



Program Progress Performance Report for University Transportation Centers

- **Federal Agency and Organization Element to which Report is Submitted:**
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- **Project Title:** University Transportation Center for Railway Safety (UTCRS)
- **Project Director (PD) Name, Title, and Contact Information:**
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The University of Texas-Pan American (UTPA)
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- **Signature of Submitting Official**

Constantine Tarawneh

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

Research Activities	Status	% Complete
Call for 2015-2016 Problem Statements	Complete	100%
Request for 2015-2016 Proposals	On Schedule	33%
2015-2016 Proposals Reviewed by Executive Committee	On Schedule	33%
Review Budgets of 2015-2016 Proposals	On Schedule	33%
Final 2015-2016 Proposal Ranking & Selection	On Schedule	33%
2015-2016 Research Projects under Contract	On Schedule	33%
Technology Transfer Tech Briefs, Webinars, & Presentations on Research Results	On Schedule	33%
Applicable Slides, Handouts, Videos, Podcasts, etc. Posted	On Schedule	33%
Website	Complete	100%
Final Reports Due & All Research Projects Complete	Forthcoming	20%
Leadership Activities		
Coordination with UTCRS Directors and Executive Committee	Complete	100%
Establishment of a UTCRS Advisory Board	Complete	100%
Educational & Outreach Activities		
UTCRS 2015 Summer Camps for K-12	Forthcoming	0%
UTCRS 2015 Research Experience for Undergraduates (REU) Program	Forthcoming	0%
UTCRS 2015 Research Experience for Teachers (RET) Program	Forthcoming	0%
Call for UTCRS 2015 Research Experience for Undergraduates (REU) Program	Complete	100%
Call for UTCRS 2015 Research Experience for Teachers (RET) Program	Complete	100%
Review and Selection of the Students to Participate in the 2015 REU Program	Complete	100%
Review and Selection of the Teachers to Participate in the 2015 RET Program	Complete	100%
UTCRS 2015 REU Program Informational Session and Workshop	Complete	100%

UTCRS 2015 RET Program Informational Session, Workshop, and Trainings	Forthcoming	0%
Develop Promotional Material and Application Packets for 2015 Summer Camps	Complete	100%
Disseminate Summer Camp Packets via Email and Website to Local School Districts	Complete	100%
Processing Applications for the 2015 UTCRS Summer Camps	On Schedule	25%
Technology Transfer Activities		
UTCRS Supported Presentations, Specialty Conferences, Workshops, Publications in Related National Conferences, and Short Courses	On Schedule	30%
UTCRS Website Information Dissemination	On Schedule	40%
UTCRS Social Media Sites Information Dissemination	On Schedule	25%
US DOT OST-R: Reporting		
Posting Directory of Key Center Personnel and UTCRS Advisory Board	Complete	100%
Posting 2015-2016 Research Project Descriptions	On Schedule	33%
UTC Program Progress Performance Reports (Semi-Annually)	On Schedule	33%
Federal Financial Reports (Quarterly)	On Schedule	33%
Annual Performance Indicators Report (Annually)	On Schedule	25%

What was accomplished under these goals?

The development and implementation of the various UTCRS activities continued at a consistent pace throughout the past six months, with all activities either on schedule toward full implementation and successful conclusion or have already completed. Five of the fourteen projects that were funded through the initial call for proposals (2014CY Projects) were completed on December 31st, 2014. Under Research Activities, the following table summarizes the progress to date toward products and impacts for each of the research projects that were approved during the UTCRS' first funding cycle (2014CY Projects):

RESEARCH AREAS Addressed in Prospectus:
<p>1. Structural Integrity of Railroad Bearing Adapters with Modifications for Onboard Monitoring Applications. The performed research produced experimentally validated Finite Element Analysis (FEA) stress results, and explored the fatigue life of conventional and modified adapters under different extreme case loading scenarios for the bearing adapters, which included the effect of a railroad wheel flat. The finite element analysis and experimental results revealed that conventional and modified adapters would have an infinite life at all studied loading conditions. The worst case scenario studied for the adapters was the case when it is subjected to periodic dynamic loading such as a wheel impact load which translates into an equivalent static load of 90,000 lb on the bearing adapter. A final report has been indexed by TRB and posted on the UTCRS Web Site at http://portal.utpa.edu/railwaysafety/research/mechanical/projects/2014/adapter-structural-fea</p>
<p>2. Single Bearing Test Rig with Vertical, Lateral, and Impact Load Capabilities. The test rig, for use by UTCRS projects, has been fully instrumented and is 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 http://portal.utpa.edu/railwaysafety/research/mechanical/projects/2014/single-bearing-tester</p>



Figure 1: Completed single railroad bearing tester

3. Effects of Vapor Grown Carbon Nanofibers on Electrical and Mechanical Properties of a Thermoplastic Elastomer. A nanofiber formulation which provides the desired conductivity has been developed, with the resulting materials extensively characterized for mechanical, electrical, and thermal performance and deemed suitable for field trials. A railroad industry has expressed interest in prototyping and field testing a product using the developed system. A final report has been indexed by TRB and posted on the UTCRS Web Site at <http://portal.utpa.edu/railwaysafety/research/mechanical/projects/2014/conductive-pad>

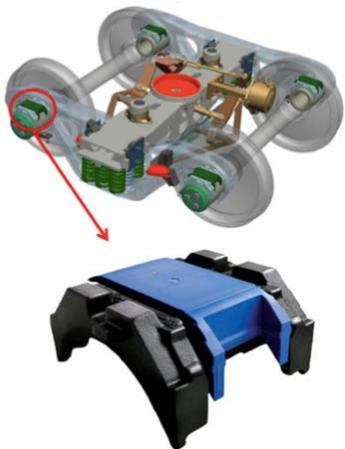


Figure 2: Elastomeric Steering Pad
(Picture courtesy of Amsted Rail)



