



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, 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:** 5100000049 and 5100000232
- **Project/Grant Period:** September 30, 2013 – December 31, 2018
- **Reporting Period End Date:** September 30, 2018
- **Report Term or Frequency (annual, semi-annual, quarterly, other):** Semi-annual
- **Signature of Submitting Official**

Constantine d.

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	95%
Technology Transfer Briefs, Webinars, Symposiums, and Presentations on Research Results	On Schedule	95%
Applicable Slides, Handouts, Videos, Pictures Posted	Complete	100%
Final Reports Due & All Research Projects Completed	On Schedule	90%
Leadership Activities		
Coordination between UTCRS Director and Leadership Team	Complete	100%
UTCRS Leadership Team Update	Complete	100%
2018 UTCRS Student Nominations for CUTC Awards	Complete	100%
2018 UTCRS Student of the Year (SOY) Selection	Complete	100%
Finalize the distinguished guests list for the 2019 UTCRS Summer Camps Closing Ceremony to be held on July 1, 2019 in the UTRGV campus	Complete	100%
Education & Outreach Activities		
2018 UTCRS K-12 Summer Camps	Complete	100%
2018 UTCRS High School Research Internship Program	Complete	100%
2018 Research Experience for Teachers (RET) Program	Complete	100%
Preparations for the 2019 UTCRS K-12 STEM Summer Camps	On Schedule	25%
Meetings with the Lower Rio Grande Valley Independent School District Superintendents and their Representatives	On Schedule	25%
Technology Transfer Activities		
2018 UTCRS K-12 STEM Teacher National Workshop	Complete	100%
Development of New High School Transportation-Related STEM Curriculum Featuring MakeBlock Robotics Kits and Arduino Board Programming	Complete	100%
UTCRS Website Information Dissemination Update	Complete	100%
UTCRS Fall 2018 Newsletter Describing Center Activities	On Schedule	50%
UTCRS Supported Journal and Conference Publications and Presentations	On Schedule	95%
UTCRS Supported Presentations, Symposiums, Workshops, and Short Courses	On Schedule	95%

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
21. 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
22. 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
23. 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
24. Heavy Truck and Bus Traversability at Highway-Rail Grade Crossings. http://www.utrgv.edu/railwaysafety/research/operations/heavy-truck-traversability-at-hrgc/index.htm
25. 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
26. Best Practices for Modeling Light Rail at Intersections. http://www.utrgv.edu/railwaysafety/research/operations/modeling-light-rail-intersections/index.htm
27. 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
28. 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
29. 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
30. 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
Ongoing Projects
31. 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
32. Estimating Bridge Span Deflections Using Data Streams from Rolling Stock. http://www.utrgv.edu/railwaysafety/research/infrastructure/bridge-span-deflection-estimation/index.htm
33. Fatigue and Service Analysis of Railroad Eyebars Members. http://www.utrgv.edu/railwaysafety/research/infrastructure/service-analysis-of-eyebars-members/index.htm

34. Strength and Fracture Toughness of Railroad Eyebars Members. http://www.utrgv.edu/railwaysafety/research/infrastructure/fracture-of-eyebars-members/index.htm
RESEARCH AREAS: Addressed in Prospectus: 2017CY Call for Proposals
Ongoing 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 **57** 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	30	20	10
Masters’ Research Assistants	14	10	4
Doctoral Research Assistants	13	11	2
Totals	57	41	16

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 major 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 about 3375 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 had 11 STEM teachers participate in the 2018 Research Experience for Teachers (RET) Program; close to 100 teachers attended the 2018 UTCRS STEM Teacher National Workshop; and 1250 K-12 students from Lower Rio Grande Valley (LRGV) school districts attended the 2018 UTCRS Summer Camps. 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 April 1, 2018 to September 30, 2018:

UTCRS ACTIVITIES and HIGHLIGHTS for period (April 1st, 2018 – September 30th, 2018)

2018 UTCRS STEM Teacher National Workshop



The UTCRS held its annual summer STEM Teacher National Workshop on June 2, 2018. The workshop attracted close to 100 teachers from over 26 different local school districts. This workshop featured a newly developed high school curriculum that utilizes MakeBlock Robotics using MBot robots. The new curriculum is designed to teach high school students advanced programming skills to program Arduino-based boards, which is a highly sought out skill in students pursuing their engineering and computer science degrees. Developing advanced programming expertise among teachers and high school students in a manner that it is both educational, interactive, and engaging is the main goal of this curriculum. The workshop also covered enhanced curriculum for the elementary and middle school levels. See: <https://www.flickr.com/photos/131769328@N02/sets/72157698199596455>

