2nd Program Progress Performance Report
for
National University Rail (NURail) Center:
Tier 1 University Transportation Center

National University Rail Center - NURail
US DOT OST-R Tier 1 University Transportation Center

Submitted to
U.S. Department of Transportation
Office of the Assistant Secretary for Research and Technology

Grant Period:
30 September 2013 through 30 September 2017

Reporting Period:
1 April 2014 through 30 September 2014

Submitted:
30 October 2014

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Grant: DTRT13-G-UTC52
Duns: 04-154-4081
EIN: 37-6000511

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1. Accomplishments

Efforts within the NURail Center have been focused on appropriately and responsibly spending any remaining funds from NURail's original grant (number DTRT12-G-UTC18) that expire on January 31, 2016 before dipping into NURail's second grant (number DTRT13-G-UTC52) which expires on September 30, 2017. While some professors and researchers are beginning to use funding from the second grant, it is in the early stages of projects and there are few accomplishments, publications or other products that can be attributed to these expenditures.

a. What was accomplished under these goals? (major activities; specific objectives; significant results (positive and negative); key outcomes)

University of Illinois at Urbana-Champaign (UIUC) –

- Planning was completed for a new full-semester graduate-level course on Railway Terminal Design and Operations.
  - Class commenced in Fall 2014.
  - 23 students enrolled this semester.
  - Educational materials are 75% complete and are being further refined and developed as the semester progresses.
- Rail Traffic Controller (RTC) simulation software work began in the summer of 2014 on the initial task of the project to investigate the interaction between mainline and terminal capacity. Work is still in progress.

University of Tennessee, Knoxville (UTK) –

- Projects have been selected and are just now under way.
- One TRB conference paper accepted for a project in-progress.

University of Kentucky (UKY) –

- Attended and presented at Global Level Crossing Safety & Trespass Prevention Symposium (GLXS)
- Attended and presented at NURail Annual Meeting and Summerail TRB meeting.
- Conducted research (data collection and analysis) for crossing index and bridge approach stiffness research projects.

University of Illinois at Chicago – College of Engineering (COE)

Research in the college is focused on one of the main NURail research areas: Railway Vehicles and Infrastructure: Analysis, Design, and Performance. Most of the research falls more particularly under the heading of Dynamic Modeling of Railroad Vehicles and Vehicle-Track Interaction. The project will develop new computational multibody system (MBS) procedures for the systematic and efficient dynamic modeling and virtual proto-typing of complex railroad vehicle systems, including both vehicles and infrastructure. It is a collaborative effort of mechanical engineers, civil engineers, and computer visualization specialists. Three projects are currently active with NURail FY13 funding:

- Improving Track-Bridge Interaction Using Recycled Plastic Crossties –
  - Tested the mechanical performance of the recycled plastic cross-ties in the laboratory and with computer simulations.
  - Beginning to simulate their performance in various bridge designs.

- Computational Ballast and Soil Models to Improve Track Transition Design –
  - Updated coupled rail/substructure simulations to fully capture the deformation of soil for postprocessing.
  - Adapted nonlinear viscoplasticity model for modeling ballast and subgrade materials

- 3D Visualization of Rail Vehicle-Track Interaction –
  - Working on a PC implementation of 3D visualization procedures for rail vehicle and infrastructure dynamics and their interactions.
  - Adapting for the PC platform a program originally engineered to run on the Electronic Visualization Laboratory's CAVE2 virtual reality environment.

b. How have the results been disseminated?

UIUC –

- Fifteen lectures in the Railway Terminal Design and Operations course have been delivered to enrolled students.

UKY –

- Presentations at three conferences:
  - GLXS 2014
  - NURail annual meeting
  - Summerail TRB meeting

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

UIUC -

- Develop remaining educational materials for the new full-semester graduate-level course on Railway Terminal Design and Operations. Assess course and evaluate for any possible content changes.
- Pending railroad data availability, work will resume on the mainline and terminal capacity interaction project in the spring semester.

UKY –

- Continue collecting data, analyzing data, and publishing/presenting results.

Massachusetts Institute of Technology (MIT) –

- Planning stages for research considering economic growth enabled by development of mega-regions through high-quality surface transportation (in particular, HSR) and complementary enhancements of urban transportation systems.
- Studying the contribution of mega-region development towards environmental sustainability that will take place through a modal shift from air and highway that are intrinsically less benign than rail transportation.

UTK –

- Making progress on the projects selected.

Michigan Technological University (Michigan Tech) –

- Complete negotiations with MI Department of Transportation for matching funds and projects to be completed under the grant.
- Start the projects.