Figure 3: Test Puck of Compounded TPU

4. Modeling the Residual Useful Life of Bearing Grease. A mathematical model that predicts the residual life of bearing grease has been developed. The following findings were established: (a) the mileage had the most significant impact upon the life of the bearing grease and the relationship was negative, (b) the bearing temperature had the second largest impact upon bearing grease and the correlation between temperature and the Oxidation Induction Time (OIT) was negative, and (c) OIT values were higher, indicating larger remaining life, for the grease samples at the spacer ring location than grease sampled at the inner and outer bearing raceways. A final report has been indexed by TRB and posted on the UTCRS Web Site at <http://portal.utpa.edu/railwaysafety/research/mechanical/projects/2014/lubrication-study>

5. Applications of Magnetostrictive Materials for Real-Time Monitoring of Vehicle Suspension Components. The use of a Terfenol-D core as both a static load sensor and an energy harvesting device has been successfully demonstrated and is ready for implementation in an engineering application. A pilot study of energy harvesting was completed using cyclic loading comparable to that found in typical railroad bearing pads. The study concluded that the power generated from the Terfenol-D core is sufficient to run several low-power electronics and sensors that can be used for onboard bearing health monitoring devices. A final report has been indexed by TRB and posted on the UTCRS Web Site at http://portal.utpa.edu/railwaysafety/research/mechanical/projects/2014/sensor-technologies
6. Development of Corridor-based Traffic Signal Preemption Strategies at Signalized Intersections near Highway Railway Grade Crossings. All phases of this project are progressing on schedule.
7. Drivers' Perceptions of Highway-Rail Grade Crossing Safety and Their Behavior. All phases of this project are progressing on schedule.
8. Safety Modeling of Highway Railway Grade Crossings using Intelligent Transportation System Data. All phases of this project are progressing on schedule.
9. Improving Safety at Rural Highway-Rail Grade Crossings by Utilizing Light Detection and Ranging (LiDAR) Technology. All phases of this project are progressing on schedule.
10. Rail Neutral Temperature In-Situ Evaluation. All phases of this project are progressing on schedule.
11. Ultrasonic Tomography for Infrastructure Inspection. All phases of this project are progressing on schedule.
12. High Speed Train Geotechnics. All phases of this project are progressing on schedule.
13. Optimizing Performance of Railroad Rail through Artificial Wear. All phases of this project are progressing on schedule.
14. Vehicle-Bourne Autonomous Railroad Bridge Impairment Detection Systems. All phases of this project are progressing on schedule.

A second call for proposals was announced in August of 2014 for 2015CY Projects. The research topics were reviewed and approved by the UTCRS advisory board. To facilitate the project review and selection process, the UTCRS Leadership team decided to have the proposal review for each of the three consortium institutions to be conducted consecutively starting with the projects at UTPA which has already concluded its projects from the 2014CY. TAMU will select its projects next followed by UNL. In each case, four reviewers were involved in the proposal review process. The reviewers were selected based on their expertise and relevance to the railway safety research area. The UTCRS Leadership team met to discuss the reviews and comments that were received, and based their final project selection decision largely on these reviews. A list of the 2015CY Projects selected thus far is provided hereafter.

RESEARCH AREAS Addressed in UTCRS 2nd Call for Proposal (2015CY Projects):
15. The Effect of Heat Generation in the Railroad Bearing Thermoplastic Elastomer Suspension Element on the Thermal Behavior of Railroad Bearing Assembly. Project started in January of 2015 and all phases of this project are progressing on schedule.
16. Demonstration of Magnetostrictive Materials for Self-Powered Monitoring of Rail Vehicle Suspension Components. Project started in January of 2015 and all phases of this project are progressing on schedule.
17. Radiative Heat Transfer Analysis of Railroad Bearings Using a Single Bearing Test Rig for Wayside Thermal Detector Optimization. Project started in January of 2015 and all phases of this project are progressing on schedule.

18. Development of Predictive Models for Spall Growth in Railroad Bearing Rolling Elements. Project started in January of 2015 and all phases of this project are progressing on schedule.

The UTCRS engaged and financially supported a total of 51 undergraduate and graduate students involved in its various research and educational activities, as summarized below.

Student Classification	Number	Male	Female
Undergraduate Research Assistants	28	17	11
Masters' Research Assistants	14	8	6
Doctoral Research Assistants	9	4	5
Totals	51	29	22

Education, workforce development, and outreach efforts featured the successful recruitment and selection of participants for the 2015 Research Experience for Undergraduates (REU) Program and the 2015 Research Experience for Teachers (RET) Program, and coordinating with the 26 different school districts in the lower Rio Grande Valley for the upcoming 2015 UTCRS Summer Camps which will host 925 elementary, middle, and high school students. Following is a summary of the educational, workforce development, and outreach activities carried out over the October 1, 2014 to March 31, 2015 reporting period.

EDUCATION, WORKFORCE DEVELOPMENT & OUTREACH ACTIVITIES (for period October 1, 2014 – March 31, 2015): Outreach and Educational Activities Aimed at Increasing Awareness of Transportation Engineering and Railway Safety

Following the successful implementation of the 2014 UTCRS Summer Camps in which 700 students (300 elementary, 300 middle, and 100 high school) participated in the largest STEM camp ever held at UTPA, it is anticipated that the 2015 UTCRS Summer Camps will be host to approximately 1000 students (450 elementary, 425 middle, and 125 high school).

The 2015 UTCRS Summer Camps are being organized in collaboration with the school districts in the lower Rio Grande Valley which are contributing both financially and by sending volunteer teachers that will be trained to assist the UTCRS staff in running the camps. These teachers will gain valuable knowledge and hands-on experience in delivering the designed teaching modules to students in the classroom.

