



## 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, 2016
- **DUNS and EIN Numbers**  
DUNS: 069444511 and EIN: 465292740
- **Recipient Organization:**  
The University of Texas Rio Grande Valley (UTRGV)  
1201 West University Drive, Edinburg, TX 78539-2999
- **Recipient Identifying Number or Account Number:** 410000049 and 410000232
- **Project/Grant Period:** September 30, 2013 – September 30, 2018
- **Reporting Period End Date:** September 30, 2016
- **Report Term or Frequency (annual, semi-annual, quarterly, other):**  
Semi-annual
- **Signature of Submitting Official**

*Constantine Tarawneh*

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



## 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, education, technology transfer and implementation, and workforce development, the following was accomplished for this reporting period:

| Research Activities   | Status      | % Complete |
|---|-------------|------------|
| Call for Problem Statements   | Complete    | 100%       |
| Request for 2015-2016 Proposals   | Complete    | 100%       |
| 2015-2016 Proposals Reviewed by Executive Committee   | Complete    | 100%       |
| Review Budgets of 2015-2016 Proposals   | Complete    | 100%       |
| Final 2015-2016 Proposal Ranking & Selection  | Complete    | 100%       |
| 2015-2016 Research Projects under Contract  | Complete    | 100%       |
| Technology Transfer Briefs, Webinars, Symposiums, and Presentations on Research Results   | On Schedule | 50%        |
| Applicable Slides, Handouts, Videos, Pictures Posted  | On Schedule | 60%        |
| Final Reports Due and All Research Projects Completed   | On Schedule | 40%        |
| Leadership Activities   |             |            |
| Coordination with UTCRS Directors   | Complete    | 100%       |
| UTCRS Leadership Update   | Complete    | 100%       |
| Selection of the 2016 UTCRS Student of the Year and Nomination of UTCRS Students to CUTC Awards   | Complete    | 100%       |
| Educational & Outreach Activities   |             |            |
| 2016 UTCRS K-12 Summer Camps  | Complete    | 100%       |
| 2016 UTCRS Transportation Engineering Summer Enrichment Program (TESEP)   | Complete    | 100%       |
| 2016 UTCRS Research Experience for Undergraduates (REU) Program   | Complete    | 100%       |
| 2016 UTCRS Research Experience for Teachers (RET) Program   | Complete    | 100%       |
| Call for 2017 UTCRS Research Experience for Undergraduates (REU) Program  | Forthcoming | 0%         |
| Technology Transfer Activities  |             |            |
| 2016 UTCRS National K-12 STEM Teachers Educational Workshop – Trained Teachers on the Use of the UTCRS Developed Elementary, Middle School, and High School Transportation Related STEM Curricula in their Classrooms | Complete    | 100%       |

|   |             |      |
|---|-------------|------|
| UTCRS Website Information Dissemination Update                          | Complete    | 100% |
| UTCRS Open Educational Resources Tab / Borrowing Agreement              | Complete    | 100% |
| UTCRS Social Media Sites Information Dissemination                      | Complete    | 100% |
| UTCRS Supported Journal and Conference Publications and Presentations   | On Schedule | 70%  |
| UTCRS Supported Presentations, Symposiums, Workshops, and Short Courses | On Schedule | 75%  |
| 2016 REU Research Symposium   | On Schedule | 50%  |
| <b>USDOT OST-R: Reporting</b>   |             |      |
| Update of Directory of Key Center Personnel                             | Complete    | 100% |
| UTC Program Progress Performance Reports (Semi-Annual)                  | 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% |
| Posting of Newly Funded Research Project Descriptions (Exhibit Fs)      | Complete    | 100% |

### What was accomplished under these goals?

The UTCRS maintained all research, education, workforce development, technology transfer, and outreach activities and programs on schedule while delivering many impactful outcomes. All federal funding received has been fully committed through the recent call for proposals at all three consortium institutions. In total, **thirty-four** different research projects have been supported using the UTCRS federal and cost share funding allotted. These projects are categorized in three railway safety thrust areas, namely, mechanical, infrastructure, and operations. A listing of all thirty-four projects including a brief description and summary of these projects can be accessed through the UTCRS web site at the following page (<http://www.utrgv.edu/railwaysafety/research/index.htm>). This page also provides links to the call for proposals and the UTCRS reports, which include all the Exhibit Fs and all the submitted PPPRs.

The thirty-four projects that have been funded were selected through two separate call for proposals (2014CY and 2015CY call for proposals) at each of the three consortium institutions. Out of the thirty-four projects funded, seven have already been completed, eleven are set to complete at the end of December 2016, and the remaining sixteen are set to complete by June of 2018. The final reports for the seven projects that completed can be found in each of the projects' web pages, and have also been submitted to the TRID database. The main descriptions, objectives, and goals of the ongoing projects can be found in the specific projects' web pages, and have also been uploaded to the Research in Progress (RIP) database. The following table lists all the projects that have been funded through the UTCRS to date, and provides links to each of the projects' web pages.

| <b>RESEARCH AREAS Addressed in Prospectus: (Inaugural 2014CY Call for Proposals)</b> |   |
|--|---|
| <b>Completed Projects</b>  |   |
| 1.   | <b>Structural Integrity of Railroad Bearing Adapters with Modifications for Onboard Monitoring Applications.</b> A final report has been indexed by TRB and posted on the UTCRS Web Site at <a href="http://www.utrgv.edu/railwaysafety/research/mechanical/2014/modified-railroad-bearing-adapter-for-onboard-monitoring/index.htm">http://www.utrgv.edu/railwaysafety/research/mechanical/2014/modified-railroad-bearing-adapter-for-onboard-monitoring/index.htm</a> |
| 2.   | <b>Single Bearing Test Rig with Vertical, Lateral, and Impact Load Capabilities.</b> The UTCRS test rig has been fully instrumented and operational and is currently being used to run tests for several projects aimed at improving railroad bearing performance and optimizing bearing health monitoring. A final report has been indexed by TRB and posted on the UTCRS Web Site at  |



