**On Schedule**	**90%**
UTCRS Website Information Dissemination Update	**Complete**	**100%**
UTCRS Spring 2018 Newsletter Describing Center Activities	**Complete**	**100%**
UTCRS Supported Journal and Conference Publications and Presentations	**On Schedule**	**90%**
UTCRS Supported Presentations, Symposiums, Workshops, and Short Courses	**On Schedule**	**90%**
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%**
Updated Exhibit Fs Posted Following the Completion of Each Project	**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. Some of these undergraduate and graduate research assistants attended the 2018 ASME Joint Rail Conference (JRC) held in Pittsburgh, PA in April 18-20, 2018, and presented their papers. In fact, the UTCRS was very well represented at this conference with four graduate and three undergraduate students and two faculty members in attendance. For the fourth consecutive year, UTCRS graduate and undergraduate students received the ASME Scholarship for presenting papers as first authors at the JRC. Preparations for the 2018 UTCRS K-12 STEM Teacher National Workshop were well underway during this reporting period and thus far, we have received more than 75 registration applications. This year, a new high school curriculum is being developed by the UTCRS faculty and staff that utilizes newly acquired MakeBlock Robotics kits to teach students programming skills featuring the computer code "Scratch" and the use of Arduino Boards. The new curriculum has been developed in response to requests from the local school districts to provide workforce development and trainings for their teachers in programming skills. The UTCRS also continued its Research Experience for Teachers (RET) Program, which will feature 15 STEM teacher participants in summer of 2018. Out of these 15 teachers, seven are funded by the UTRGV UTeach program, and five are 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 fifth consecutive year, the UTCRS Summer Camps will be hosting more than 1100 K-12 students who will be 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 ($120K) of the Independent School Districts (ISDs) in the Lower Rio Grande Valley (LRGV) for the 2018 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).

The UTCRS has funded a total of **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. Six 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. 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
18. **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
19. **A Mechanistic Investigation of Concrete Tie Degradation in the Rail Seat.** http://www.utrgv.edu/railwaysafety/research/infrastructure/investigation-concrete-tie-degradation/index.htm
20. **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
On-going Projects
21. **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
22. **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
23. **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
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 Eyebar Members.** http://www.utrgv.edu/railwaysafety/research/infrastructure/service-analysis-of-eyebar-members/index.htm
26. **Strength and Fracture Toughness of Railroad Eyebar Members.** http://www.utrgv.edu/railwaysafety/research/infrastructure/fracture-of-eyebar-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

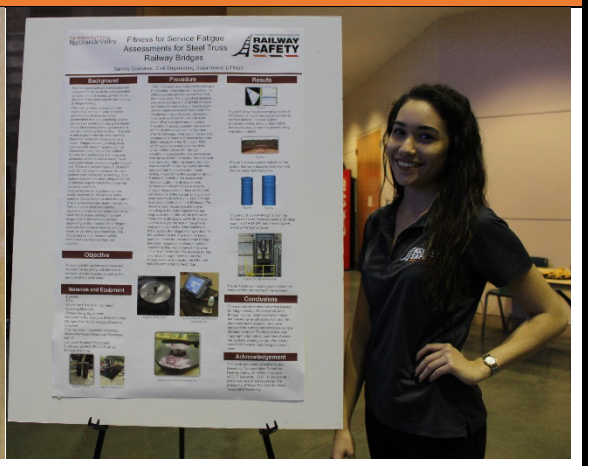
During this reporting period, the UTCRS financially supported 43 undergraduate, master's, and doctoral students actively involved in the various UTCRS funded research projects and educational programs. As part of our commitment to transportation industry workforce development, a substantial number of 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	25	16	9
Masters' Research Assistants	10	8	2
Doctoral Research Assistants	8	7	1
Totals	43	31	12