2018 UTCRS K-12 STEM Summer Camps



The 2018 UTCRS STEM Summer camps hosted about 1250 K-12 students (650 elementary, 487 middle school, and 113 high school) from over 26 different local school districts during the month of June 2018. Students in the elementary and middle school levels were introduced to new challenges and curricula that presented fundamental laws of physics and motion using interactive and engaging transportation-related activities, whereas, high school students were exposed to advanced programming of Arduino-based robots. Programming skills are very important as we move towards intelligent transportation systems. Over the past five years, the UTCRS Summer Camps have engaged close to 5500 K-12 students in interactive transportation-related STEM activities. The majority of these students come from schools that reside in counties that are among the lowest per capita income in the country. In fact, these camps provide the only opportunity for these students to be exposed to STEM fields at an early age. See: <https://www.utrgv.edu/railwaysafety/news/gallery/index.htm>

2018 UTCRS STEM SUMMER CAMPS CLOSING CEREMONY



The UTCRS held its 2018 STEM Summer Camps Closing Ceremony on July 6, 2018. Close to 1000 members of the community attended this event to celebrate the accomplishments of the K-12 students who participated in the summer camps. The winners of the final competition from elementary, middle school, and high school were recognized during the ceremony and were presented with railways safety attire and certificates of completion. The teachers that participated in the 2018 RET Program were also recognized during this ceremony. State Representative Armando Martinez, Vice-Chairman of the Transportation Committee, gave the keynote speech. Also among the speakers was Ms. Victoria Garza who shared with the community her inspiring journey from a student participant in the UTCRS camps to a mechanical engineering student working as a UTCRS undergraduate research assistant and helping with these summer camps to inspire females to pursue careers in STEM fields.

THE JOURNEY OF MELISSA MARTINEZ FROM UTCRS REU PARTICIPANT TO BNSF RAILWAY ENGINEER



At the UTCRS, we measure our success by that of our students. Melissa Martinez is one of those bright young engineers that joined the UTCRS in her junior year pursuing her bachelor's degree in Civil Engineering. She was one of only eight students selected to participate in the inaugural 2014 UTCRS Research Experience for Undergraduates (REU) program where she spent ten weeks conducting research with faculty at Texas A&M University (TAMU). The UTCRS received fifty competitive applications for the 2014 UTCRS REU program, which highlights the strengths of students that were selected to participate in that cohort. The faculty at TAMU were impressed by the quality of work performed by Melissa and she was invited to join the 2015 UTCRS REU cohort to continue the work she started the previous summer. When she first joined the UTCRS, Melissa wanted to finish her bachelor's degree in Civil Engineering and get a job immediately after. However, as a result of her participation in the UTCRS REU program, Melissa applied for the master's program at TAMU in Fall 2015 and was admitted in Spring 2016. Melissa graduated with her master's degree in Civil Engineering in May of 2018 and started her job at BNSF Railway in Denver, Colorado in September 2018. The pictures shown portray a very inspiring story. During her participation in the 2015 UTCRS REU program, Dr. Gary Fry, Director of the Center for Railway Research at TAMU, arranged for a field trip to BNSF Railway facilities in Denver, Colorado, which is where Melissa took that first picture on the left. She was intrigued and excited about the work done at BNSF Railway and she promised herself that she will pursue a career at BNSF Railway upon graduation. Three years later, Melissa Martinez returns to BNSF Railway as an engineer with her master's degree. She fulfilled her promise to herself and was able to gain

employment at BNSF Railway where she started in September of 2018. The pictures in the middle and the right were taken in 2018 after she started her employment at BNSF Railway. We, at the UTCRS, could not be more proud of what Melissa Martinez has been able to accomplish. She is pursuing a career in a field that she is very passionate about and in a company that she envisioned she would be working for when she visited three years earlier. The impact of this story on the rail industry is realized when considering that there are less than 1% Female Hispanic U.S. citizens working in STEM-related transportation jobs in the U.S., and an even lower percentage working in the rail industry. Melissa Martinez had this to say in an email she sent to UTCRS Director, Dr. Constantine Tarawneh: "I know we haven't spoken since I graduated but I would like to thank you for believing in me since the beginning. Without you, I would never be working for such a great company!"