|   |   |
|---|---|
| <a href="http://www.utrgv.edu/railwaysafety/research/mechanical/2014/single-bearing-test-rig/index.htm">http://www.utrgv.edu/railwaysafety/research/mechanical/2014/single-bearing-test-rig/index.htm</a> |   |
| 3.  | <b>Effects of Vapor Grown Carbon Nanofibers on Electrical and Mechanical Properties of a Thermoplastic Elastomer.</b> A final report has been indexed by TRB and posted on the UTCRS Web Site at <a href="http://www.utrgv.edu/railwaysafety/research/mechanical/2014/conductive-railroad-bearing-suspension-element/index.htm">http://www.utrgv.edu/railwaysafety/research/mechanical/2014/conductive-railroad-bearing-suspension-element/index.htm</a>    |
| 4.  | <b>Modeling the Residual Useful Life of Bearing Grease.</b> A final report has been indexed by TRB and posted on the UTCRS Web Site at <a href="http://www.utrgv.edu/railwaysafety/research/mechanical/2014/life-of-bearing-grease/index.htm">http://www.utrgv.edu/railwaysafety/research/mechanical/2014/life-of-bearing-grease/index.htm</a>  |
| 5.  | <b>Applications of Magnetostrictive Materials for Real-Time Monitoring of Vehicle Suspension Components.</b> A final report has been indexed by TRB and posted on the UTCRS Web Site at <a href="http://www.utrgv.edu/railwaysafety/research/mechanical/2014/applications-of-magnetostrictive-materials/index.htm">http://www.utrgv.edu/railwaysafety/research/mechanical/2014/applications-of-magnetostrictive-materials/index.htm</a>                     |
| 6.  | <b>Improving Safety at Rural Highway-Rail Grade Crossings by Utilizing Light Detection and Ranging (LiDAR) Technology.</b> A final report has been indexed by TRB and posted on the UTCRS Web Site at <a href="http://www.utrgv.edu/railwaysafety/research/operations/improving-safety-at-hrgc-by-using-lidar-technology/index.htm">http://www.utrgv.edu/railwaysafety/research/operations/improving-safety-at-hrgc-by-using-lidar-technology/index.htm</a> |
| 7.  | <b>High Speed Train Geotechnics.</b> A final report has been indexed by TRB and posted on the UTCRS Web Site at <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/high-speed-train-geotechnics/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/high-speed-train-geotechnics/index.htm</a>   |
| <b>On-going Projects</b>  |   |
| 8.  | <b>Development of Corridor-based Traffic Signal Preemption Strategies at Signalized Intersections near Highway Railway Grade Crossings.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/operations/traffic-signal-preemption-strategies-near-hrgc/index.htm">http://www.utrgv.edu/railwaysafety/research/operations/traffic-signal-preemption-strategies-near-hrgc/index.htm</a>                       |
| 9.  | <b>Drivers' Perceptions of Highway-Rail Grade Crossing Safety and Their Behavior.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/operations/drivers-perceptions-of-hrgc/index.htm">http://www.utrgv.edu/railwaysafety/research/operations/drivers-perceptions-of-hrgc/index.htm</a>   |
| 10.   | <b>Safety Modeling of Highway Railway Grade Crossings using Intelligent Transportation System Data.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/operations/modeling-of-hrgc-using-its/index.htm">http://www.utrgv.edu/railwaysafety/research/operations/modeling-of-hrgc-using-its/index.htm</a>   |
| 11.   | <b>Rail Neutral Temperature In-Situ Evaluation.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/evaluation-of-rail-neutral-temperature/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/evaluation-of-rail-neutral-temperature/index.htm</a>   |
| 12.   | <b>Ultrasonic Tomography for Infrastructure Inspection.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/ultrasonic-tomography-for-infrastructure-inspection/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/ultrasonic-tomography-for-infrastructure-inspection/index.htm</a>   |
| 13.   | <b>Optimizing Performance of Railroad Rail through Artificial Wear.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/railroad-rail-performance/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/railroad-rail-performance/index.htm</a>   |
| 14.   | <b>Vehicle-Borne Autonomous Railroad Bridge Impairment Detection Systems.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/railroad-bridge-impairment-detection-systems/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/railroad-bridge-impairment-detection-systems/index.htm</a>   |
| <b>RESEARCH AREAS Addressed in UTCRS 2<sup>nd</sup> Call for Proposal (2015CY Projects):</b>  |   |
| 15.   | <b>The Effect of Heat Generation in the Railroad Bearing Thermoplastic Elastomer Suspension Element on the Thermal Behavior of Railroad Bearing Assembly.</b> All phases of this project are on schedule. <i>This project has already resulted in two conference paper publications in national rail</i>  |

|     |  |
|-----|--|
|     | <p>conferences and a number of professional presentations.<br/> <a href="http://www.utrgv.edu/railwaysafety/research/mechanical/2015/heat-generation-in-the-railroad-bearing-suspension-element/index.htm">http://www.utrgv.edu/railwaysafety/research/mechanical/2015/heat-generation-in-the-railroad-bearing-suspension-element/index.htm</a></p>  |
| 16. | <p><b>Development of Predictive Models for Spall Growth in Railroad Bearing Rolling Elements.</b> All phases of this project are on schedule. <i>This project has already resulted in one conference paper publication in a national rail conference and a number of professional presentations.</i><br/> <a href="http://www.utrgv.edu/railwaysafety/research/mechanical/2015/predictive-models-for-spall-growth-in-railroad-bearings/index.htm">http://www.utrgv.edu/railwaysafety/research/mechanical/2015/predictive-models-for-spall-growth-in-railroad-bearings/index.htm</a></p>                                      |
| 17. | <p><b>Radiative Heat Transfer Analysis of Railroad Bearings Using a Single Bearing Test Rig for Wayside Thermal Detector Optimization.</b> All phases of this project are on schedule. <i>This project has already resulted in one conference paper publication in a national rail conference and a number of professional presentations.</i><br/> <a href="http://www.utrgv.edu/railwaysafety/research/mechanical/2015/radiative-heat-transfer-analysis-of-railroad-bearings/index.htm">http://www.utrgv.edu/railwaysafety/research/mechanical/2015/radiative-heat-transfer-analysis-of-railroad-bearings/index.htm</a></p> |
| 18. | <p><b>Demonstration of Magnetostrictive Materials for Self-Powered Monitoring of Rail Vehicle Suspension Components.</b> All phases of this project are on schedule. <i>This project has already resulted in two conference paper publications in national rail conferences, one journal paper publication in a high impact journal, and a number of professional presentations.</i><br/> <a href="http://www.utrgv.edu/railwaysafety/research/mechanical/2015/energy-harvesting-applications/index.htm">http://www.utrgv.edu/railwaysafety/research/mechanical/2015/energy-harvesting-applications/index.htm</a></p>        |
| 19. | <p><b>Anti-Icing LED Light Covers for Railroad Safety.</b> All phases of this project are on schedule.<br/> <a href="http://www.utrgv.edu/railwaysafety/research/operations/anti-icing-led-light-covers-for-railroad-safety/index.htm">http://www.utrgv.edu/railwaysafety/research/operations/anti-icing-led-light-covers-for-railroad-safety/index.htm</a></p>  |
| 20. | <p><b>Heavy Truck and Bus Traversability at Highway-Rail Grade Crossings.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/operations/heavy-truck-traversability-at-hrgc/index.htm">http://www.utrgv.edu/railwaysafety/research/operations/heavy-truck-traversability-at-hrgc/index.htm</a></p>  |
| 21. | <p><b>Improving Crash Prediction - A More Relevant Exposure Measure than AADT for Highway-Rail Crossing Safety Models.</b> All phases of this project are on schedule.<br/> <a href="http://www.utrgv.edu/railwaysafety/research/operations/improving-crash-predictions-at-hrgc/index.htm">http://www.utrgv.edu/railwaysafety/research/operations/improving-crash-predictions-at-hrgc/index.htm</a></p>  |
| 22. | <p><b>Best Practices for Modeling Light Rail at Intersections.</b> All phases of this project are on schedule.<br/> <a href="http://www.utrgv.edu/railwaysafety/research/operations/modeling-light-rail-intersections/index.htm">http://www.utrgv.edu/railwaysafety/research/operations/modeling-light-rail-intersections/index.htm</a></p>  |
| 23. | <p><b>Unifying Railcar Monitoring Sensor Data, Maintenance Records, and Railcar Usage Information through Big Data Processing for Optimizing Railcar Maintenance and Safety.</b> All phases of this project are on schedule.<br/> <a href="http://www.utrgv.edu/railwaysafety/research/operations/rail-equipment-safety/index.htm">http://www.utrgv.edu/railwaysafety/research/operations/rail-equipment-safety/index.htm</a></p>  |
| 24. | <p><b>Shipments of Oil By Rail: Economic Implications for Safety and Safety-Related Investments.</b> All phases of this project are on schedule.<br/> <a href="http://www.utrgv.edu/railwaysafety/research/operations/shipments-of-oil-by-rail/index.htm">http://www.utrgv.edu/railwaysafety/research/operations/shipments-of-oil-by-rail/index.htm</a></p>  |
| 25. | <p><b>Highway-Rail Crossing Safety Improvement by Diverting Motorists to Alternate Routes.</b> All phases of this project are on schedule.<br/> <a href="http://www.utrgv.edu/railwaysafety/research/operations/highway-rail-crossing-safety-diverting-motorists/index.htm">http://www.utrgv.edu/railwaysafety/research/operations/highway-rail-crossing-safety-diverting-motorists/index.htm</a></p>  |
| 26. | <p><b>Railyard Worker Safety through innovative Mobile Active Train Detection and Risk Localization.</b> All phases of this project are on schedule.<br/> <a href="http://www.utrgv.edu/railwaysafety/research/operations/railyard-worker-safety-mobile-active-">http://www.utrgv.edu/railwaysafety/research/operations/railyard-worker-safety-mobile-active-</a></p>  |