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 conducted at the UTCRS. The UTCRS outreach efforts reached more than 3000 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 2018. The UTCRS will have 15 STEM teachers participate in the 2018 Research Experience for Teachers (RET) Program; close to 100 teachers have registered to attend the 2018 STEM Teacher National Workshop; and more than 1100 K-12 students from Lower Rio Grande Valley (LRGV) school districts have enrolled to attend the 2018 UTCRS Summer Camps, with more than 100 students still on the waiting list hoping to be allowed to participate. Moreover, the UTCRS had a significant presence at the 2018 ASME Joint Rail Conference where a group of four graduate and three undergraduate students and two faculty members presented their UTCRS funded research at this conference. Two of the UTCRS students received the ASME scholarship, with the only undergraduate scholarship awarded to one of the UTCRS undergraduate students. The following is a summary of some of the research, educational, workforce development, and technology transfer activities carried out over the period from October 1, 2017 to March 31, 2018:

UTCRS ACTIVITIES and HIGHLIGHTS for period (October 1st, 2017 – March 31st, 2018)

2017 UTCRS FALL RESEARCH SYMPOSIUM



The UTCRS held its annual fall research symposium on November 20, 2017. Graduate and undergraduate research assistants benefitted greatly from presenting their work to their peers and getting much appreciated feedback on the work they are doing and ways to improve and optimize their methodologies. The symposium was open to all students in the college and to the public. Many students in the college have been inquiring about ways to join the UTCRS research team because the topics presented were very interesting and spanned across several disciplines.

STUDENT EXCELLENCE PROFILE: CASSANDRA LOZANO SIAS

Cassandra Sias was a member of the University Transportation Center for Railway Safety (UTCRS) while pursuing her BS degree in Civil Engineering at The University of Texas Rio Grande. As a freshman student, she was chosen as part of the inaugural cohort of students that participated in the 2014 research experience for undergraduate (REU) program administered by the UTCRS. Her outstanding performance led to her being chosen for the 2015 UTCRS REU cohort which consisted of 12 students. Cassandra used the knowledge she gained from participating in the REU Program to land an internship in Summer of 2017 working for the Railroad Division (RRD) at Texas Department of Transportation (TxDOT) - Austin District. Her project focused on the state-owned South Orient Railroad (SORR) track rehabilitation project in Upton, Crane, and Crockett counties. Throughout the summer, she learned about the mechanics/components of the railroad tracks and how to inspect and detect defects for restoration – ties, stock rail, pins, etc. In addition, she developed a plan set using MicroStation that consisted of five grade crossing sketches depicting the placement of the Storm Water Pollution Prevention Plan (SW3P) developed by the environmentalist. Quantity tables for each county were also drafted to state the number of ties, ballast loads, and other track parts that are due for replacement. Cassandra stated that working at TxDOT was an incredible experience. She was able to challenge herself by applying her theoretical knowledge of railways into

practical field applications. In Fall of 2017, Cassandra graduated with her BS in Civil Engineering with three job offers in the field of transportation engineering. Currently, she is working in HDR Engineering, Inc. in Austin Texas as a Utility Design Engineer. Her job functions in support of project engineer/design engineer include working on utility relocation/coordination projects within Texas for several agencies - TxDOT, Counties, Cities, and major railroad companies; identifying and resolving utility conflicts in the most feasible and time sensitive manner; inputting utility information into MicroStation creating utility layouts and plan sheets for design of utility relocation. Cassandra provided the following quote: "Special thanks to Dr. Tarawneh for his unconditional support and mentorship throughout my undergraduate career."

2017 UTCRS STUDENT OF THE YEAR RECEPIENT

Highlighting the Success of the UTCRS REU Program

In the picture, from right to left, are: James Aranda, Constantine Tarawneh (UTCRS Director), Tiffany Trevino, and Santos Ramos.