COMING FULL CIRCLE: THE STORY OF VICTORIA GARZA



Victoria Garza, a UTRGV mechanical engineering major from Pharr, said summer camps set her future career path. "I chose engineering because of the camps that I were in while I was younger," she said. "Without the camps, I wouldn't have known what all of this was."

Victoria attended the inaugural 2014 UTCRS Summer Camps as a high school student and was inspired by what engineers do, so she decided to pursue a degree in mechanical engineering. During her summer camp experience, she toured the UTCRS facilities and she promised that she will be a part of the team one day. She kept her promise as Victoria is one of the UTCRS undergraduate research assistants helping with a railroad bearing power consumption optimization project. She is also helping inspire other female K-12 students choose careers in STEM fields. Her story was shared on the UTRGV web site and in the local newspapers along with a video highlighting her story.

See: <https://www.utrgv.edu/en-us/about-utrgv/news/press-releases/2018/july-17-former-participant-helping-new-generation-learn-at-utrgv-railway-safety-camp/index.htm>

See: https://www.valleymorningstar.com/education/utrgv/former-participant-helping-new-generation-learn-at-utrgv-railway-safety/article_ec1820f0-89f3-11e8-862b-0786d9c872dd.html

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 test 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 Director and Research Faculty conducted **eight** mandatory trainings attended by research assistants; namely: (1) Data Acquisition and Analysis Training; (2) Sensors and Instrumentation Training; (3) Basic Electronics Training; (4) Bearing Test Rig Setup and Maintenance Procedures Training; (5) Preparing Well-Drafted Technical Briefs and Reports Training; (6) Performing test axle disassembly and complete railroad bearing tear down and inspection; (7) Effective Oral Presentation Skills Training; and (8) Laboratory Safety Training.

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 undergraduate and graduate research assistants funded by the UTCRS continue to participate in national conferences alongside professors with whom they collaborate. Supervising professors provide mentorship, guidance, knowledge, and support allowing students the opportunity to enhance their skills, develop a professional network, and become recognized by their future peers in the transportation industry. The UTCRS faculty and students had a strong showing in the 2018 ASME Joint Rail Conference (JRC), held in Pittsburgh, PA in April 17-20, 2018, where six papers were presented by student authors. The UTCRS research group will have another strong showing at 2019 ASME JRC Conference where six more papers, co-authored by seven graduate and four undergraduate students, will be presented summarizing the findings and results 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 2018 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 is also finalizing a newsletter to disseminate results, news, events, 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.

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

1. Implementation and completion of center activities as outlined in the first table.
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. Tarawneh, C., Lima, J., De Los Santos, N., and Jones, R., "Prognostics Models for Railroad Tapered-Roller Bearings with Spall Defects on Inner or Outer Rings," *Journal of Tribology*, under review, submitted October 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*, in press, accepted September 2018.
3. Zhao, S. and Khattak, A. J., "Direct and Indirect Effect of Nebraska Motor Vehicle Drivers' Characteristics on Inattentive Driving at Highway-Rail Grade Crossings," *Journal of the Transportation Research Board*, September 2018, <https://doi.org/10.1177/0361198118794067>.
4. Iranitalab, A., Khattak, A., and Thompson E., "Statistical Modeling of the Types and Consequences of Rail-Based Crude Oil Release Incidents in the United States," *Safety Science*, submitted in August 2018.
5. Khan, W. A., and Khattak, A. J., "Injury Severity of Truck Drivers in Crashes at Highway-Rail Grade Crossing in the United States," *Journal of the Transportation Research Board*, June 2018, <https://doi.org/10.1177/0361198118781183>.
6. Chen, Y. and Rilett, L. R., "Signal Timing Optimization for Corridors with Multiple Highway-Rail Grade Crossings Using Genetic Algorithm," *Journal of Advanced Transportation*, vol. 2018, Article ID 9610430, 14 pages, April 2018, <https://doi.org/10.1155/2018/9610430>.
7. 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.