|  |
|--|
| <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/train-detection/index.htm">train-detection/index.htm</a>   |
| 27. <b>Estimating Bridge Span Deflections Using Data Streams from Rolling Stock.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/bridge-span-deflection-estimation/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/bridge-span-deflection-estimation/index.htm</a>   |
| 28. <b>Bumps in High Speed Rails: What is Tolerable?</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/bumps-in-high-speed-rails/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/bumps-in-high-speed-rails/index.htm</a>   |
| 29. <b>Dynamic Live Load Effects of Railroad on Retaining Walls and Temporary Shoring.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/dynamic-live-load-effects-of-railroads-on-retaining-walls/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/dynamic-live-load-effects-of-railroads-on-retaining-walls/index.htm</a> |
| 30. <b>Strength and Fracture Toughness of Railroad Eyebars Members.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/fracture-of-eyebars-members/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/fracture-of-eyebars-members/index.htm</a>  |
| 31. <b>A Mechanistic Investigation of Concrete Tie Degradation in the Rail Seat.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/investigation-concrete-tie-degradation/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/investigation-concrete-tie-degradation/index.htm</a>   |
| 32. <b>Fatigue and Service Analysis of Railroad Eyebars Members.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/service-analysis-of-eyebars-members/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/service-analysis-of-eyebars-members/index.htm</a>   |
| 33. <b>Method for Predicting Thermal Buckling in Rails.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/thermal-buckling-in-rails/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/thermal-buckling-in-rails/index.htm</a>  |
| 34. <b>Multi-Scale Fatigue Damage Life Assessment of Railroad Wheels.</b> All phases of this project are on schedule. <a href="http://www.utrgv.edu/railwaysafety/research/infrastructure/wheel-fatigue-damage-life-assessment/index.htm">http://www.utrgv.edu/railwaysafety/research/infrastructure/wheel-fatigue-damage-life-assessment/index.htm</a>  |

During this reporting period, the UTCRS engaged a total of 104 undergraduate and graduate students actively engaged in the various research, education, workforce development, technology transfer, and community outreach activities. The UTCRS has been successful in attracting populations typically underrepresented in the transportation workforce, which is highlighted by the fact that, for the third consecutive year, almost 40% of the students involved in the center activities are female. The latter statistic more than doubles the national average of 15.7% female workforce in Transportation and Materials Moving Occupations reported by the Department of Labor Statistics in 2014.

| Undergraduate and Graduate Students Actively Involved in the UTCRS Research, Education, Workforce Development, Technology Transfer, and Community Outreach Activities |       |      |        |
|---|-------|------|--------|
| Classification  | Total | Male | Female |
| Undergraduate Students  | 70    | 42   | 28     |
| Masters' Level Students   | 21    | 14   | 7      |
| Doctoral Level Students   | 13    | 7    | 6      |
| Totals  | 104   | 63   | 41     |

The UTCRS takes great pride in the fact that it has been very successful in leveraging resources and

engaging colleges, departments, and units outside of the College of Engineering and Computer Science in its various research, education, workforce development, technology transfer, and community outreach activities. Referring to the table above, the UTCRS engaged **11** undergraduate students (10 female and 1 male) from the College of Education funded by the **UTeach Program** at UTRGV (a secondary math and science educator preparation program), **15** undergraduate students from the various student organizations, and **4** high school students participating in the High Scholars and the Howard Hughes Medical Institute (HHMI) Research Programs. The undergraduate students from the UTeach Program and the student organizations assisted faculty, staff, and teachers participating in the Research Experience for Teachers (RET) Program in running the 2016 UTCRS Summer Camps that attracted **1300** K-12 students. The number of participants in our annual UTCRS summer educational programs for K-12 students increased from **700** students in 2014 to a **1000** students in 2015 to **1300** students in 2016. The following table summarizes the results of the various educational activities and programs implemented by the UTCRS over the reporting period from April 1, 2016 to September 30<sup>th</sup>, 2016:

**EDUCATION & OUTREACH ACTIVITIES for period (April 1, 2016 - September 30, 2016)**  
Outreach and Educational Activities aimed at Increasing Awareness of Transportation Engineering and Railway Safety Careers

A total of **1300** students, grades 3-12 participated in the largest STEM camp ever held at UTRGV, June 6<sup>th</sup> through July 8<sup>th</sup> 2016. During the five weeks of camp, UTCRS hosted 577 elementary students, 525 middle school students, and 198 high school students. Demographics of program participants confirm the success of the efforts to recruit underrepresented groups in the STEM fields.  
See: <http://www.utrgv.edu/railwaysafety/news/gallery/index.htm>

**2016 UTCRS Summer Camp Participation by Grade Level and Gender**

| Grade Level         | Male | Female |
|---------------------|------|--------|
| High School (9-12)  | 76   | 24     |
| Middle School (6-8) | 57   | 43     |
| Elementary (3-5)    | 52   | 48     |

**2016 UTCRS Summer Camp Participation by Ethnicity**

| Ethnicity | Percentage |
|-----------|------------|
| Hispanic  | 92%        |
| Caucasian | 5%         |
| Other     | 3%         |



The UTCRS in collaboration with the Texas Higher Education Coordinating Board (THECB) hosted its third annual Transportation Engineering Summer Enrichment Program (TESEP) from July 5-9, 2019. The **26 high school students** were pre-selected to participate in TESEP due to their interest in engineering careers. Students were exposed to research-intensive activities involving conceptualization of physics laws, sensors, actuators, and data collection systems related to transportation engineering and railway safety. Out of the 26 students participating in TESEP, 20 were male and six were female, and 25 were Hispanic. The success of the UTCRS in promoting interest in transportation engineering careers among underrepresented groups is a point of great pride. See: <https://www.flickr.com/photos/131769328@N02/sets/72157670925688675>



**Fourteen** undergraduate students from UTRGV participated in the 2016 Research Experience for Undergraduates (REU) Program. During the ten-week REU Program (6/1 – 8/5), students worked alongside consortium faculty, staff, and students from Texas A&M University and the University of Nebraska-Lincoln on research-intensive projects directly related to the UTCRS strategic research goals. This year's REUs also conducted professional field visits, mentored high school students, and presented their research to professionals in the railroad industry. Moreover, the 2016 REU participants will be presenting their final research findings to the UTCRS consortium directors during the annual fall symposium scheduled at UTRGV on December 2<sup>nd</sup>, 2016.