The Council of the University Transportation Centers (CUTC) celebrated the accomplishments of the students involved in the various research and educational activities of their corresponding UTCs during the annual winter banquet held on January 6, 2018 in Washington, DC. During the banquet, Students of the Year (SOY) as selected by their respective UTC were honored by receiving a certificate in recognition of their achievements and contribution to transportation research and education. The University of Texas Rio Grande Valley (UTRGV) is proud of the accomplishments and achievements of its students pictured alongside University Transportation Center for Railway Safety (UTCRS) Director, Dr. Constantine Tarawneh. Mr. James Aranda, a graduate student pursuing his master's degree in mechanical engineering at UTRGV, was selected as the UTCRS Student of the Year Award Recipient. Ms. Tiffany Trevino, a graduate student pursuing her master's degree in mechanical engineering at the University of Nebraska-Lincoln (UNL), was selected as the MATC Student of the Year Award Recipient. Mr. Santos Ramos graduated with his bachelor's degree in civil engineering from UTRGV in Fall 2017 and is currently pursuing his master's degree in civil engineering at UNL. Both, Ms. Tiffany Trevino and Mr. Santos Ramos, participated in the Research Experience for Undergraduates (REU) Program organized by the UTCRS in summer of 2015 and 2016. Prior to participation in the UTCRS REU Program, both Tiffany and Santos had no intention of pursuing their master's degrees, but the research experience they received gave them the confidence they needed to pursue their graduate degrees. The success of these students in their academic careers speaks volumes to the research and education opportunities they received at UTRGV through the UTCRS. To date, the UTCRS REU Program has been responsible for placing eleven UTRGV students with majors in mechanical, civil, and computer science in graduate programs at UNL. Moreover, almost 75% of the UTCRS REU participants have joined graduate programs at UTRGV, UNL, and TAMU, which is an impressive statistic and a great achievement when compared to the success rate of other REU Programs nationally.

UTCRS-UTRGV Research Group HAS STRONG SHOWING IN 2018 ASME JOINT RAIL CONFERENCE

The UTCRS UTRGV Research Group had a strong showing at the 2018 ASME Joint Rail Conference (JRC) held in Pittsburgh, PA in April 17-20. The research group presented four papers on work performed as part of the projects funded by the University Transportation Center for Railway Safety (UTCRS) under the USDOT Grant No. DTRT13-G-UTC59. The UTCRS group consisted of two faculty and seven students from UTRGV (4 graduates and 3 undergraduates). 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 19, 2018, one of our graduate students received one of four ASME Graduate Scholarships (Joseph Montalvo), and one of our undergraduate students (Veronica Hernandez) received the only ASME Scholarship presented to undergraduate students at this conference. The four graduate students are currently working on their Master's Thesis and are set to defend this year. We are

extremely proud of the accomplishments of the UTCRS Research Group! Especially the work of the graduate and undergraduate students involved in the various UTCRS research projects. 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 rail industry. Pictured from left to right: Oscar Rodriguez (Graduate Student), Veronica Hernandez (Undergraduate Student), Dr. Constantine Tarawneh (UTCRS Director), Jennifer Lima (Undergraduate Student), Dr. Robert Jones (UTCRS Faculty), Nancy De Los Santos (Graduate Student), Claudia Ramirez (Undergraduate Student), Joseph Montalvo (Graduate Student), James Aranda (Graduate Student), and Jeff Gordon (Office of Research and Development, Federal Railroad Administration, USDOT). (See: https://www.flickr.com/photos/131769328@N02/sets/72157666446095647)

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 **seven** 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; (6) Effective Oral Presentation Skills Training, provided by the UTCRS faculty; and (7) 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 two UTCRS-UTRGV students, one graduate and one undergraduate, who received ASME Scholarships, which were awarded during the 2018 ASME Joint Rail Conference, held in Pittsburgh, PA in April 17-20, 2018. UTCRS student Joseph Montalvo received the graduate scholarship, whereas, Veronica Hernandez received the ***only*** undergraduate scholarship awarded at this conference. The UTCRS-UTRGV research group had a strong showing at this conference with four graduate and three undergraduate students co-authoring and presenting four papers summarizing their findings and results as part of the work performed under their UTCRS funded projects.