In all, the 2015 UTCRS Summer Camps are expected to engage 1000 students and 85 STEM teachers in its various educational and work force development activities.

The University Transportation Center for Railway Safety will be hosting a summer camp where kids can learn SCIENCE & ENGINEERING concepts of railway safety in an exciting interactive way!

Join the fun for FREE!

You choose (one) of the weekly sessions!

- Week 1: JUNE 8-12, 2015
- Week 2: JUNE 15-19, 2015
- Week 3: JUNE 22-26, 2015
- Week 4: JUNE 29-JULY 3, 2015
- Week 5: JULY 6-10, 2015

APPLICATIONS NOW AVAILABLE!
THROUGH THE SCHOOL DISTRICTS

3-5
Magnetic Levitation

6-8
NXT 2.0 Mindstorm

9-12
TXPREP

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Following the successful implementation of the 2014 Research Experience for Undergraduates (REU) Program, where **eight** UTPA undergraduate engineering students worked alongside faculty and students from the two other consortium institutions (TAMU and UNL) on transportation engineering and railway safety related research projects, the 2015 REU Program will feature **twelve** student participants (pictured here) who were selected from **21** highly competitive applications that were received this year. Link: <http://portal.utpa.edu/railwaysafety>



Following the successful implementation of the 2014 Research Experience for Teachers (RET) Program, where **five** secondary-level STEM teachers were provided with educational tools and modules designed to introduce STEM concepts using transportation engineering applications, the 2015 RET Program will feature **eight** STEM teacher participants who were selected from **33** highly competitive applications that were received this year. Several other STEM teachers have also volunteered to be a part of the 2015 UTCRS Summer Camps to gain hands-on experience with the designed teaching modules as part of their professional development.



One of the main objectives of the Research Experience for Teachers (RET) Program is to provide secondary-level STEM teachers with carefully designed teaching modules that they can use to deliver STEM concepts to students in their classroom using transportation engineering applications focused on railway safety. These STEM teachers gain valuable hands-on experience and knowledge from running the UTCRS Summer Camps so that they can bring this knowledge back to their own classrooms. One such example is the work of Mr. Andres Benitez (one of the 2014 UTCRS RET Program participants) who brought the designed modules he learned during his involvement with the 2014 UTCRS Summer Camps back to his own classroom in his school. The pictures to the right document the implementation of one of the teaching modules (Mag-Lev trains) in one of his science class lessons. Two other RET participants have followed suit and have implemented the Lego Mindstorm modules in their STEM classes.



The UTCRS had its first **Student of the Year** honoree since the center’s inception in Fall of 2013. Mr. Raul Estrada, picture to the right between UTCRS Director Constantine Tarawneh and Assistant Secretary Gregory Winfree, was selected as the **Student of the Year** representing the Center for Railway Safety. Mr. Estrada completed his Master’s degree in December of 2014. His thesis study entitled “Applications of Magnetostrictive Materials in the Real-Time Monitoring of Vehicle Suspension Components” was funded by the UTCRS through one of the 2014CY Projects. Moreover, Mr. Estrada co-authored with his two thesis advisors a paper that was presented in the 2015 ASME Joint Rail Conference in San Jose, CA.



One graduate and one undergraduate student were selected to receive the WTS-SAR 2014-2015 scholarship, which is a national scholarship given to women conducting advanced research related to transportation.



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

During this reporting period, both graduate and undergraduate students had the opportunity to develop and enhance their oral and written presentation skills in several occasions by presenting their research in national railroad conferences, and to K-12 students, high profile visitors, university community, community engagement events, departmental seminars, REU Program, and to their faculty mentors and research supervisors. The presentations served several purposes such as engaging pre-college students to become interested in engineering careers while exposing them to railway research and other transportation fields, encouraging undergraduate students to pursue their graduate studies, building the confidence of graduate students by having them present their research in front of railroad industry professionals and railroad researchers from other institutions, and creating a supportive environment in which all students can succeed and reach their fullest potential.

Graduate students’ leadership role encompassed serving as mentors to undergraduates and assisting the principal investigators (PIs) with oversight of the research projects. Such activities facilitate establishing mentoring programs to ensure that UTCRS undergraduate and graduate students have the necessary support system to succeed by acquiring the skills, knowledge, and work habits that are essential to thrive in a multidisciplinary research and educational setting.

Undergraduate and graduate students engaged in the various research projects have been able to develop both technical skills (such as material compounding, testing, thermal and dynamic analysis, machining, instrumentation and data acquisition, coding and programming, troubleshooting, and problem solving) and project management skills (such as leadership, organizational, planning, design, and presentation).

Other opportunities for professional development have centered around the 2014 RET participants who were actively working on ways to incorporate and implement what they learned over the UTCRS Summer Camps period into their STEM lesson plans. These secondary-level teachers were in constant communication with faculty and staff at the UTCRS while planning the implementation of the acquired teaching modules in their science and math classes. The teachers documented the implementation of the modules at their schools and have adopted these transportation engineering based teaching modules in their curriculum. The UTCRS makes available to these teachers and their colleagues the Mag-Lev and Lego Mindstorm educational kits to use with the designed teaching modules.

How have the results been disseminated?

UTCRS Research teams, staff, and students meet frequently and no less than once a week in order to ensure that all UTCRS activities are on schedule. The executive committee meets weekly via a Skype conference call to ensure that the consortium institutions are on track with all planned activities. As reported below, several projects have yielded co-authored journal papers and conference publications which have been presented at major international railroad conferences. The work of the UTCRS is also being effectively disseminated via its website, as illustrated by an October 30, 2014 e-mail request from Timken, a major railroad bearing manufacturer and supplier, about using the single railroad bearing test rig, which is built through a UTCRS research project, for critical testing they wish to perform.