See: <https://www.flickr.com/photos/131769328@N02/sets/72157668795295976>  
<https://www.flickr.com/photos/131769328@N02/sets/72157666363674683>

Following the successful implementation of the Research Experience for Teachers (RET) Program over the past two years, **eleven** local STEM teachers, selected from a pool of 50 applicants, were funded to participate in the 2016 UTCRS Summer Camps. The RET participants assisted in optimizing the developed UTCRS Curricula for elementary, middle school, and high school. The Curricula focuses on STEM concepts related to transportation engineering with an emphasis on railway safety. The RET participants are required to implement and promote the UTCRS STEM Curricula and Modules in their home school districts and classrooms as part of their commitment to raise awareness of the transportation engineering and railway safety field. See: <http://www.utrgv.edu/railwaysafety/education/summer-exp/ret/2016-ret/index.htm>



**100 K-12** STEM teachers from **26** different school districts participated in the 2016 UTCRS National STEM Teachers Workshop held at the UTRGV campus on June 2-3. Participants attended four different 4-hour



sessions during the two-day workshop where they were introduced to concepts of physics, magnetic levitation, robotics, and transportation engineering outlined in the developed UTCRS Curricula. As part of the workshop, the teachers had to work in groups and develop their own modules based on the UTCRS curricula for implementation in their own classrooms. The majority of these STEM teachers were given the opportunity to apply what they learned in this workshop as part of their participation in the 2016 UTCRS Summer Camps. See: <https://www.flickr.com/photos/131769328@N02/albums/72157668961172102/with/27474063056/>



**Eleven** interns from the UTRGV College of Education, funded by the **UTeach** Program, and **fifteen** members of the student organizations (SAE, ASME, ASCE, SWE, and SHPE) within the College of Engineering and Computer Science assisted in mentoring the K-12 students during the 2016 UTCRS Summer Camps. Interns had the opportunity to experience teaching STEM in a real classroom scenario, as well as conducting research to develop STEM instructional best practices and teaching methodology. The data collected during the summer camps is being used in numerous presentations and publications aimed at finding ways to effectively engage and retain female students in STEM career fields.



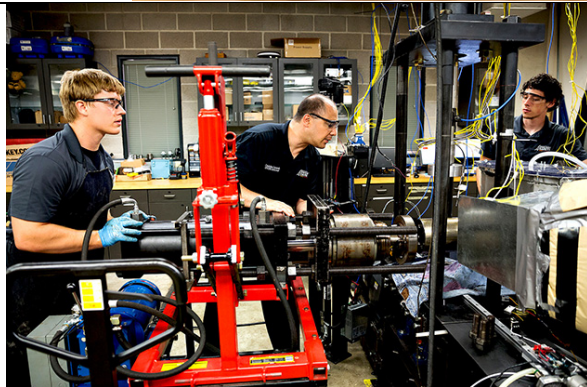
**Twenty** research assistants directed more than **45** guided tours of the UTCRS research facilities for the **1300** K-12 students that attended the 2016 UTCRS Summer Camps, and more than **3000** other K-12 students and members of the community that visited the UTCRS during this reporting period, including HESTEC community day. Over **4300** students learned about the various ongoing railway safety projects from the UTCRS students conducting the research. These tours helped the UTCRS research assistants develop their professional presentation skills while providing the visitors the opportunity to visualize and relate the railway safety research and engineering concepts to real-life applications.



## UTCRS HIGHLIGHTS for period (April 1, 2016 - September 30, 2016)

On July 11<sup>th</sup>, 2016, the UTCRS hosted its Third Annual UTCRS Summer Camps Closing Ceremony. This year's ceremony was highlighted by our keynote speaker, US Congressman Rubén Hinojosa, who emphasized the importance of STEM programs like the UTCRS Summer Camps to raising awareness and engaging young minds at an early age to STEM concepts and career fields. More than **1300** people attended this celebration including family members, students, faculty, staff, and UTRGV Upper Administration. The ceremony featured talks by UTRGV Vice President for Academic Affairs, Havidán Rodríguez, UTRGV Vice President for Governmental Relations, Veronica Gonzalez, Dean of the UTRGV College of Engineering and Computer Science, Alexander Domijan, and UTCRS Director, Constantine Tarawneh. A video highlighting the student accomplishments and activities during the 2016 UTCRS Summer Camps was shown, followed by the selection of the Transportation Engineering Challenge Competition winners for Elementary, Middle School, and High School (see <http://www.utrgv.edu/railwaysafety/news/video-galleries/index.htm>). The 2016 UTCRS Summer Camps were also featured in the local and regional news as several articles and news segments were produced emphasizing the U.S. Department of Transportation (USDOT) support toward local research and education efforts, as well as the UTCRS consortium universities role in supporting the initiatives and goals of the USDOT.

Link to Articles: <http://www.utrgv.edu/railwaysafety/news/newsletter/index.htm>



The UTCRS research and education activities were featured in a number of UTRGV press releases that highlighted the importance of the work being conducted by the center towards ensuring that students stay on track for engineering careers in the transportation field. (See: <http://www.utrgv.edu/en-us/about-utrgv/news/press-releases/2016/july-06-utrgv-railway-safety-students-stay-on-track-for-engineering-careers/index.htm>)



On July 29<sup>th</sup>, 2016, Esmeralda Infante, a 2014 UTCRS Summer Camp Alum, and one of **four** High School Interns working with our UTCRS research team, won 1st place in the Howard Hughes Medical Institute (HHMI) Program research competition. (See: <http://www.utrgv.edu/railwaysafety/news/index.htm> and <https://www.flickr.com/photos/131769328@N02/sets/72157668762526453/>)



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

The UTCRS continued its strong commitment to develop a trained professional transportation workforce by focusing on graduating a highly-skilled and experienced cadre of graduate and undergraduate students. The UTCRS requires all students to present their research findings and progress during the bi-weekly seminar series, where UTCRS Director, Constantine Tarawneh, and the faculty who have funded projects through the center give students feedback and discuss future tasks to be completed to ensure that the work stays on schedule. This practice has contributed to much improved verbal communication skills, and has allowed the students to build confidence and gain much-needed professional presentation experience by fielding questions regarding their research work. Moreover, students participate in a number of career-building activities such as: co-authoring scholarly publications, presenting at national rail and engineering conferences, preparing technical reports, attending specialized research trainings, engaging high profile visitors during university and community engagement events, and taking part in departmental and college seminars, UTCRS Symposiums, pre-college recruitment, and REU Programs.

Undergraduate and graduate students involved in funded research are assigned leadership roles within research working groups, serving as primary mentors to new research assistants and as principal investigator assistants with oversight of research projects. In this way, students are expected to influence their professional supportive environment and create accountability in ensuring all UTCRS undergraduate and graduate students reach their fullest potential. Students with set graduation dates are also expected to train their position replacement to pass down knowledge, skills, and work habits before transitioning research responsibilities to a successor. This latter task was particularly important this reporting period since we had **eight** undergraduate, **six** master's, and **two** doctoral students complete their degrees. Ensuring that the UTCRS research transitions smoothly when students graduate is a center priority.

In collaboration with the UTRGV **UTeach Program**, a secondary math and science educator preparation program, the UTCRS provided the opportunity for **21** interns enrolled in Education and Curriculum degrees, to date, to engage in teaching and research in the UTCRS Summer Camps. These students have been working as paid interns to gain teaching experience as well as engage in STEM education research. **Seven** of these students presented their findings at the 2016 National Association for Research in Science Teaching (NARST) annual conference in Baltimore, Maryland this past April. In addition, **nine** students are currently investigating the role of gender and family culture in the summer camps. Under the supervision of Dr. Angela Chapman, UTCRS Education Coordinator, these students are submitting their findings to peer-reviewed STEM education journals including the Journal of Women and Minorities in Science and Engineering. Overall, this collaboration has proven to be very successful in giving students real-life teaching experience of transportation engineering and STEM concepts.