Conference Publications:

8. Tarawneh, C., Montalvo, J., and Fuentes, A., "Defect Detection System for Freight Railcar Tapered-Roller Bearings Using Vibration Techniques," *Proceedings of the Fourth International Conference on Railways Technology (Railways 2018)*, Sitges, Barcelona, Spain, September 3-7, 2018. [Extended Abstract]
9. Tarawneh, C., Ley, J., Blackwell, D., Crown, S., and Wilson, B., "Onboard Load Sensor for Use in Freight Railcar Applications," *Proceedings of the Fourth International Conference on Railways Technology (Railways 2018)*, Sitges, Barcelona, Spain, September 3-7, 2018. [Extended Abstract]
10. Tarawneh, C., Aranda, J., Hernandez, V., and Ramirez, C., "An Investigation into Wayside Hot-Box Detector Efficacy and Optimization," *Proceedings of the Fourth International Conference on Railways Technology (Railways 2018)*, Sitges, Barcelona, Spain, September 3-7, 2018. [Extended Abstract]
11. Lee, M. and Khattak, A. J., "A Case Study of Crash Severity Spatial Pattern Identification in Hot Spot Analysis," *Transportation Research Board*, August 2018.
12. Liu, H., Lee, M., and Khattak, A. J., "Updating Annual Average Daily Traffic Estimates at Highway-Rail Grade Crossings with Geographically Weighted Poisson Regression," *Transportation Research Board*, August 2018.
13. 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.
14. Montalvo, J., Tarawneh, C., and Fuentes, A., "Vibration-Based Defect Detection for Freight Railcar Tapered-Roller Bearings," *Proceedings of the 2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.

15. 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.
16. 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.
17. Albakay, N., Hempel, M., and Sharif, H., "Novel Insights for Railroad Maintenance Using Big Data Analytics," *Proceedings of the 2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
18. Banerjee, S., Santos, J., Hempel, M., and Sharif, H., "A New Railyard Safety Approach for Detection and Tracking of Personnel and Dynamic Objects Using Software-Defined Radar," *Proceedings of the 2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
19. Banerjee, S., Hempel, M., and Sharif, H., "A Novel Proposal for Implementing Massive MIMO and User Control Plane Decoupling with UPWARC," International Conference on Communication Systems & Networks (COMSNETS), Bengaluru, India, January 3-7, 2018.
20. 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.
21. 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.
22. 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.
23. 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.
24. 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.

Theses and Dissertations:

25. Zhou, J., "Effects of Moving Bottlenecks on Traffic Operations on Four-Lane Level Freeway Segments," Doctoral Dissertation, Department of Civil Engineering, University of Nebraska-Lincoln, August 2018.
26. Zhao, L., "Safety Modeling of Highway-Rail Grade Crossings Using Intelligent Transportation System Data," Doctoral Dissertation, Department of Civil Engineering, University of Nebraska-Lincoln, December 2017.
27. 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.
28. Murru, P. T., "Study of Damage in Concrete Based on Microscopic Changes in Density," Master's Thesis, Zachry Department of Civil Engineering, Texas A&M University, May 2019.
29. Aranda, J., "Radiative Heat Transfer Analysis of Railroad Bearings for Wayside Thermal Detector Optimization," Master's Thesis, Department of Mechanical Engineering, The University of Texas Rio Grande Valley, December 2018.
30. Iranitalab, A., "Statistical Investigation of Road and Railway Hazardous Materials Transportation Safety," Master's Thesis, Department of Civil Engineering, University of Nebraska-Lincoln, December 2018.

31. 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.
32. Khan, W. "Injury Severity of Truck Drivers in Crashes at Highway-Rail Grade Crossings," Master's Thesis, Department of Civil Engineering, University of Nebraska-Lincoln, December 2017.

Technical Reports:

33. Khattak, A., and Lee, M. Highway-Rail Crossing Safety Improvements by Diverting Motorist to Alternate Routes. UTCRS Final Project Report, Lincoln, NE, August 2018.
34. Khattak, A., and Liu, H. Improving Crash predictions – A More Relevant Exposure Measure than AADT for Highway-Rail Grade Crossing Safety Models. UTCRS Final Project Report, Lincoln, NE, August 2018.
35. Sangster, J., and Haque, M. M. S. Best Practices for Modeling Light Rail at Intersections. UTCRS Final Project Report, Lincoln, NE, August 2018.
36. Schmidt, J., and Lingenfelter, J. Heavy Truck and Bus Traversability at Highway-Rail Grade Crossings. UTCRS Final Project Report, Lincoln, NE, August 2018.
37. Sharif, H., and Hempel, M. Unifying Railcar Monitoring Sensor Data, Maintenance Records, and Railcar Usage Information through Big Data Processing for Optimizing Railcar Maintenance and Safety. UTCRS Final Project Report, Lincoln, NE, August 2018.
38. Sharif, H., and Hempel, M. Railyard Worker Safety through Innovative Mobile Active Train Detection and Risk Localization. UTCRS Final Project Report, Lincoln, NE, August 2018.
39. Thompson, E., Khattak, A., Iranitalab, A., and Greer, C. Shipments of Oil by Rail: Economic Implications for Safety and Safety-Related Investments. UTCRS Final Project Report, Lincoln, NE, August 2018.
40. Alexander, D. R., Shield, J., Zuhlke, C., Song, Y., & Ediger, A. (2018). Studies on Forming Anti-Icing Railroad Traffic Signal Lens by Using Femtosecond Laser Surface Processing Directly (FLSP) or by Stamping Tungsten Carbide FLSP Surfaces into Railroad Lens Materials.

Professional Presentations:

41. Tarawneh, C. Advanced Rolling Stock Condition Monitoring Technologies for Freight Rail Transport. *Invited Speaker for the Center for Advanced Infrastructure and Transportation (CAIT) Seminar Series*, Rutgers University, Piscataway, NJ, October 26, 2018.
42. Tarawneh, C. Defect Detection System for Freight Railcar Tapered-Roller Bearings Using Vibration Techniques. *Fourth International Conference on Railways Technology (Railways 2018)*, Sitges, Barcelona, Spain, September 3-7, 2018.
43. Tarawneh, C. Onboard Load Sensor for Use in Freight Railcar Applications. *Fourth International Conference on Railways Technology (Railways 2018)*, Sitges, Barcelona, Spain, September 3-7, 2018.
44. Tarawneh, C. An Investigation into Wayside Hot-Box Detector Efficacy and Optimization. *Fourth International Conference on Railways Technology (Railways 2018)*, Sitges, Barcelona, Spain, September 3-7, 2018.
45. 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.
46. Tarawneh, C. An Analysis of the Efficacy of Wayside Hot-Box Detector Data. *2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
47. Montalvo, J. Vibration-Based Defect Detection for Freight Railcar Tapered-Roller Bearings. *2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
48. 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.

49. Albakay, N. Novel Insights for Railroad Maintenance Using Big Data Analytics. *2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
50. Banerjee, S. A New Railyard Safety Approach for Detection and Tracking of Personnel and Dynamic Objects Using Software-Defined Radar. *2018 ASME Joint Rail Conference*, Pittsburgh, PA, April 18-20, 2018.
51. Banerjee, S. A Novel Proposal for Implementing Massive MIMO and User Control Plane Decoupling with UPWARC. *International Conference Communication Systems & Networks (COMSNETS)*, Bengaluru, India, January 3-7, 2018.
52. Lingenfelter, J. L. Highway-Rail Grade Crossings and Low Clearance Vehicles. *Transportation Technology Center, Inc. (TTCI)*, Pueblo, CO, July 2018.
53. Lingenfelter, J. L. Rail Grade Crossings and Low Ground Clearance Vehicles. *WoPhyS Conference*, University of Nebraska-Lincoln, Lincoln, NE, 2018.
54. Rilett, L. R. At-Grade Railway Safety Research: A Nebraska Perspective. *Scientific Conference of the Committee for Calculating Land and Water and the PZITB Science Committee*, Krynica-Zdrój, Poland, 2018.

Technical Committees, Conference Session Chairs, and Panels:

55. Zachary Grasley, Professor of Civil Engineering, ACI Committee 236 Materials Science of Concrete.
56. Zachary Grasley, Professor of Civil Engineering, TAMU, Director of the Center for Infrastructure Renewal (CIR).
57. David Allen, Director, TAMU Center for Railway Research (CRR), is a member of the AAR Railway Transportation Working Committee (RTWC).
58. Constantine Tarawneh, Advanced Bearing Condition Monitoring Technologies Session, Railways 2018.
59. Hamid Sharif, Charles Vranek Professor, IEEE International Workshop on Mobile Applications.
60. Hamid Sharif, IEEE International Conference on Signal Processing and Communication Systems.
61. Hamid Sharif, IEEE Signal Processing, Intelligent Recognition Techniques and Applications.
62. Hamid Sharif, IEEE Symposium on Computers and Communications.
63. Aemal Khattak, TRB Standing Committee on Highway/Rail Grade Crossings (AHB60).
64. Jennifer Schmidt, Research Assistant Professor, TRB AFB20 Committee Member.
65. Ronald K. Faller, MwRSF Director and Research Associate Professor, TRB AFB20 Committee Member.
66. Aemal Khattak, Transportation Research Board 97th Annual Meeting, Presiding Officer, Session 222 "Safety at Highway/Rail Grade Crossings," January 7-11, 2018.
67. 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.
68. Aemal Khattak, Transportation Research Board 97th Annual Meeting, Presiding Officer, Session 613 "Human Behavior at Highway/Rail Grade Crossings," January 7-11, 2018.