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

- Implementation of the activities outlined in the previous tables for all research, education, workforce development, and technology transfer projects will proceed on-schedule.
- The 2015CY call for proposals has yielded four new funded projects at UTPA. Eight more new research projects are anticipated from this call of proposals for TAMU and UNL.
- Website will be updated accordingly for each of the research projects. Furthermore, the UTCRS will remain vigilant of timeline progress of each research project by requesting progress reports to be turned in on schedule to ensure the timely submission of the final project reports. These reports will also be uploaded to the TRB website and posted on the UTCRS website. So far, the final reports for five projects have already been posted to the UTCRS website and indexed by TRB.
- Continue conference calls with consortium Associate Directors and Executive Committee.
- Continue bi-weekly research meetings with PIs, Co-PIs, student research assistant, UTCRS staff, and administrative staff in order to address research needs (*i.e.* place purchase orders, and coordinate with relevant university departments and services to ensure the timely completion of research projects, final reports, and students' theses and dissertations).
- Continue faculty seminars to UTCRS research teams and staff.

- Continue weekly meetings with research faculty, staff, and students in charge of the summer educational and outreach activities to ensure very successful implementation of the 2015 UTCRS Summer Camps, REU and RET programs.
- Faculty researchers will continue to reach out to railroad industry partners to address their research and workforce development needs.

2. PRODUCTS

Publications, conference papers, and presentations:

Ongoing work on UTCRS sponsored projects has resulted in several paper publications and presentations in relevant journals and national and international conferences, as follows:

1. Rilett, L. and **Chen, Y.**, "A Train Speed Measurement and Arrival Time Prediction System for Highway-Rail Grade Crossings," *21st World Congress on Intelligent Transportation Systems*, Detroit, MI, September 8, 2014.
2. Timmer, D., **Martinez, T.**, Jones, R., and Tarawneh, C., "Modeling the Useful Life of Railroad Bearing Grease," *2014 Informs Conference*, San Francisco, CA, November 9-12, 2014.
3. **Montalvo, J.**, **Trevino, A.**, Fuentes, A.A., and Tarawneh, C., "Structural Integrity of Conventional and Modified Railroad Bearing Adapters for Onboard Monitoring," *Proceedings of the ASME 2014 International Mechanical Engineering Congress & Exposition, IMECE2014*, Montreal, Canada, November 14-20, 2014.
4. Khattak, A.J., "Investigation of Train Warning Times and Gate Violations," *Transportation Research Record 2458, Journal of the Transportation Research Board*, December 2014.
5. **Tung, L.W.** and Khattak, A.J., "Distracted Motor Vehicle Driving at Highway-Rail Grade Crossings," Paper recommended for publication in the *Transportation Research Records, Journal of the Transportation Research Board*, paper no. 15-4692, January 2015.
6. **Trevino, A.**, Fuentes, A.A., Tarawneh, C., and **Montalvo, J.**, "FEA Fatigue Life Estimation of Modified Railroad Bearing Adapters for Onboard Monitoring Applications," *Proceedings of the ASME 2015 Joint Rail Conference*, San Jose, CA, March 23-26, 2015.
7. **Estrada, R.**, Foltz, H., Tarawneh, C., and **Moreno, R.**, "Energy Harvesting Potential of Terfenol-D for On-Board Bearing Health Monitoring Applications," *Proceedings of the ASME 2015 Joint Rail Conference*, Paper Number JRC2015-5756, San Jose, CA, March 23-26, 2015.
8. **Martinez, T.**, Timmer, D., Jones, R., and Tarawneh, C., "Developing Empirical Models of Railroad Bearing Grease," *Proceedings of the ASME 2015 Joint Rail Conference*, San Jose, CA, March 23-26, 2015.

Moreover, in a span of 15 months, two graduate students that were working on UTCRS funded projects completed their work and successfully defended their theses on December of 2014, and are listed hereafter:

1. "Applications of Magnetostrictive Materials in the Real-Time Monitoring of Vehicle Suspension Components" by Raul Estrada, December 2014.

2. “Effects of Vapor Grown Carbon Nanofibers on Electrical and Mechanical Properties of a Thermoplastic Elastomer” by Daniel Basaldua, December 2014.

An additional area of dissemination is related to the educational research conducted over the summer based on the impact of the UTCRS summer camps on student achievement and student interest in science, technology, engineering, and math (STEM) fields. As a result, an abstract and a poster were presented at the Eighth UTC Spotlight Conference held on December 11-12, 2014 in Washington, DC (The poster can be downloaded at <http://portal.utpa.edu/railwaysafety/files/2014-summer-camps-poster.pdf>). In addition, two proposals were submitted to the Society for Information Technology and Teacher Education (SITE), and were presented in March 2015. Furthermore, the UTCRS faculty and staff were invited to participate in a STEM learning symposium at the National Association for Research in Science Teaching (NARST) which was held in April of 2015. The findings from these presentations will be developed into longer more in-depth manuscripts to be submitted to journals in Technology and Teacher Education as well as Technology and Math and Science Education.

Website or other Internet Material:

Since its inception, the UTCRS website has continued to be a great resource for anyone interested in the various research, education, workforce development, technology transfer, and community engagement activities. The website receives a lot of traffic during peak periods, such as the months leading up to and during the UTCRS Summer Camps, Research Experience for Undergraduates (REU) Program, and Research Experience for Teachers (RET) Program. Statistics over the past six months follow:

October 1, 2014 – March 31, 2015: 4,997 pageviews, ranging from 1,880 in March, to 599 in October; average time per page of 1 minute and 30 seconds.