Finally, during this reporting period, the UTCRS faculty, staff, and students organized two STEM Teacher professional development workshops, the first, a **two-day** National Teacher Workshop that hosted **100** STEM teachers at the UTRGV campus from June 2-3, 2016 (see picture on left), and the second, a **two-session** Teacher Workshop that hosted **30** STEM teachers during Hispanic Engineering, Science, and Technology (HESTEC) week at the UTRGV campus (see picture on right). Both workshops were very successful in engaging teachers with the UTCRS K-12 developed curricula, and have had a huge impact on the implementation of transportation-related concepts in classrooms across the Rio Grande Valley.

#### **How have you disseminated your results?**

The results of the **34** research projects funded through the UTCRS are disseminated through professional presentations at local and national symposiums, national and international conferences, refereed journal and conference publications, technical reports, TRID and RIP Databases, CUTC meetings, local community engagement and outreach events, and on the UTCRS website which is updated on a daily basis.

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

1. Upload the reports and results of the projects that have concluded to the UTCRS website and the TRID database, and provide copies to the USDOT UTC grant managers.
2. Continue to expand the UTCRS visibility and social media presence for greater dissemination, specifically to professional transportation workforce.
3. Continue the bi-weekly research meetings between faculty and student research assistants to address the UTCRS goals and objectives, and identify tasks needed to meet project deliverables.
4. Continue to develop student experience and leadership skills through specialized research trainings, mentoring, and engagement in scholarly work and activities with the UTCRS faculty team.
5. Initiate outreach activities to plan and organize the 2017 UTCRS Summer Camps for elementary, middle school, and high school students.
6. Devise a student tracking system to follow the academic and professional careers of students participating in UTCRS programs and activities in order 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, and theses, as follows:

1. Mealer, A., Tarawneh, C. and Crown, S. W., "Radiative Heat Transfer Analysis of Railroad Bearings for Wayside Hot-Box Detector Optimization," *Proceedings of the 2017 ASME Joint Rail Conference*, Philadelphia, Pennsylvania, USA, April 4-7, 2017.
2. De Los Santos, N., Jones, R., Tarawneh, C., Fuentes, A. A., and Villarreal, A., "Development of Prognostic Techniques for Surface Defect Growth in Railroad Bearing Rolling Elements," *Proceedings of the 2017 ASME Joint Rail Conference*, Philadelphia, Pennsylvania, USA, April 4-7, 2017.
3. Rodriguez, O., Fuentes, A. A., Tarawneh, C., and Jones, R., "Hysteresis Heating of Railroad Bearing Thermoplastic Elastomer Suspension Element," *Proceedings of the 2017 ASME Joint Rail Conference*, Philadelphia, Pennsylvania, USA, April 4-7, 2017.
4. Timmer, D., Tarawneh, C. and Jones, R., "Models for the Residual Life of Railroad Bearing Grease in Laboratory and Industry Applications," *Proceedings of the 2017 ASME Joint Rail Conference*, Philadelphia, Pennsylvania, USA, April 4-7, 2017.
5. Wilson, B. M., Fuller, A. J., Tarawneh, C., and Turner, J. A., "Near Race Inclusions in Bearing Components and the Resultant Effect on Fatigue Initiation and Component Life," *Proceedings of the 2016 Conference on Railway Excellence (CORE)*, Melbourne, Australia, May 16-18, 2016.



6. Tarawneh, C., Sotelo, L., De Los Santos, N., Lechtenberg, R., Villarreal, A., and Jones, R., "Temperature Profiles of Railroad Tapered Bearings with Defective Inner and Outer Rings," *Proceedings of the 2016 ASME Joint Rail Conference*, Columbia, South Carolina, USA, April 12-15, 2016.
7. Rodriguez, O., Fuentes, A. A., Tarawneh, C., Jones, R., and Carbone, J., "Heat Generation in the Railroad Bearing Thermoplastic Elastomer Suspension Element," *Proceedings of the 2016 ASME Joint Rail Conference*, Columbia, South Carolina, USA, April 12-15, 2016.
8. Chapman, A., Fleming, M., Walls, L., Garza, A., Hinojosa, L., Hernandez, M., Palomino, E., Rodriguez, F., Zarinana, C., Rojas, E., and Rojas, J., "A Critical Examination of Social, Cultural, and Gender Research in Science Education," *2016 Annual Meeting of National Association for Research in Science Teaching*, Baltimore, MD, April 14-17, 2016.
9. Zhao, S. and Khattak, A. J., "Motor Vehicle Drivers' Injuries in Crashes Reported at or Near Highway-Rail Grade Crossings," *Proceedings of the 95th Annual Meeting of the Transportation Research Board*, Paper No. 16-5919, Washington D.C., January 2016.
10. Zhao, S., Iranitalab, A., and Khattak, A. J., "Investigation of Pedestrian Injury Severity in Crashes at Highway-Rail Grade Crossings Using Latent Class Analysis," *Proceedings of the 95th Annual Meeting of the Transportation Research Board*, Paper No. 16-3697, Washington D.C., January 2016.

#### Presentations:

1. A. J. Khattak. Railway Engineering Programs at the University of Nebraska-Lincoln. *Presented at the 2016 Summer Rail Conference*, Council Bluffs, Iowa, August 10, 2016.
2. J. L. Briaud. High Speed Rail Geotechnics. *The Delta Group*, San Diego, California, July 7, 2016.
3. C. Tarawneh. Temperature Profiles of Railroad Tapered Bearings with Defective Inner and Outer rings. *2016 ASME Joint Rail Conference*, Columbia, SC, April 12-15, 2016.
4. O. Rodriguez. Heat Generation in the Railroad Bearing Thermoplastic Elastomer Suspension Element. *2016 ASME Joint Rail Conference*, Columbia, SC, April 12-15, 2016.

#### Posters:

1. Benham, G., Lechtenberg, R., Bensen, J., and Tarawneh, C., "Design and Construction of an Automated Solenoid Spooler," poster presented at the *High Scholars Research Competition*, Edinburg, TX, August 5, 2016.
2. Vail, A., Aranda, J., Montalvo, J., and Tarawneh, C., "Using Computational Fluid Dynamics to Test Air Flow and Heat Generation for a Four Bearing Test Rig," poster presented at the *High Scholars Research Competition*, Edinburg, TX, August 5, 2016.
3. Infante, E., Mealer, A., and Tarawneh, C., "Demonstrating and Studying the Emissivity Difference Over a Single Railroad Bearing and a Population of Bearings," poster presented at the *Howard Hughes Medical Institute (HHMI) Program Closing Ceremony*, Edinburg, TX, July 29, 2016. [**Won First Place Honors**]
4. Siegel, H., Ontiveros, M., Jones, R., and Tarawneh, C., "The Effects of Residual Crystallization on the Resistivity of TPU-CNF Blend," poster presented at the *Howard Hughes Medical Institute (HHMI) Program Closing Ceremony*, Edinburg, TX, July 29, 2016.

#### Theses and Dissertations:

1. Mohammadrajabi, M., "Live Load Effects of Railroads on Retaining Walls and Temporary Shoring," Doctoral Dissertation, Texas A&M University, August 2016.
2. Posluszny, R., "Application of AFRP Bars in Concrete Railroad Ties," Master's Thesis, Texas A&M University, August 2016.
3. Appavuravther, E. T., "Stability of a Four Story Steel Frame Building Under Seismic Loading," Master's Thesis, Texas A&M University, August 2016.