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 co-authored a journal publication that discusses ways to develop persistence in Hispanic females in STEM.

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 also released the third semi-annual newsletter this spring to disseminate results, news, events, and highlights of the center. This newsletter was distributed by email to all collaborating faculty, students, UTC counterparts, industry contacts, and K-12 educators and program coordinators, and was posted on several social media outlets for the 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. Chapman, A., Rodriguez, F., Hinojosa, E., Morales, L., Del Bosque, V., Tijerina, Y., Pena, C., and Tarawneh, C., "Nothing is Impossible: Developing Persistence in Hispanic Females in STEM," *Int. J. of Science and Mathematics Education*, under review, submitted April 2018.
2. Tarawneh, C., Ley, J., Blackwell, D., Crown, S., and Wilson, B.M., "Onboard Load Sensor for Use in Freight Railcar Applications," *Int. J. of Railway Technology*, under review, submitted February 2018.
3. Tarawneh, C., Aranda, J., Hernandez, V., and Ramirez, C., "An Investigation into Wayside Hot-Box Detector Efficacy and Optimization," *Int. J. of Railway Technology*, under review, submitted January 2018.
4. Tarawneh, C., and Montalvo, J., "Defect Detection System for Freight Railcar Tapered-Roller Bearings Using Vibration Techniques," *Int. J. of Railway Technology*, under review, submitted January 2018.
5. Chen, Y. and Rilett, L. R., "A GA-Based Signal Timing Optimization Program for Corridors with Multiple Highway-Rail Grade Crossings," *Journal of Advanced Transportation*, Accepted for publication, 2018.
6. Zhao, S. and Khattak, A. J., "Factors Associated with Self-Reported Inattentive Driving at Highway-Rail Grade Crossings," *Accident Analysis and Prevention*, **109**, pp. 113-122, 2017.

7. Zhao, L., Rilett, L. R., and Tufuor, E., "Calibrating The Robertson's Platoon Dispersion Model at Coordinated Corridor with Advance Warning Flashers," *Transportation Research Record: Journal of the Transportation Research Board*, No. 2623: DOI 10.3141/2623-02, 2017.

Conference Publications:

8. Tarawneh, C., Aranda, J., Hernandez, V., and Ramirez, C., "An Analysis of the Efficacy of Wayside Hot-Box Detector Data," *Proceedings of the 2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
9. Montalvo, J., Tarawneh, C., and Fuentes, A., "Vibration-Based Defect Detection System for Freight Railcar Tapered-Roller Bearings," *Proceedings of the 2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
10. De Los Santos, N., Tarawneh, C., Jones, R., and Fuentes, A., "Defect Prognostic Models for Spall Growth in Railroad Bearing Rolling Elements," *Proceedings of the 2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
11. Rodriguez, O., Fuentes, A., and Tarawneh, C., "Impact of Hysteresis Heating of Railroad Bearing Thermoplastic Elastomer Suspension Pad on Railroad Bearing Thermal Management," *Proceedings of the 2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
12. Liu, H. and Khattak, A. J., "A Method for Better Estimation of Motor Vehicle Crash Exposure at Highway-Rail Grade Crossings," *Transportation Research Board 97th Annual Meeting*, Washington D.C., (paper 18-04778), January 7-11, 2018.
13. Iranitalab, A. and Khattak, A. J., "Investigation of United States Rail-based Crude Oil Incidents - Types and Consequences of Crude Oil Release," *Transportation Research Board 97th Annual Meeting*, Washington, D.C., January 7-11, 2018.
14. Wu, Z., Rilett, L. R., and Chen, Y., "Evaluating the Impact of Highway-Railway Grade Crossings on Travel Time Reliability on a Highway Network Level," *Transportation Research Board 97th Annual Meeting*, Washington, D.C., (paper 18-04762), January 7-11, 2018.
15. Zhao, L., Rilett, L. R., and Spiegelman, C., "Predicting Highway-Rail Grade Crossing (HRGC) Gate Violations Using Tree-Based Ensemble Techniques," Extended Abstract 18-05343, *Transportation Research Board 97th Annual Meeting*, Washington, D.C., January 7-11, 2018.
16. Zhao, L., Rilett, L.R., and Zhou, J., "Using High Fidelity Vehicle Trajectory Data for Safety Analyses: Case Study," Extended Abstract 18-05895, *Transportation Research Board 97th Annual Meeting*, Washington, D.C., January 7-11, 2018.
17. Banerjee, S., Hempel, M., Rakshit, S. M., and Sharif, H., "5G-UCDA in High Speed Rail with Multi Antenna-to-Logical Cell Circular FIFO Mapping Strategy," *International Conference on Computing, Networking and Communications*, Silicon Valley, CA, January 26-29, 2017.