The UTCRS website features a picture slider that showcases the most recent activities of the center: <http://railwaysafety.utpa.edu/>

The website also features an announcement for the 2015 UTCRS Summer Camps that will be held in coordination with the school districts in the lower Rio Grande Valley. A link to the flyer that has been disseminated to 26 school districts and over 130 schools is provided hereafter: <http://portal.utpa.edu/portal/page/portal/railwaysafety/files/utcrs-summer-camp-2015-flyer.pdf>

The UTCRS was featured in the December 2014 issue of the USDOT UTC Spotlight Newsletter. The newsletter highlighted the educational, workforce development, and outreach activities of the center over the summer of 2014. A link to the newsletter is provided hereafter: http://www.rita.dot.gov/utc/sites/rita.dot.gov.utc/files/utc_spotlights/pdf/spotlight_1214.pdf

Links to the REU and RET Programs, and the 2015 UTCRS Summer Camp are provided hereafter:
REU Program: <http://portal.utpa.edu/railwaysafety/education/internships/reu>
RET Program: <http://portal.utpa.edu/railwaysafety/education/internships/ret>
UTCRS Summer Camp: <http://portal.utpa.edu/railwaysafety/education/outreach/summercamp>

The UTCRS website is updated regularly to incorporate any news, events, or other ongoing center activities and outreach programs. Currently, the UTCRS staff are working on

incorporating photo galleries and videos of the various educational, research, workforce development, technology transfer, and outreach activities into the website.

Technologies or techniques:

Five of the fourteen initial 2014CY projects that were funded by the UTCRS in the inaugural call for proposals completed in December of 2014. These five projects have yielded the following products, technologies, or techniques:

- [1] The Single Bearing Tester, depicted in Figure 4, provides unique testing capabilities in which vertical, lateral, and impact loading can be applied simultaneously. This tester makes it possible to characterize the performance of railroad tapered-roller bearings in environments that closely mimic those of field service operation. This tester is vital for characterizing railroad bearing performance under realistic operating conditions. There are currently no other test rig designs that can duplicate this tester's functionality. The test rig is now fully instrumented and operational, and is currently being used by other UTCRS funded projects to acquire data for product validation and theoretical results verification.
- [2] A nanofiber formulation which provides the desired electrical conductivity for railroad bearing adapter elastomer steering pads.
- [3] A mathematical model that utilizes Oxidation Induction Time (OIT) to predict the residual life of bearing grease.
- [4] A Terfenol-D core energy harvesting device capable of running low-power sensor electronics to be used in onboard bearing condition monitoring devices.
- [5] A finite element (FE) model that can be used to study the structural integrity of railroad bearing adapters, which have been modified for onboard monitoring applications, under different loading scenarios that can occur in field service operation.



Figure 4: Picture of the Single Bearing Tester with Vertical, Lateral, and Impact Load Capabilities

All other current research and workforce development activities are progressing on-schedule.

Inventions, patent applications, and/or licenses:

There is nothing to report at this time.

Other products:

As the projects conclude, a summary of the pertinent results and findings will be uploaded to the TRB website and posted on the UTCRS web site. Links to all the completed/ongoing research projects sponsored by the UTCRS are listed by university hereafter.

University Name	Project Title	Lead PI	Project Status	Project Link
UTPA	Structural Integrity of Railroad Bearing Adapters with Modifications for Onboard Monitoring Applications	Arturo Fuentes	Completed	http://portal.utpa.edu/railway-safety/research/mechanical/projects/2014/adapter-structural-fea
UTPA	Conductive Elastomers for Steering Pads	Robert Jones	Completed	http://portal.utpa.edu/railway-safety/research/mechanical/projects/2014/conductive-pad
UTPA	Modeling the Residual Useful Life of Bearing Grease	Doug Timmer	Completed	http://portal.utpa.edu/railway-safety/research/mechanical/projects/2014/lubrication-study
UTPA	Applications of Magnetostrictive Materials for Real-Time Monitoring of Vehicle Suspension Components	Heinrich Foltz	Completed	http://portal.utpa.edu/railway-safety/research/mechanical/projects/2014/sensor-technologies
UTPA	Single Bearing Test Rig with Vertical, Lateral, and Impact Load Capabilities	Stephen Crown	Completed	http://portal.utpa.edu/railway-safety/research/mechanical/projects/2014/single-bearing-tester
UTPA	The Effect of Heat Generation in the Railroad Bearing Thermoplastic Elastomer Suspension Element on the Thermal Behavior of Railroad Bearing Assembly	Arturo Fuentes	Ongoing	http://portal.utpa.edu/railway-safety/research/mechanical/projects/2015/pad-heat-generation
UTPA	Development of Predictive Models for Spall Growth in Railroad Bearing Rolling Elements	Robert Jones	Ongoing	http://portal.utpa.edu/railway-safety/research/mechanical/projects/2015/spall-growth-models
UTPA	Radiative Heat Transfer Analysis of Railroad Bearings Using a Single Bearing Test Rig for Wayside Thermal Detector Optimization	Stephen Crown	Ongoing	http://portal.utpa.edu/railway-safety/research/mechanical/projects/2015/wayside-thermal-detector-analysis
UTPA	Demonstration of Magnetostrictive Materials for Self-Powered Monitoring of Rail Vehicle Suspension Components	Heinrich Foltz	Ongoing	http://portal.utpa.edu/railway-safety/research/mechanical/projects/2015/power-generation-applications