University of Illinois at Chicago - College of Urban Planning and Public Affairs (CUPPA) –

- Continue research similar to that being conducted under the FY2011-funded NURail Center. Work includes research concerning the planning, operations, funding, finance and economic impact of passenger and freight rail systems.
- Continue supporting graduate students in their educational and professional development as transportation researchers, planners, and eventually contributing members of the transportation field.

UIC – COE -

- Dynamic Modeling of Railroad Vehicles and Vehicle-Track Interaction.
  - The Mechanical Engineering department will begin to spend NURail 2013 funds to pay research assistants for further work on the above goals, previously pursued under earlier NURail funding.
- Improving Track-Bridge Interaction Using Recycled Plastic Crossties.
  - Continue to use the laboratory results for the recycled plastic crossties as inputs into various computer simulations, including the use of plastic ties in high-speed rail bridge design.
- Computational Ballast and Soil Models to Improve Track Transition Design.
  - Couple the new nonlinear viscoplasticity model for the rail track and substructure with Mechanical Engineering's vehicle dynamics model. This should help model the dynamics of train transitions from ballasted track to bridges in order to understand issues of ride quality and possible derailments.
- 3D Visualization of Rail Vehicle and Track and Infrastructure Dynamic Simulations.
  - Complete the PC adaptation of the EVL CAVE2 visualization of rail vehicle and infrastructure dynamic data and begin to share this PC version with other NURail partners for both research and teaching.

2. Products

a. Journal publications:

Xu. P., R. Liu., Q. Sun, R. Souleyrette and J. Rose, "An Optimization Model for Aligning Track Inspections of Track Geometry Car," accepted for publication in the *Journal of Computer-Aided Civil and Infrastructure Engineering*

b. Books or other non-periodical, one-time publications:

Nothing to report.

c. Other publications, conference papers and presentations:

Rose, J. and R. Souleyrette, "Hot-Mix Asphalt (Bituminous) Railway Trackbeds: In-Track Tests, Evaluations, and Performances -- A Global Perspective: Part I -- Introduction to Asphalt Trackbeds and International Applications and Practices," Proceedings of the 3rd International Conference on Transportation Infrastructures - ICTI 2014, Pisa, Italy, April 22-25, 2014

Rose, J. and R. Souleyrette, "Hot-Mix Asphalt (Bituminous) Railway Trackbeds: In-Track Tests, Evaluations, and Performances -- A Global Perspective: Part II -- United States Asphalt Trackbed Applications and Practices," Proceedings of the 3rd International Conference on Transportation Infrastructures - ICTI 2014, Pisa, Italy, April 22-25, 2014

Rose, J. and R. Souleyrette, "Hot-Mix Asphalt (Bituminous) Railway Trackbeds: In-Track Tests, Evaluations, and Performances -- A Global Perspective: Part III -- U.S. Asphalt Trackbed Materials Evaluations and Tests," Proceedings of the 3rd International Conference on Transportation Infrastructures - ICTI 2014, Pisa, Italy, April 22-25, 2014

Rose, J. S. Liu, and R. Souleyrette, "Kentrack 4.0: A Railway Trackbed Structural Design Program," Proceedings of the 2014 Joint Rail Conference, Colorado Springs, CO, April 2-4, 2014

Malloy, B., J. Rose and R. Souleyrette, "Rehabilitation, Assessment and Management Practices to Ensure Long-Life, High Performance Highway-Railway At-Grade Crossings," Proceedings of the 2014 Joint Rail Conference, Colorado Springs, CO, April 2-4, 2014

Wang, T., R. Souleyrette, D. Lau and P. Xu, "Rail Highway Grade Crossing Roughness Quantitative Measurement Using 3D Technology," Proceedings of the 2014 Joint Rail Conference, Colorado Springs, CO, April 2-4, 2014

"HSR as Transit: The Continuing Transportation-Driven Evolution of Metropolitan Form", Westrom, R.J., Sussman, J.M. 2014 Post Presentation

"The Impact of High-Speed Rail and Low-Cost Carriers on European Air Passenger Traffic" Clewlow R.R.L., Sussman J.M., Balakrishnan H. (2014) Transport Policy, Volume 33, May 2014, Pages 136-143, ISSN 0967-070X

"Productivity of Passenger Rail Transportation Services in the Northeast Corridor Archila" A.F., Sakamoto R., Fearing R., Sussman J.M. (2014) Accepted by the Transportation Research Board