Theses and Dissertations:

18. Tafti, S. R., "High Speed Train Geotechnics: Numerical and Experimental Simulation of Some Embankment Problems," Doctoral Dissertation, Zachry Department of Civil Engineering, Texas A&M University, December 2017.
19. Rodriguez, O., "The Effect of Heat Generation in the Railroad Bearing Thermoplastic Elastomer Suspension Element on the Thermal Behavior of Railroad Bearing Assembly," Master's Thesis, Department of Mechanical Engineering, The University of Texas Rio Grande Valley, May 2018.

Professional Presentations:

20. Rodriguez, O. Impact of Hysteresis Heating of Railroad Bearing Thermoplastic Elastomer Suspension Pad on Railroad Bearing Thermal Management. *2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.

21. Tarawneh, C. An Analysis of the Efficacy of Wayside Hot-Box Detector Data. *2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
22. Montalvo, J. Vibration-Based Defect Detection System for Freight Railcar Tapered-Roller Bearings. *2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
23. De Los Santos, N. Defect Prognostic Models for Spall Growth in Railroad Bearing Rolling Elements. *2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
24. 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, June 26-30, 2017.
25. Sharif, H. High Speed Rail with Multi Antenna-to-Logical Cell Circular FIFO Mapping Strategy. *International Conference on Computing, Networking and Communications*, Silicon Valley, CA, January 26-29, 2017.
26. Lingenfelter, J. UTCRS – Rail Grade Crossings and Low Ground Clearance Vehicles. *Conference for Undergraduate Women in Physical Sciences*, Lincoln, NE, November 9, 2017.

Technical Committees, Conference Session Chairs, and Panels:

27. Zachary Grasley, Professor of Civil Engineering, ACI Committee 236 Materials Science of Concrete, Secretary.
28. Zachary Grasley, Professor of Civil Engineering, was appointed as the Director of the Center for Infrastructure Renewal (CIR) at TAMU.
29. David Allen, Director, TAMU Center for Railway Research (CRR), is a member of the AAR Railway Transportation Working Committee (RTWC).
30. Hamid Sharif, Charles Vranek Professor, IEEE Vehicular Technology Conference.
31. Hamid Sharif, Charles Vranek Professor, IEEE Conference on Communications.
32. Hamid Sharif, IEEE International Conference on Signal and Image Processing Applications.
33. Hamid Sharif, IEEE International Journal of Computing and Digital Systems (IJCDS).
34. Hamid Sharif, Charles Vranek Professor, International Workshop on Mobile Applications.
35. Hamid Sharif, Advanced Research in Electrical and Electronic Engineering Technology (ARiEET 2017).
36. Hamid Sharif, Communication Track Chair, 16th Annual IEEE International Conference on Electro Information Technology (EIT 2017).
37. Aemal Khattak, TRB Standing Committee on Highway/Rail Grade Crossings (AHB60).
38. Jennifer Schmidt, Research Assistant Professor, TRB AFB20 Committee Member.
39. Ronald K. Faller, MwRSF Director and Research Associate Professor, TRB AFB20 Committee Member.
40. Hamid Sharif, Charles Vranek Professor, 11th International Conference on Signal Processing and Communication Systems, ICSPCS 2017.
41. Aemal Khattak, Transportation Research Board 97th Annual Meeting, Presiding Officer, Session 222 “Safety at Highway/Rail Grade Crossings,” January 7-11, 2018.
42. Aemal Khattak, Transportation Research Board 97th Annual Meeting, Presiding Officer, Session 324 “Analysis of Safety Concerns at Highway/Rail Grade Crossings,” January 7-11, 2018.
43. Aemal Khattak, Transportation Research Board 97th Annual Meeting, Presiding Officer, Session 613 “Human Behavior at Highway/Rail Grade Crossings,” January 7-11, 2018.
44. Eric Thompson, Director of the Bureau of Business Research, Session Chair, North American Regional Science Association International Meeting, November 2018.