4. Smith, S., "Estimating Load Distributions for Retaining Structures Subjected to Railroad Live Loads," Master's Thesis, Texas A&M University, August 2016.
5. Chen, Y., "An Adaptive Corridor-Wide Signal Timing of Optimization Methodology for Traffic Networks with Multiple Highway-Rail Grade Crossings," Doctoral Dissertation, University of Nebraska-Lincoln, April 2016.
6. Williams, N., "Nondestructive Testing Methods for Railroad Tunnel Lining Inspection," Master's Thesis, Texas A&M University, December 2015.
7. Rachal, L., "Determination of Bent Cap and Stringer Deflections for Timber Railway Bridges Under Live Load," Master's Thesis, Texas A&M University, December 2015.
8. Martinez, T., "Modeling the Residual Useful Life of Bearing Grease," Master's Thesis, The University of Texas Rio Grande Valley, December 2015.

UTCRS faculty participated in the following technical committees and editorial boards:

1. **Fry, G.**, Past Chair, *Committee 7: Timber Structures AREMA*. July 27-28, 2016.
2. **Fry, G.**, Technical Committee Member, *Railway Working Technology Committee*. May 18-20, 2016.
3. **Fry, G.**, Technical Committee Member, *Committee 15: Steel Structures AREMA*. February 2-3, 2016.
4. **Khattak, A. J.**, Chair, *Transportation Research Board (TRB) Standing Committee on Highway/Rail Grade Crossings (AHB60)*.
5. **Khattak, A. J.**, Member, Editorial Board of the *Journal of Transportation Research Forum*
6. **Khattak, A. J.**, Area Editor, *Journal of Transportation Safety and Security*.
7. **Sharif, H.**, Co-Editor-in-Chief, *Wiley Security and Communication Networks (SCN) Journal*.
8. **Grasley, Z.**, Associate Editor, *Journal of Materials: Civil Engineering*.
9. **Tarawneh, C.**, Expert Reviewer, *DOE-NE Consolidated Innovative Nuclear Research FOA*.

#### Website or other Internet Material:

UTCRS Research, education, workforce development, technology transfer, and community engagement activities are primarily disseminated through our center website (<http://railwaysafety.utrgv.edu>). The UTCRS website is maintained on a daily basis to ensure that all material and links are working properly. A designated undergraduate student works closely with a UTRGV web designer to keep the website current and compliant with all USDOT and UTRGV requirements. The website contains extensive photo galleries and videos of the various educational, research, workforce development, technology transfer, and outreach activities. Numerous hours went into professionally transitioning the website from the legacy institution (UTPA) to the current institution (UTRGV). To ensure that the UTCRS website provides valuable information to the nation and the community at large, all the scholarly work including journal and paper publications, technical reports and presentations, and other products of the UTCRS are made available through this website. Over this reporting period, the UTCRS K-12 developed curricula were made available online at <http://www.utrgv.edu/railwaysafety/education/resources/curricula-2016/index.htm>.

#### Technologies or techniques:

The **Single Bearing Tester** designed and built by the UTCRS research team provides specialized testing capabilities in which vertical, lateral, and impact loading can be applied simultaneously in a manner that very closely mimics field service operating conditions. While this tester is excellent for carefully-designed short-duration



research studies, it is not the optimal choice for continuous service life testing of railroad bearing components. Over the past six months, the UTCRS research team composed of faculty and students designed and fabricated an efficient and compact **Four Bearing Tester** that can be used to perform long-duration service life tests to characterize bearing performance and assess the quality of the bearing steel. This four bearing tester is housed in a specially designed environmental chamber that can mimic ambient conditions as low as -40°F and as high as 150°F. The addition of this tester to the UTCRS infrastructure provides enhanced research capabilities that can accelerate projects of interest to the rail industry.

#### **Inventions, patent applications, and/or licenses:**

Nothing to report, all current research and workforce development activities are under implementation.

#### **Other products:**

A UTCRS-UNL research team are in the process of developing a novel fisheye camera-based object detection algorithm to be used to detect moving objects in railyard environments and to gauge their distance. This product will enable researchers to track potential threats to railyard workers in real-time. UTCRS K-12 STEM Curricula are now available for teachers, educators, and STEM program coordinators to borrow and implement at their own institutions. Moreover, faculty and students have developed an interactive UTCRS Learning Module (<http://faculty.utrgv.edu/constantine.tarawneh/flash/story.html>).

### **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 hereafter, 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 |
|---------------------|---|--------------|--------|
| <b>State</b>        |   |              |        |
| Acton, Jessica      | Texas Higher Education Coordinating Board (THECB) | Education    | Female |
| Crown, Stephen, PhD | Director of UTRGV Texas Pre-Freshman Program      | Education    | Male   |
| Nayeli Parra        | Texas Department of Transportation (TxDOT)        | Governmental | Female |
| <b>Local</b>        |   |              |        |
| Dr. Roni Rentfro    | Brownsville ISD                                   | Community    | Female |
| Dr. Alma Benavides  | La Joya ISD                                       | Community    | Female |
| Kelly Watson        | Donna ISD   | Community    | Male   |
| Dr. Rene Gutierrez  | Edinburg CISD                                     | Community    | Male   |
| Sandra Tovar        | Harlingen CISD                                    | Community    | Female |
| Cynthia Torres      | La Feria ISD                                      | Community    | Female |
| Wendy Grouler       | McAllen ISD                                       | Community    | Female |
| Dr. Sharon Roberts  | Mission CISD                                      | Community    | Female |
| Ana Zepeda          | Monte Alto ISD                                    | Community    | Female |
| Ana Castro          | South Texas ISD                                   | Community    | Female |
| Dr. Daniel P. King  | PSJA ISD  | Community    | Male   |
| Mario Alvarado      | San Isidro ISD                                    | Community    | Male   |
| Dr. Nora V. Casarez | BETA  | Community    | Female |
| Brenda DeHoyos      | Hidalgo ISD                                       | Community    | Female |
| Dr. Maria Leo       | Sharyland ISD                                     | Community    | Female |
| Joseph Villarreal   | Los Fresnos ISD                                   | Community    | Male   |
| Ramiro Balderas     | Valley View ISD                                   | Community    | Male   |