Editorial Boards:

69. Constantine Tarawneh, Fourth International Conference on Railway Technology: Research, Development, and Maintenance (Railways 2018), Editorial Board.
70. Constantine Tarawneh, Transport Research Arena 2018, Editorial Board.
71. Constantine Tarawneh, Journal of Acoustics, Hapres, Editorial Board.
72. Zachary Grasley, Journal of Materials: Civil Engineering, Associate Editor.
73. Laurence Rilett, Journal of Intelligent Transportation Systems: Technology, Planning and Operations, Editorial Board.
74. Laurence Rilett, ASCE Journal of Transportation Engineering, Part A: Systems, Managing Editor.
75. Laurence Rilett, Journal of Transportation Engineering, Textbook Editor.
76. Hamid Sharif, Charles Vranek Professor, IEEE Transactions on Mobile Computing, Editorial Board.

77. Hamid Sharif, Wiley Security and Communications Networks (SCN) Journal, Co-Editor-in-Chief.
78. Hamid Sharif, International Journal of Computing and Digital Systems, Editorial Board.
79. Ronald K. Faller, MwRSF Director and Research Associate Professor, International Roadside Safety Conference, e-Circular Editorial Board.
80. Aemal Khattak, Journal of Transportation Safety and Security (SCI-Indexed Journal), Area Editor.
81. 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 over five 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) or inner ring (cone) spalls. These models have received much interest when presented at the ASME Joint Rail Conference in 2017 and 2018, and have recently been submitted for publication in the Journal of Tribology. The ultimate goal of this work has been the development of reliable spall growth prognostic models, which can be coupled with the UTCRS developed advanced bearing condition monitoring system that will allow economical and effective scheduling of proactive maintenance cycles and mitigate costly catastrophic train derailments.

The University of Nebraska-Lincoln (UNL) Center for Electro-Optics purchased a tunable femtosecond laser surface processing (FLSP) system and a high vacuum laser interaction chamber connected to a material analysis chamber via a load cell. This equipment allows researchers to understand the role of hydrocarbon attachment to the surface as FLSP surfaces become superhydrophobic, which is essential for future applications of FLSP stamped surfaces that will be used in the next generation of railroad traffic signals.

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
Roberto Moreno	2018 RET Program Participant – La Joya ISD	District Level	Male
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
Leslie de la Peña	2018 RET Program Participant – UTeach Program	UTRGV	Female
Miriam Calderon	2018 RET Program Participant – UTeach Program	UTRGV	Female
Amada Rodriguez	2018 RET Program Participant – UTeach Program	UTRGV	Female
Anakaren Suarez	2018 RET Program Participant – UTeach Program	UTRGV	Female
Brittney Peña	2018 RET Program Participant – UTeach Program	UTRGV	Female
Private			
Monaco, Jay	Vice President of Engineering, Amsted Rail Co.	Advisory Board	Male
Connell, David	Vice President of Engineering, Union Pacific Railroad Co.	Advisory Board	Male
Fry, Gary	Vice President of 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 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 Co-Director, UTRGV UTeach Program	Researcher/ Executive Committee	Female
Ley-Martinez, Brenda	UTCRC – 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
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
Hernandez, Veronica	Society of Automotive Engineers (SAE)	Institutional	Female
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 UTCRC is able to report various indicators of impact, including:

- The UTRGV-UTCRC was chosen as one of the HSI sites for the 2018 Dwight David Eisenhower Transportation Fellowship Program (DDETFP) local competition. The UTCRC Director served as the campus manager for this DDETFP local competition, which attracted 12 very competitive applications from students majoring in four different engineering and computer science majors. This fellowship will attract these excellent students to pursue research in transportation-related fields, and will hopefully result in increasing the number of underrepresented groups in transportation-related jobs.
- A clear pathway to graduate studies between the three consortium institutions has been established providing students with several options to pursue their graduate 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 and doctoral degrees in transportation-related fields. The UTCRC 75% admission to graduate programs as a result

of participation in an REU Program is well above the national average for these programs. Moreover, 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.
- Fifty-four graduate and forty 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 was one of the main drivers to establish a Master's of Science in Civil Engineering Program at UTRGV with an emphasis on transportation. This program started this fall 2018 semester, and the department is in the process of hiring two additional faculty with expertise in transportation systems, with one more faculty to be hired in the upcoming recruitment cycle.

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. Since 2014, more than 40 undergraduate students in the UTeach program have been actively involved in teaching and research. Sixteen students have presented at national science or STEM education conferences, and five students have co-authored a manuscript that is under review with Cultural Studies of Science Education. Working in the railway 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, the UTCRS Diversity and Education Coordinator, was granted tenure and promotion to associate professor largely due to her work with the UTCRS. The tenure and promotion committee emphasized the strong collaboration between the college of engineering and computer science and the college of education and P-16 integration, which have joined forces to deliver high quality STEM education programs to UTRGV students, and K-12 students and teachers, in support of the transportation engineering career fields.

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

Since its inception in the fall of 2013, the UTCRS has engaged over 300 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. Moreover, of the 300 UTCRS students that were engaged in the various center activities, about **38%** 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 four other female engineers joined the ranks of TxDOT. None of these young women envisioned pursuing their MS degrees or working in the transportation engineering field when they started their studies at UTRGV a few years ago. Considering that Hispanics represent less than 6.5% of the transportation engineering workforce, with female Hispanic representation lower than 1%, the placement of these seven females in transportation jobs along with the more than 5500 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 facilitated a number of hands-on STEM workshops for educators geared towards developing the skill-sets required to teach transportation engineering concepts in their classroom. 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. This has enabled teachers and educators to deliver age-appropriate STEM concepts, related to transportation engineering, in their classrooms, while also promoting STEM career fields. The skill-sets gained by these educators helped them boost their resumes.

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. During this reporting period, the UTCRS partnered with Vanguard Academy, a charter school, on a Gear Up proposal which was successful. Vanguard Academy was one of only two charter schools in the country to receive this grant. As part of this grant, Vanguard Academy will sponsor 320 spots for the UTCRS summer camps over the next seven years. The 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. The UTCRS outreach efforts and educational programs are well aligned with UTRGV's institutional mission of encouraging K-12 students to attend college and pursue degrees 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. In fact, UTRGV has entered into a contract with the Transportation Technology Center Inc. (TTCI) to perform their railroad bearing testing, making UTRGV an international testing facility. The UTRGV-UTCRS received an **honorable mention** in the 2018 *Excelencia* in Education conference.

What is the impact on technology transfer?

For this reporting period, the UTCRS technology transfer activities included three doctoral dissertations, five Master's theses, 17 conference papers, seven journal articles, two research symposiums, ten technical reports, and 17 professional presentations. Moreover, 12 projects that were funded through the 2015-2016CY call for proposals have completed during this reporting period. Final project reports have been posted on the UTCRS web site and are available for 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. As a result, TTCI has funded a project that investigates the performance of reconditioned railroad bearings in service operation. The vibration-based bearing condition monitoring techniques developed by the UTCRS-UTRGV research group are being utilized for this project. The results of this study will be used to implement new Association of American Railroads (AAR) standards for railroad bearing reconditioning in North America.

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, 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 several education and professional development programs that promote STEM learning and facilitate many opportunities for the community that will otherwise not be possible. The UTCRS serves a population that is 90% Hispanic, of which 50% earn incomes that are significantly below the state average. One specific focus of the summer camps has been increasing female participation, especially for high school students. In 2016, it was reported that elementary participation was approximately equal for boys and girls, but that dropped to 21% female participation in high school. Efforts to increase female participation have been very effective as 37% of the 2018 high school participants were female.

The UTCRS offers the necessary teaching tools, experiences, trainings, and professional development opportunities to K-12 students and teachers at no cost to them. 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. 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, ethnic, and 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.

5. CHANGES/PROBLEMS:

Nothing to report

6. SPECIAL REPORTING REQUIREMENTS:

Nothing to report.