Editorial Boards:

45. Constantine Tarawneh, Fourth International Conference on Railway Technology: Research, Development, and Maintenance (Railways 2018), Editorial Board.
46. Constantine Tarawneh, Transport Research Arena 2018, Editorial Board.

47. Zachary Grasley, Journal of Materials: Civil Engineering, Associate Editor.
48. Laurence Rilett, Journal of Intelligent Transportation Systems: Technology, Planning and Operations, Editorial Board, 2005 – Present.
49. Laurence Rilett, ASCE Journal of Transportation Engineering, Part A: Systems, Managing Editor, 2007 – Present.
50. Laurence Rilett, Journal of Transportation Engineering, Textbook Editor, 2010 – Present.
51. Hamid Sharif, Wiley Security and Communications Networks (SCN) Journal, Co-Editor-in-Chief.
52. Hamid Sharif, International Journal of Computing and Digital Systems, Editorial Board.
53. Ronald K. Faller, MwRSF Director and Research Associate Professor, International Roadside Safety Conference, e-Circular Editorial Board.
54. Aemal Khattak, Journal of Transportation Safety and Security (SCI-indexed journal), Area Editor.
55. Dennis Alexander, Kingery Engineering Professor, Multiscale and Multidisciplinary Modeling, Experiments, and Design, Associate Editor.

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, news articles, and professional scholarly work and publications that carefully document the UTCRS operations and activities over the past five years.

Technologies or techniques:
As a result of several years of railroad bearing testing performed at the UTCRS-UTRGV Bearing Laboratory, the UTCRS research group has been able to develop prognostic models that characterize the spall size growth and spall growth speed as a function of miles of operation for railroad bearings containing outer ring (cup) and inner ring (cone) spalls. The experimental testing revealed that only mileage under full railcar load is predictive of spall growth. Moreover, the results of testing indicate there are two growth regimes at play in cone spalls. Spalls forming at the center of the raceway obey a different growth law and grow much more rapidly than spalls that initially form on the cone edges. Thus, the use of a center spall model to predict growth will be conservative for all spall locations. The high fidelity of the fitted models ($R^2 > 0.86$) indicates that this approach has promise for field service application. The ultimate goal of this study is the development of reliable spall growth prognostic models, which can be coupled with bearing condition monitoring systems that will allow economical and effective scheduling of proactive maintenance cycles and mitigate costly catastrophic derailments.

Inventions, patent applications, and/or licenses:
Nothing to report at this time.