TAMU	Rail Neutral Temperature In-Situ Evaluation	Stefan Hurlebaus	Ongoing	http://portal.utpa.edu/railway-safety/research/infrastructure/projects/2014/rail-neutral-temp-eval
TAMU	Ultrasonic Tomography for Infrastructure Inspection	Stefan Hurlebaus	Ongoing	http://portal.utpa.edu/railway-safety/research/infrastructure/projects/2014/ultrasonic-tomography
TAMU	High Speed Train Geotechnics	Jean-Louis Briaud	Ongoing	http://portal.utpa.edu/railway-safety/research/infrastructure/projects/2014/high-speed-train-geotechnics
TAMU	Optimizing Performance of Railroad Rail through Artificial Wear	Gary Fry	Ongoing	http://portal.utpa.edu/railway-safety/research/infrastructure/projects/2014/optimizing-rail-thru-artificial-wear
TAMU	Vehicle-Bourne Autonomous Railroad Bridge Impairment Detection Systems	Gary Fry	Ongoing	http://portal.utpa.edu/railway-safety/research/infrastructure/projects/2014/vehicle-bourne-bridge-impairment-detection
UNL	Development of Corridor-Based Traffic Signal Preemption Strategies at Signalized Intersections near Highway Railway Grade Crossings	Laurence Rilett	Ongoing	http://portal.utpa.edu/railway-safety/research/operations/projects/2014/corridor-based-traffic-signal-strategies
UNL	Drivers' Perceptions of Highway-Rail Grade Crossing Safety and Their Behavior	Aemal Khattak	Ongoing	http://portal.utpa.edu/railway-safety/research/operations/projects/2014/drivers-perceptions-hgrcs
UNL	Safety Modeling of Highway Railway Grade Crossings Using Intelligent Transportation System Data	Laurence Rilett	Ongoing	http://portal.utpa.edu/railway-safety/research/operations/projects/2014/safety-modeling-hgrcs
UNL	Improving Safety at Rural Highway-Rail Grade Crossings by Utilizing Light Detection and Ranging (LiDAR) Technology	Aemal Khattak	Ongoing	http://portal.utpa.edu/railway-safety/research/operations/projects/2014/safety-rural-hgrcs

(UTPA – The University of Texas-Pan American; TAMU – Texas A&M University; UNL – University of Nebraska-Lincoln)

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 educational, research, workforce development, technology transfer, and outreach activities of UTCRS.

NAME	ORGANIZATION NAME	RELATION	GENDER
Tarawneh, Constantine, Ph.D., Bentsen Fellow	UTCRS – Director Professor, Mechanical Engineering University of Texas-Pan American 1201 West University Drive Edinburg, TX 78539	Researcher / Executive Committee	Male
Fry, Gary, Ph.D., P.E.	UTCRS – Associate Director TAMU Assoc. Professor, Civil Engineering Texas A&M University 3135 TAMU College Station, Texas 77843-3135	Researcher / Executive Committee	Male
Rilett, Laurence, Ph.D., P.E.	UTCRS – Associate Director UNL Professor, Civil Engineering University of Nebraska-Lincoln 262D Whittier Research Center P.O. Box 830851, Lincoln, NE 68583-0851	Researcher / Executive Committee	Male
Freeman, Robert, Ph.D.	UTCRS – Associate Director UTPA Professor and Chair, Mechanical Engineering	Executive Committee	Male
Lawrence-Fowler, Wendy, Ph.D.	UTCRS – Diversity Coordinator UTPA Professor, Computer Science	Executive Committee	Female
Chapman, Angela, Ph.D.	UTCRS – Education Coordinator UTPA Assistant Professor, Curriculum & Inst.	Researcher / Executive Committee	Female
Flores, Julissa	UTCRS – Interim Sr. Prog. Coordinator UTPA	Staff	Female
Pena, Melissa Iliana	UTCRS – Office Assistant III UTPA	Staff	Female
White, Amy	Program Coordinator TAMU Center for Railway Research Texas A&M Transportation Institute 3135 TAMU, College Station, TX 77843-3135	Staff	Female
Thandayithabani, Laviania, M.B.A.	Assistant Director of Operations UNL 2200 Vine Street 262D Whittier Research Center P.O. Box 830851, Lincoln, NE 68583-0851	Staff	Female
Timmer, Douglas, Ph.D.	Professor & Assoc. Dean for Research Manufacturing Engineering, UTPA	Researcher	Male
Crown, Stephen, Ph.D.	Professor and Director of TexPREP Mechanical Engineering, UTPA	Researcher	Male
Foltz, Heinrich, Ph.D., P.E.	Professor and Department Chair Electrical Engineering, UTPA	Researcher	Male
Fuentes, Arturo, Ph.D.	Professor, Mechanical Engineering, UTPA	Researcher	Male

Jones, Robert, Ph.D.	Professor, Mechanical Engineering, UTPA	Researcher	Male
Pena, Carmen, Ph.D.	Assoc. Professor, Curriculum & Inst., UTPA	Researcher	Female
Hurlebaus, Stefan, Ph.D.	Texas A&M University – Civil Engineering 3135 TAMU College Station, Texas 77843-3135	Researcher	Male
Briaud, Jean-Louis, Ph.D.	Texas A&M University – Civil Engineering 3135 TAMU College Station, Texas 77843-3135	Researcher	Male
Aemal Khattak, Ph.D.	University of Nebraska-Lincoln – Civil Engr. 262D Whittier Research Center P.O. Box 830851, Lincoln, NE 68583-0851	Researcher	Male
Villalobos, Cristina, Ph.D.	Director – C-STEM Center UTPA	Center	Female
Lozano, Karen, Ph.D.	Director – Nano Materials Center UTPA	Center	Female
Ben Ghalia, Mounir, Ph.D.	NSF RET/ENET Grant PI UTPA	Collaborator	Male
Kypuros, Javier, Ph.D.	Professor & NSF-STEP Grant PI Mechanical Engineering, UTPA	Collaborator	Male
Wilson, Brent, Ph.D.	Director of Research and Development Amsted Rail Company, Inc. 1700 Walnut St., Granite City, IL 62040	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 – Track Amtrak	Advisory Board	Male
Trejo-Vasquez, Cristina	UTPA Community Engagement Liaison	Community	Female
Barrera, Daniela	Research Experience for Teachers (RET) Mission C.I.S.D	District Level	Female
Barrera, Mariela	Research Experience for Teachers (RET) La Joya I.S.D	District Level	Female
Benitez, Andres	Research Experience for Teachers (RET) Sharyland I.S.D	District Level	Male
Camargo, Angela	Research Experience for Teachers (RET) McAllen I.S.D	District Level	Female
Enriquez, Eric	Research Experience for Teachers (RET) Donna I.S.D	District Level	Male
Garcia, Renee	Research Experience for Teachers (RET) Pharr-San Juan-Alamo I.S.D	District Level	Male
Ochoa, Teresa	Research Experience for Teachers (RET) La Joya I.S.D	District Level	Female
Sanchez, Jose Jesus	Research Experience for Teachers (RET) Pharr-San Juan-Alamo I.S.D	District Level	Male
Reyes, Velinda	UTPA Director of Corporate and Foundation Relations	Institutional	Female
Mahmoud, Enad	Assistant Professor, Civil Engineering, UTPA	Institutional	Male
Garza, Barbara	Director, Office of P-16 Initiatives, UTPA	Institutional	Female