"Uncertainty and Inter-Jurisdictional High-Speed Rail Planning: Insights from Portugal and the United Kingdom" Stein N.E.G., Sussman J.M. (2014) Accepted by the Transportation Research Board

"Rail Infrastructure Manager Problem: Analyzing Capacity Pricing and Allocation in Shared Railway System" Peña-Alcaraz M., Ramos A., Webster, M.D., Sussman J.M. (2014) Paper presented at CESUN 2014 - Fourth International Engineering Systems Symposium, June 8-11, 2014, at Stevens Institute of Technology

"Transport Infrastructure Evaluation Using Cost-Benefit Analysis: Improvements to Valuing the Asset Through Residual Value - A Case Study" Jones H., Domingos T., Moura F., Sussman J.M. (2014) Accepted by the Transportation Research Board

Wang, Xin, Khattak, A.J., Liu, Jun, and Clarke, D.B., "Non-crossing Rail-Trespassing Crashes in the Past Decade: A Spatial Approach to Analyzing Injury Severity", 94nd Annual Meeting of the Transportation Research Board, January 2015.

d. Website(s) or other Internet site(s):

MIT - Continues to update and maintain the MIT HSR website: http://web.mit.edu/hsr-group/index.html

e. Technologies or techniques:

UKY - Continues development of 3D sensor and accelerometer platforms.

f. Inventions, patent applications and/or licenses:

Nothing to report.

g. Other products (i.e. databases, audio/video products):

UIUC – Created CEE 598 RTD Railway Terminal Design & Operations course materials.

3. Participants and Other Collaborating Organizations

a. What other organizations have been involved as partners?

(Partner organizations may provide financial or in-kind support, supply facilities or equipment, collaborate in the research, exchange personnel, or otherwise contribute.)

NURail University	Organization or University Name	Location	Contribution to the Project	Name (First and Last)
UKY	University of Illinois at Chicago	Chicago	Dynamic vehicle simulation	Ahmed Shabana and students/staff
MIT	JR East	Tokyo	Financial Support	

b. Additional collaborators:

(example: interdepartmental or interdisciplinary collaborations, collaborations with individuals outside the UTC or U.S.)

Univ	Name (First and Last)	Company, University, Organization Name	Location	Contribution to the Project
UKY	Sam Carter	CSX RR	Jacksonville, FL	Advisor
UIUC	Jeremiah Dirnberger	CSX Transportation	Jacksonville FL	CEE 598 RTD semester design proj. development, in-kind support
UTK	Rupy Sawhney	UTK, Ind. Engr.	Knoxville	Collaborator
UTK	Richard Bennett	UTK, Civil Engr.	Knoxville	Collaborator
UTK	Asad Khattak	UTK, Civil Engr.	Knoxville	Collaborator
UTK	Xin Wang	UTK, Civil Engr.	Knoxville	Collaborator

4. Impact

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

UIUC - With terminal capacity constraints becoming a major issue for the railroads, and major investments in new intermodal, port and hump yard projects underway,

design of new yards and terminals is a growing need for the rail industry. The Railway Terminal Design & Operations course fills the demand for graduates with skills in developing these capital-intensive facilities. This is a unique course that is not taught elsewhere in North America.

UKY - Changes in course curriculum; basis for future research; better understanding of the effect and performance of RR designs, materials and maintenance policies

b. What is the impact on other disciplines?

Nothing to report.

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

UIUC - The Railway Terminal Design & Operations course helps fill the demand for young transportation professionals with a breadth of knowledge that spans all facets of rail industry engineering and operations, and not just the infrastructure design of mainline tracks. The course compliments other advanced track and rail vehicles courses being developed or recently taught for the first time at UIUC.

UKY - Getting more educators involved in RR education via REES facilitates more students going into the rail industry

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

UKY - Development of lab and field test equipment and procedures.

e. What is the impact on technology transfer?

Nothing to report.

f. What is the impact on society beyond science and technology?

UIUC – Properly designed rail yards and terminals operate more efficiently, lowering supply chain costs and improving reliability of the transportation system, to the economic benefit of society.

UKY – Safer, more economical transportation systems

5. Changes/Problems

a. Changes in approach and reasons for change

Nothing to report.

b. Actual or anticipated problems or delays and actions or plans to resolve them

Michigan Tech - Negotiations with MDOT delayed, as they wanted to complete previous round of projects before discussing next ones. Projects completed, so discussions for new projects have been initiated.

c. Changes that have a significant impact on expenditures

Nothing to report.

d. Significant changes in use or care of human subjects, vertebrate animals and/or biohazards

Nothing to report.

e. Change of primary performance site location from that originally proposed

Nothing to report.