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
Alejandro Carranza	La Joya ISD	Community	Male
Kelly Watson	Donna ISD	Community	Male
Sandra Tovar	Harlingen CISD	Community	Female
Veronica Torres	La Feria ISD	Community	Female
Dr. Jose A. Gonzalez	McAllen ISD	Community	Male
Dr. Sharon Roberts	Mission CISD	Community	Female
Ramon Mejia	Mercedes ISD	Community	Male
Jessica Villanueva	Pharr-San Juan-Alamo ISD	Community	Female
Yoelia Nava	Sharyland ISD	Community	Female
Mary Garza	Edcouch Elsa ISD	Community	Female
Dr. Rene Gutierrez	Edinburg CISD	Community	Male
Ramiro Balderas	Valley View ISD	Community	Male
Dr. Narciso Garcia	Vanguard Academy	Community	Male
Angel Mata Ortega	IDEA ISD	Community	Male
Jimmy McDonough	Los Fresnos ISD	Community	Male
Brenda DeHoyos	Hidalgo ISD	Community	Female
Geneva Gomez	Monte Alto ISD	Community	Female
Dr. Adrian Vega	San Benito CISD	Community	Male
Maria J. Chavez	Santa Maria ISD	Community	Female
Yulia Molina	Progreso ISD	Community	Female
Samantha Mize	Weslaco ISD	Community	Female
Sarah Leal-Mendez	RGV Homeschool Cooperative Resource	Community	Female
Norberto Garza	2018 RET Program Participant – La Joya ISD	District Level	Male
Deborah Garrett	2018 RET Program Participant – La Joya ISD	District Level	Female
Imelda Dumalaog	2018 RET Program Participant – La Joya ISD	District Level	Female
Teresa Ochoa	2015-2018 RET Program Participant – La Joya ISD	District Level	Female
Andres Benitez	2014-2018 RET Program Participant – Sharyland ISD	District Level	Male
Rene Garcia	2014-2017 RET Program Participant – PSJA ISD	District Level	Male
Valerie Del Bosque	2018 RET Program Participant – UTeach Program	UTRGV	Female
Yakeline Tijerina	2018 RET Program Participant – UTeach Program	UTRGV	Female
Stephanie Soto	2018 RET Program Participant – UTeach Program	UTRGV	Female
Erica Hinojosa	2018 RET Program Participant – UTeach Program	UTRGV	Female
Lizbeth Morales	2018 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	UTCRS – Director Professor, Mechanical Engineering, UTRGV 1201 West University Drive, Edinburg, TX 78539-2999	Researcher/ Executive Committee	Male
Allen, David, PhD, PE	UTCRS – TAMU Associate Director Professor, Civil Engineering, TAMU 3135 TAMU, College Station, TX 77843-3135	Researcher/ Executive Committee	Male

Rilett, Laurence, PhD, PE	UTCRS – 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	UTCRS – UTRGV Associate Director Professor and Chair, Mechanical Engineering, UTRGV	Executive Committee	Male
Chapman, Angela, PhD	UTCRS – Education and Diversity Coordinator Assistant Professor, Curriculum & Instruction, UTRGV Co-Director, UTRGV UTeach Program	Researcher/ Executive Committee	Female
Ley-Martinez, Brenda	UTCRS – UTRGV Program Assistant	Staff	Female
Dove, Russell	Web Designer II, Internet Services, UTRGV	Institutional	Male
Hadenfeldt, Amber	Research Coordinator, Nebraska Transportation Center UNL, 2200 Vine Street, Lincoln, NE 68583-0815	Staff	Female
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
Ley, Jazmin, MS	Lecturer, Mechanical Engineering, UTRGV	Researcher	Female
Al-Shalash, Aws	Lecturer, 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
Smith, Chris, 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
Lima, Jennifer	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 (57% female) are

already enrolled in graduate programs at the three consortium institutions pursuing Master's degrees in transportation-related fields. The UTCRS 75% 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 significant percentage of females and 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, fabrication of testing fixtures, and the use of hydraulic machinery.
- Forty-three graduate and thirty-six 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, Ansys, 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 by The Higher Education Coordinating Board (THECB). The department has already hired one faculty with expertise in transportation systems, and has been approved to hire two more faculty in the upcoming recruitment cycle.
- In collaboration with the UTCRS, a new Surface Transportation Operations and Safety (STOpS) Laboratory has been established at UTRGV with the main objective of devising and developing 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, two manuscripts are under review, one in the Journal of Women and Minorities in Science and Engineering, and a second in the Journal of Science and

Mathematics Education. 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. Moreover, Dr. Angela Chapman has been awarded the Greater Texas Fellowship Grant. She received this award in recognition of her work with the UTCRS and the collaboration between the college of engineering and computer science and the college of education and P-16 integration, which have joined efforts to deliver high quality STEM education programs to undergraduates, K-12 students, and teachers, related to transportation engineering career fields with emphasis on rail industry applications.