|                               |  |                                       |        |
|-------------------------------|--|---------------------------------------|--------|
| Robert L. Ramirez             | Vanguard Academy   | Community                             | Male   |
| Sister Cindy Mello            | Catholic Diocese of Brownsville School District  | Community                             | Female |
| Sarah Leal-Mendez             | RGV Homeschool Cooperative Resource  | Community                             | Female |
| Molly Mejia                   | Boyscouts of America   | Community                             | Female |
| Jorge Chipres                 | IDEA ISD   | Community                             | Male   |
| Cantu, Brenda                 | 2016 RET – Mission CISD  | District Level                        | Female |
| Wells, Frances                | 2016 RET – IDEA ISD  | District Level                        | Female |
| Saenz, Andrea                 | 2016 RET – Hidalgo ISD   | District Level                        | Female |
| Ybarra, Michelle              | 2016 RET – Brownsville ISD   | District Level                        | Female |
| Benitez, Andres               | 2016 RET – Sharyland ISD   | District Level                        | Male   |
| Reyes, Patricia               | 2016 RET – Valley View ISD   | District Level                        | Female |
| Reyes, Jose                   | 2016 RET – McAllen ISD   | District Level                        | Male   |
| Garcia, Renee                 | 2016 RET – Pharr San-Juan Alamo ISD  | District Level                        | Male   |
| Ochoa, Teresa                 | 2016 RET – La Joya ISD   | District Level                        | Female |
| Carrasquero, Nelson           | 2016 RET – Pharr San-Juan Alamo ISD  | District Level                        | Male   |
| Proctor, Stacey               | 2016 RET – Pharr San-Juan Alamo ISD  | District Level                        | Male   |
| Contreras, Robert             | Co-director, UTeach Program  | Institutional                         | Male   |
| Gonzales, Veronica            | VP for Governmental and Community Relations, UTRGV   | Institutional                         | Female |
| Dove, Russell                 | Web Designer II, Internet Services, UTRGV  | Institutional                         | Male   |
| Aranda, James                 | Society of Automotive Engineers (SAE)  | Institutional                         | Male   |
| Belmares, Milagros            | Society of Women Engineers (SWE)   | Institutional                         | Female |
| Ortega, Gabby                 | Society of Hispanic Professional Engineers (SHPE)  | Institutional                         | Female |
| Muñoz, Miguel                 | American Society of Mechanical Engineers (ASME)  | Institutional                         | Male   |
| Pruneda, Ana                  | American Society of Civil Engineers (ASCE)   | Institutional                         | Female |
| <b>Private</b>                |  |                                       |        |
| 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.   | Advisory Board                        | Male   |
| Staplin, David                | Deputy Chief Engineer – Amtrak   | Advisory Board                        | Male   |
| <b>Consortium</b>             |  |                                       |        |
| Tarawneh, Constantine, PhD    | UTCRS – Director<br>Professor, Mechanical Engineering, UTRGV<br>1201 West University Drive, Edinburg, TX 78539               | Researcher/<br>Executive<br>Committee | Male   |
| Fry, Gary, PhD, PE            | UTCRS – Associate Director TAMU<br>Assoc. Professor, Civil Engineering, TAMU<br>3135 TAMU, College Station, Texas 77843-3135 | Researcher/<br>Executive<br>Committee | Male   |
| Rilett, Laurence, PhD, PE     | UTCRS – Associate Director UNL<br>Professor, Civil Engineering, UNL<br>262D Whittier Research Center, Lincoln, NE 68583      | Researcher/<br>Executive<br>Committee | Male   |
| Freeman, Robert, PhD          | UTCRS – Associate Director UTRGV<br>Professor and Chair, Mechanical Engineering  | Executive<br>Committee                | Male   |
| Lawrence-Fowler, Wendy, PhD   | UTCRS – Diversity Coordinator – UTRGV<br>Professor, Computer Science   | Executive<br>Committee                | Female |
| Chapman, Angela, PhD          | UTCRS – Education Coordinator – UTRGV<br>Assistant Professor, Curriculum & Instruction                                       | Executive<br>Committee                | Female |
| Garcia, Citlalli, MAIS        | UTCRS – Sr. Program Coordinator – UTRGV  | Staff                                 | Female |
| Pena, Melissa Iliana          | UTCRS – Program Assistant – UTRGV  | Staff                                 | Female |
| Pelton, Amanda                | UTCRS – Program Coordinator – TAMU   | Staff                                 | Female |
| Thandayithabani, Lavania, MBA | Assistant Director of Operations – UNL<br>262D Whittier Research Center, Lincoln, NE 68583                                   | 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   |
| Hurlebaus, Stefan, PhD    | Assistant Professor, Civil Engineering, TAMU        | Researcher | Male   |
| Briaud, Jean-Louis, PhD   | Assistant Professor, Civil Engineering, TAMU        | Researcher | Male   |
| Aemal Khattak, PhD        | Associate Professor, Civil Engineering, UNL         | Researcher | Male   |
| Hamid Sharif, PhD         | Professor, Telecommunication and Computer Eng., UNL | Researcher | Male   |
| Villalobos, Cristina, PhD | Director – UTRGV C-STEM Center                      | Center     | Female |
| Mahmoud, Enad, PhD        | Assistant Professor, Civil Engineering, UTRGV       | Researcher | Male   |
| Lozano, Karen, PhD        | Director – UTRGV Nano Materials Center              | Center     | 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 bridge to graduate programs 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. The REU Program participants are now required to take an online GRE preparation course during their 10-week research experience. This practice has encouraged many of the REU participants to apply for graduate programs at the three consortium institutions. Since 2014, there are **nine** UTRGV students who participated in the UTCRS REU program that are currently pursuing their master's degree in the consortium institutions working on railway research. **Three** more REU students have been admitted to graduate programs at the three consortium institutions and are set to start this spring semester. This brings the total number of students, to date, who were encouraged by the REU Program to pursue their graduate degrees to **twelve** students. These students come from mechanical, civil, and computer engineering departments; a fact that demonstrates the impact of the UTCRS on several engineering programs. This fact is particularly important considering that there are no Master's Programs in Civil or Computer Engineering at UTRGV and the UTCRS has just provided a clear avenue for these students.
- The UTCRS has been successful in attracting a large percentage of minorities, typically underrepresented in transportation engineering fields, to the discipline. These groups are receiving rigorous hands-on training through active engagement in railway safety research applications that are vital for the railroad industry.
- Training of a critical mass of engineering students on hands-on skills that include welding, machining, design, assembly, material characterization, and the use of hydraulic machinery.
- Twelve graduate and eleven undergraduate students have gained valuable technical writing and oral presentation experience by co-authoring paper publications, writing and defending theses, and presenting at national and international conferences relevant to the rail transportation industry.
- Students also gained experience in using complex mathematical and statistical modeling and state-of-art engineering software tools and packages such as SolidWorks, Algor, MatLab and Labview.
- The success of the UTCRS REU Program has highlighted the need for Master's Programs in Civil and Computer Engineering at UTRGV. Currently, the Civil Engineering Department at UTRGV is putting together a proposal to establish a Master's of Science in Civil Engineering Program with an emphasis on transportation. The department has already hired two faculty in the transportation field.

##### What is the impact on other disciplines?

UTCRS brought together faculty and students from seven different departments across two colleges with the purpose of exemplifying the interdisciplinary nature of the transportation industry. The various

UTCRS activities involve collaborative efforts between mechanical, electrical, civil, manufacturing, and computer engineering fields as well as computer science and curriculum and instruction. Faculty and students from these different disciplines are working in unison towards promoting transportation engineering and improving railway safety.

In the field of curriculum and instruction, the UTCRS has brought STEM pedagogical research opportunities to the College of Education and P-16 Integration at UTRGV. These opportunities have resulted in the establishment of a research group within the College of Education that is investigating how to improve retention of underrepresented groups in the Rio Grande Valley in STEM fields and careers. The findings from the 2014 and 2015 UTCRS Summer Camps were presented at the National Association for Research in Science Teaching (NARST) and have resulted in two manuscript submissions to the Journal of STEM Education. In addition, the 2016 UTCRS Summer Camps provided the opportunity for **11** undergraduate students (10 female and 1 male) sponsored by the UTeach program at UTRGV to conduct educational studies related to the statistics and surveys collected from the **1300** camp participants. These students are continuing the work they started in the summer during the Fall 2016 semester. One of the main objectives of the aforementioned studies is to analyze student participant perceptions on the various aspects of instruction, including developing an engaging curriculum and teaching tools for K-12 students.

The workforce development efforts of the Center are led by a dedicated group of faculty comprised of members from the department of curriculum and instruction (College of Education) in collaboration with the various engineering programs involved in the Center (mechanical, civil, electrical, manufacturing, computer, and computer science). Through this collaboration, a number of hands-on STEM Workshops for educators have been offered to develop the skill-sets required to teach transportation engineering concepts in their classroom and to expose educators to use appropriate pedagogy to engage students and expose them to all areas of the STEM fields. Teachers unable to attend the STEM Workshops can now benefit by borrowing the developed UTCRS STEM Curricula and available toolkits, which comprise complete lesson plans based on national and state science standards.