Dove, Russell	Web Designer II, Internet Services, UTPA	Institutional	Male
Carreon, Victor	REU, UTPA Student heading to TAMU	REU	Male
De la Fuente, Nataly	REU, UTPA Student heading to TAMU	REU	Female
De Leon, Zenia	REU, UTPA Student heading to TAMU	REU	Female
Gonzalez, Sandra	REU, UTPA Student heading to TAMU	REU	Female
Martinez, Melissa	REU, UTPA Student heading to TAMU	REU	Female
Reyes, Christopher	REU, UTPA Student heading to TAMU	REU	Male
De Los Santos, Rodolfo	REU, UTPA Student heading to UNL	REU	Male
Jacome, Ricardo	REU, UTPA Student heading to UNL	REU	Male
Pruneda, Ana	REU, UTPA Student heading to UNL	REU	Female
Sotelo, Luz	REU, UTPA Student heading to UNL	REU	Female
Trevino, Tiffany	REU, UTPA Student heading to UNL	REU	Female
Sias, Cassandra	REU, UTPA Student heading to UNL	REU	Female
Abrego, Rigoberto	Undergraduate Research Assistant, UTPA	Student	Male
Bantz, James Leland III	Graduate Research Assistant, UTPA	Student	Male
Basaldua, Daniel Thomas	Graduate Research Assistant, UTPA	Student	Male
Blackwell, Dylan	Graduate Research Assistant, UTPA	Student	Male
Cancel, Bryan	Undergraduate Research Assistant, UTPA	Student	Male
Carbone, Juan	Undergraduate Research Assistant, UTPA	Student	Male
Drouin, Marc	Undergraduate Research Assistant, TAMU	Student	Male
Estrada, Raul Gilberto	Graduate Research Assistant, UTPA	Student	Male
Foster, Virginia	Graduate Research Assistant, TAMU	Student	Female
Garza, Mark Anthony	Undergraduate Research Assistant, UTPA	Student	Male
Gonzalez, Yolanda	Undergraduate Research Assistant, UTPA	Student	Female
Hessler, Brian	Undergraduate Research Assistant, TAMU	Student	Male
Hurley, Sam	Graduate Research Assistant, TAMU	Student	Male
Kiani, Maysam	Doctoral Research Assistant, TAMU	Student	Male
Lyons, Kimberly	Graduate Research Assistant, TAMU	Student	Female
Martinez, Jackeline Kafie	Doctoral Research Assistant, TAMU	Student	Female
Martinez, Thania	Graduate Research Assistant, UTPA	Student	Female
Mealer, Arthur Alonzo	Undergraduate Research Assistant, UTPA	Student	Male
Moczygamba, Cody	Undergraduate Research Assistant, TAMU	Student	Male
Montalvo, Joseph	Undergraduate Research Assistant, UTPA	Student	Male
Moreno, Rene	Undergraduate Research Assistant, UTPA	Student	Male
Owens, Allen Edward	Undergraduate Research Assistant, UTPA	Student	Male
Posey, Johanna	Undergraduate Research Assistant, TAMU	Student	Female
Ryan, Cynthia	Undergraduate Research Assistant, TAMU	Student	Female
Salinas, Johnny	Graduate Research Assistant, UTPA	Student	Male
Tafti, Somayeh Rezaei	Doctoral Research Assistant, TAMU	Student	Female
Trevino-Flores, Alexis	Undergraduate Research Assistant, UTPA	Student	Male
Villarreal, Anthony Alex	Undergraduate Research Assistant, UTPA	Student	Male
Xiayun, Huang	Doctoral Research Assistant, TAMU	Student	Female
Zapata, Edson Edelmiro	Undergraduate Research Assistant, UTPA	Student	Male

4. IMPACT:

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

- Training of a critical mass of engineering students in the use of finite element analysis (FEA) techniques and methodologies, while attracting other students to the transportation field through the presentation of several research case studies in the Introduction to Finite Element Method course offered at UTPA.
- Training of a critical mass of engineering students on instrumentation, data acquisition, and condition monitoring techniques of railroad components and infrastructure.
- Training of a critical mass of engineering students on hands-on skills that include welding, machining, design specifications, assembly, and using hydraulic machinery.
- Six graduate and three 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 industry with a focus on railway safety. These students also gained experience in using complex mathematical and statistical modeling and state-of-art engineering software tools and packages such as MatLab and Labview.

What is the impact on other disciplines?