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

Since its inception in the fall of 2013, the UTCRS has engaged over 250 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 250 UTCRS students that were engaged in the various center activities, about **40%** 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. More importantly, some of these students have already graduated with their Master's degrees and accepted jobs in transportation engineering fields. Most recently, Ms. Melissa Martinez accepted a position with BNSF Railway in Denver, CO; Ms. Gabriela Perales accepted a job with Siemens Industries, Inc. within their Mobility Division, Intelligent Traffic Systems; Ms. Cassandra Sias accepted a job with HDR Engineering, Inc. in Austin, TX; and three other female engineers joined the ranks of TxDOT. None of these young ladies envisioned pursuing their MS degrees or working in the transportation engineering field when they started their studies at UTRGV a few years ago. These examples along with the more than 5000 K-12 students, 45% of whom are female, engaged in STEM activities related to transportation engineering during the summer camps serve as prime examples of the wonderful work that the UTCRS is doing to reverse the alarming trends of Hispanics in STEM career fields.

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 **500** 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 have been collaborating with the UTCRS in the organization of the Railway Safety Summer Camps since 2014. 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 have funded the majority of the expenses incurred for the 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, three more REU participants have enrolled in graduate programs at the three consortium institutions.

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 one doctoral dissertation, one Master's thesis, ten conference papers, seven journal articles, four research symposiums, five technical reports, and thirteen professional presentations. Moreover, five 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.

One major outcome this reporting period resulted from the efforts of the UTCRS-UTRGV research group that presented four papers at the 2018 ASME Joint Rail Conference. Engineers from the Transportation Technology Center, Inc. that attended these presentations at the conference were impressed with the railroad bearing testing capabilities available at the UTCRS-UTRGV Bearing Laboratory. They also found synergy between some of the work they are doing at TTCI and the work currently being performed at the UTCRS-UTRGV facilities. Based on that, a new collaborative project, funded by TTCI, will commence this month to investigate the performance of bearings that undergo reconditioning at bearing refurbishing facilities across the US. The vibration-based bearing condition monitoring techniques developed by the UTCRS-UTRGV research group will be utilized for this collaborative project between UTRGV and TTCI.

What is the impact on society beyond science and technology?

The critical ethnic disparity in the education of students in science, technology, engineering, and mathematics (STEM) fields is evident by the acute underrepresentation of Hispanics in STEM careers. Hispanics represent 17% of the U.S. population and 2 of every 3 Hispanics in the U.S. are of Mexican descent. About 10 million Hispanics live in Texas alone. Yet in 2010, the percentage of Hispanics working

in a STEM field is 6.5% with the number of Hispanic women in these fields even lower. To reverse these trends, the UTCRS runs a number of education and professional development programs every summer that include K-12 Summer Camps, Research Experience for Teachers (RET) Program, Research Experience for Undergraduates (REU) Program, STEM Teacher Workshops, and the Transportation Engineering Summer Enrichment Program (TESEP). 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. 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. Moreover, almost 40% of the participants in all the UTCRS activities are female, which is significantly higher than the national average of female representation in transportation related fields. The racial and ethnicity representation as well as the gender representation of the participants in all of the UTCRS programs provides clear evidence that the UTCRS is effective in attracting and recruiting underrepresented groups to STEM fields.

Through the strong collaborative partnership that has been established between the UTCRS and the local school districts, the 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.

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