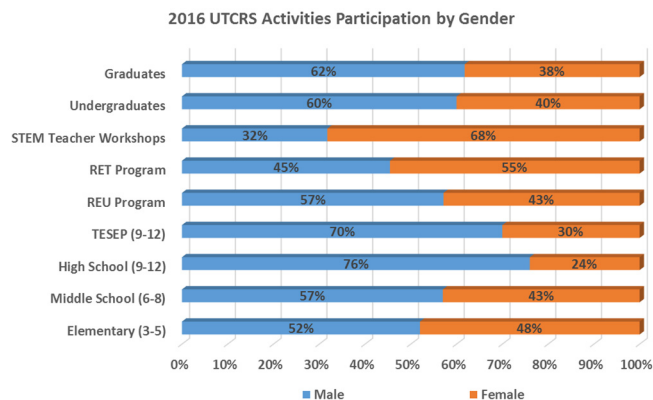
The UTCRS continued its partnership with The Higher Education Coordinating Board (THECB) to extend STEM camp opportunities to high school students who do not qualify for TexPREP. For the third consecutive year, the UTCRS offered the Transportation Engineering Summer Enrichment Program (TESEP) that was funded by the THECB. TESEP exposed high school students interested in engineering careers to transportation engineering concepts emphasizing railway safety. As a transportation center committed to addressing the overwhelming interest in STEM camps, the UTCRS has been successful in closing this gap as evident by the significant increase in the number of K-12 students served from **700** in 2014, to **1000** in 2015, to **1300** in 2016. The UTCRS camps are now part of the RGV community.

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

The UTCRS had a number of major contributions to workforce development this reporting period. The training of a critical mass of K-12 STEM teachers (**130** teachers) and providing them with learning modules and teaching tools that will aid in raising awareness of transportation engineering fields and railway safety among K-12 students. Additionally, the UTCRS continued its mission to develop the graduate and undergraduate student talent working on the various research projects on transportation engineering issues pertaining to railway safety in terms of mechanical, infrastructure, and operations research. Through their involvement in these research projects, students are acquiring advanced engineering and technical skills in materials development, manufacturing, design and fabrication of mechanical systems, structural design, operations management, and instrumentation and controls.

Furthermore, the students receive highly specialized cross-training from a diverse group of faculty that are involved in the UTCRS. The UTCRS research, education, and professional workforce development programs have impacted a wide range of stakeholders, as seen in the table and chart below. A point of great pride for the UTCRS is the significantly high percentage of females, typically underrepresented in transportation engineering fields, that have been engaged in the various UTCRS activities.

|                        | Total No. Served |
|------------------------|------------------|
| Graduates              | 34               |
| Undergraduates         | 70               |
| STEM Teacher Workshops | 130              |
| RET Program            | 11               |
| REU Program            | 14               |
| TESEP (9-12)           | 26               |
| High School (9-12)     | 198              |
| Middle School (6-8)    | 525              |
| Elementary (3-5)       | 577              |



One great success story that highlights the UTCRS workforce development efforts is that Ms. Esmeralda Infante. Ms. Infante was one of the participants of the Inaugural 2014 UTCRS High School STEM Summer Camp. The camp peaked her interest in science and engineering and she promised back in 2014 to return to the UTCRS and be a part of the research team. In two short years, not only did Esmeralda keep her promise, but she also managed to win 1<sup>st</sup> place prize for her research work entitled "Demonstrating and Studying the Emissivity Difference Over a Single Bearing and Population of Bearings." Ms. Infante was mentored by a group of UTCRS students and faculty. This accomplishment is just the beginning in her very promising and bright future in engineering and the transportation field. Ms. Infante has applied for admission to UTRGV starting spring 2017. She has expressed interest in being a part of the UTCRS-UTRGV research team, participating in the REU program, and pursuing her graduate studies.

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

Since the UTCRS operates across multiple departments and colleges, the faculty involved in the various UTCRS activities have been very accommodating and open to sharing of resources to ensure that projects are completed efficiently and effectively. The cross-training of students in the engineering and computer science fields working alongside the curriculum and instruction students has been beneficial to these students and the workforce development efforts of the center. UTRGV is striving to become a Tier 1 Research Institution. The advanced research conducted by the UTCRS is generating high-caliber publications that are being presented at national and international conferences are in line with the overall institutional research goals. Furthermore, the effective collaboration among the consortium institutions is providing students superior research opportunities since they have access to the resources available at the three institutions.

The community outreach activities of the UTCRS have strengthened the institutional collaborations between UTRGV and the local Rio Grande Valley School Districts. More than **26** school districts have signed interlocal agreements with UTRGV, which financially supported the 2016 UTCRS Summer Camps and STEM Teacher Workshops that benefited **1300** K-12 students and **130** teachers. This mutually beneficial relationship provides resources for school districts and K-12 STEM teachers and, in return, UTRGV and UTCRS meet their educational goals of encouraging students to learn and consider careers in

STEM, transportation, and railway safety fields. Moreover, the UTCRS work has resulted in plans to start some High School research mentoring programs at UTRGV that are funded by the school districts.

The UTCRS REU Program has generated tremendous benefits to all three consortium institutions. The UTRGV College of Engineering and Computer Science does not have doctoral graduate programs, or Master's Programs in Civil or Computer Engineering. Hence, the REU Program has established pathways for undergraduate and graduate students from UTRGV to enroll in doctoral granting graduate programs at TAMU and UNL. To date, the UTCRS REU Program has been responsible for **twelve** undergraduate students joining graduate programs at all three UTCRS consortium institutions.

### **What is the impact on technology transfer?**

The UTCRS impact on technology transfer for this reporting period is measured by the following:

- 10 conference papers, 8 professional presentations, 2 doctoral dissertations, and 8 theses.
- Development of a novel fisheye camera-based object detection algorithm to be used to detect moving objects in railyard environments and to gauge their distance. This product will enable researchers to track potential threats to railyard workers in real-time.
- A new, efficient, and compact design of a Four Bearing Tester for use in service life testing of bearings.
- Transportation-related STEM curricula and learning modules for use by K-12 teachers and educators.

### **What is the impact on society beyond science and technology?**

The UTCRS has had a noticeable impact on society through the various research, education, workforce development, technology transfer, and outreach activities. The UTCRS programs address the needs of a population that is considered one of the poorest in the nation, where 50% earn incomes that are significantly below the national average. About 70% of the student population at UTRGV are the first in their families to attend college, and the majority of these students qualify for financial aid. The Rio Grande Valley (RGV) has more than 300,000 K-12 students that have limited resources and opportunities to engage in STEM programs. The UTCRS Programs have provided many K-12 students, undergraduates, graduates, and educators with great opportunities for professional development and career growth. The significant increase in the number of participants in all UTCRS led programs during this reporting period is a clear indicator that the UTCRS is offering the necessary teaching tools, experiences, trainings, and research programs that meet the needs of its stakeholders.

Finally, during this reporting period, an estimated 5,000 community members have been made aware of the work and importance of the USDOT and the transportation fields in their society. The UTCRS has highlighted the initiatives and goals of the USDOT UTC Program, and the need to keep developing the talent that will feed into the various transportation fields, especially among underrepresented groups. The UTCRS faculty and students strongly believe that the work performed by the center should aim to improve the lives of people in our society, and provide proactive solutions to address issues that trouble the rail industry in hopes of preparing this industry to meet the challenges highlighted in "Beyond Traffic 2045". A list of some of the UTCRS community outreach activities along with links to photo galleries can be accessed here: <http://www.utrgv.edu/railwaysafety/education/community/index.htm>

### **5. CHANGES/PROBLEMS:**

Nothing to report.

### **6. SPECIAL REPORTING REQUIREMENTS:**

Nothing to report.