The partnerships established by the UTCRS between faculty and students from ten different departments and five colleges at UTPA and the two consortium institutions (TAMU and UNL) has continued to develop and grow. The funded research projects are a collaborative effort between mechanical, electrical, civil, and manufacturing engineering faculty and students all working together towards improving railway safety. The educational and workforce development efforts of the Center are led by two faculty from the curriculum and instruction department (College of Education) in collaboration with the various engineering programs involved in the Center (mechanical, civil, electrical, manufacturing, and computer science). The aforementioned collaborations have resulted in two conference paper publications and presentations at national educational conferences, which are:

- Chapman, A.M., and Walls, L., "Hispanic and White Students Perceptions of Scientists: Findings Using the Identify-a-Scientist (IAS) Instrument," *Annual Conference for National Association for Research in Science Teaching*, Chicago, IL, April 11-14, 2015.
- Fleming, M., Kenyon, L., Upadhyay, B., Kachur, B., Schinkten, O., Chapman, A., Lewis, A., Baker, S., and Phelps, K., "Examining NGSS Practices through Cultural, Social, and Gender Perspectives: STEM Education in the Borderlands: Impact of a Summer Camp at a Hispanic Serving Institution and Next Steps," *Annual Conference for National Association for Research in Science Teaching*, Chicago, IL, April 11-14, 2015.

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

Workforce development contributions are primarily in the thorough introduction to railway systems for the participating graduate and undergraduate students involved in the UTCRS. The Center is training a critical mass of engineering students in the transportation field pertaining to railway safety in terms of mechanical, infrastructure, and operations research. The students are developing advanced engineering skills in materials development, characterization and testing,

manufacturing, design and fabrication of mechanical systems, structural design, thermal and dynamic modeling and analysis, operations management, and measurements, instrumentation, and controls. Additionally, the students are cross-trained to use mechanical and electrical equipment in order to build an efficient system. Having mechanical engineering students working alongside electrical, computer science, manufacturing, and civil engineering students provides these students with valuable expertise that will help them moving forward with their careers in the transportation engineering fields.

Furthermore, a bridge to graduate studies has been well established between the three consortium institutions. UTPA does not have a Master's Program in Civil Engineering or a Doctoral Program in Mechanical Engineering. Therefore, undergraduate and graduate students working on UTCRS funded projects now have the option to go to either one of the two consortium institutions, based on their preferred area of study, and pursue their Master's or Doctoral degree in a transportation engineering related field of study. In fact, one UTPA civil engineering undergraduate student that took part in the 2014 REU program has already started her Master's degree studies in Civil Engineering at the University of Nebraska-Lincoln in January of 2015. Her Master's is funded by the UTCRS and she is working on a project related to Highway Railway Grade Crossing (HRGC) safety. A mechanical engineering undergraduate student who also took part in the 2014 REU program has also been admitted to the mechanical engineering graduate program at UNL and will be starting her studies this coming summer. Two other undergraduate students who participated in the 2014 REU program are expected to start their Master's studies at Texas A&M University this coming fall. The UTCRS has been directly responsible for these students pursuing their Master's degrees in a transportation engineering related field, whereas, without the educational programs put in place by the UTCRS, these students would have probably forgone graduate studies and pursued jobs in other fields.

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

The UTCRS has expanded the collaborations between the various departments and colleges involved in this effort, which has greatly facilitated and expedited the progress in the various center activities. For example, mechanical, manufacturing, and civil engineering students have learned a great deal from their fellow computer science and electrical engineering students and vice-a-versa and the resources of the five departments were made available to all students involved in the center, which has led to increased productivity and efficiency. The cross-training of students in these engineering fields is essential for workforce development efforts in the area of railroad research.

Furthermore, the UTCRS has established direct lines of communication with all the school districts in the lower Rio Grande Valley which has greatly facilitated the planning of the 2015 UTCRS Summer Camps and has allowed the center to expand its educational and outreach activities as evident by the increase in the number of student participants from 700 in 2014 to 1000 in 2015. The school districts are contributing both financially and by sending teachers that will assist UTCRS faculty and staff in running the camps while gaining professional development.

What is the impact on technology transfer?

All UTCRS products including final research reports, paper publications, newsletters, poster presentations, and media content are available for download from the UTCRS website.

Furthermore, in terms of research, the Single Bearing Test Rig (see Figure 4) capable of applying simultaneous vertical, lateral, and impact loading is now fully operational. This tester design, which is the only one of its kind in the US, allows the Center to be able to characterize the performance of railroad tapered-roller bearings under operating conditions that closely mimic those of field service operation.

The results acquired from the various UTCRS research projects and educational activities have produced 10 paper publications, which were co-authored with six graduate and three undergraduate students, and two master's theses.

The research conducted by the UTCRS has also attracted attention from a major railroad industry company that expressed interest in the conductive polymer pad project. Prototyping and laboratory testing are currently underway using the nano-fiber modified elastomer conductive pads that have been developed as a result of this research, to see if they meet the needs of the railroad industry. The latter is in line with one of the core missions of the UTCRS, which is to accelerate product development of material that will promote railway safety. In this case, operator safety is enhanced by making the compliant steering pad in a railcar suspension a reliable and durable conductor. This will reduce operator exposure to dust, noise, and the risk of injury from manual intervention in HRGC and in loading/unloading of bulk product railcars.

What is the impact on society beyond science and technology?

The University Transportation Center for Railway Safety (UTCRS) has had a noticeable impact on society through the various research, educational, workforce development, technology transfer, and outreach activities. The Summer Camps, and REU and RET Programs have received great interest, with all programs exceeding enrollment and participation goals for Summer 2015. The research projects have yielded results and products that have been disseminated in various national and international rail conferences and journals. The rail industry has benefitted from the project findings, and one company is working on implementing the results on a product that will meet customer needs and improve operation safety.

The UTCRS has engaged to date more than 51 graduate and undergraduate students, seventeen faculty, and seven staff members in its various educational, research, workforce development, technology transfer, and outreach activities. The latter has helped increase awareness of transportation engineering and railway safety initiatives and demonstrated the USDOT's commitment to enhancing railway safety across the nation.

5. CHANGES/PROBLEMS:

Nothing to Report.

6. SPECIAL REPORTING REQUIREMENTS:

Nothing to Report.