

3rd Program Progress Performance Report
for
National University Rail (NURail) Center:
Tier 1 University Transportation Center



National University Rail Center - NURail
USDOT-RITA Tier I University Transportation Center (UTC)

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A handwritten signature in black ink, appearing to read 'Chris Barkan', with a stylized, cursive script.

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Table of Contents

1. Accomplishments.....	3
a. What are the major goals of the program?	3
b. What was accomplished under these goals?	3
c. How have the results been disseminated?.....	6
d. What do you plan to do during the next reporting period to accomplish the goals?.....	7
2. Products: What has the program produced	9
a. Publications, conference papers, and presentations	9
b. Journal publications:	10
c. Books or other non-periodical, one-time publications:.....	11
d. Other publications, conference papers and presentations:	11
e. Website(s) or other Internet site(s):	13
f. Technologies or techniques:.....	13
g. Inventions, patent applications and/or licenses:.....	13
h. Other products:.....	13
3. Participants and Other Collaborating Organizations.....	13
a. Partners	13
b. Additional collaborators.....	15
4. Impact	15
a. What is the impact on the development of the principal discipline(s) of the program?.....	15
b. What is the impact on other disciplines?	16
c. What is the impact on the development of transportation workforce development?.....	17
d. What is the impact on physical, institutional and information resources at the university or other partner institutions?.....	18
e. What is the impact on technology transfer?.....	19
f. What is the impact on society beyond science and technology?.....	19
5. Changes/Problems.....	20
a. Changes in approach and reasons for change	20
b. Actual or anticipated problems or delays and actions or plans to resolve them	20
c. Changes that have a significant impact on expenditures	20
d. Significant changes in use or care of human subjects, vertebrate animals and/or biohazards	20
e. Change of primary performance site location from that originally proposed	20

1. Accomplishments

a. What are the major goals of the program?

The NURail Center's principal goals are, as stated in the proposal, to achieve a set of Research, Education, Technology Transfer Collaboration and Leadership objectives that will not only fulfill center objectives, but support and assist achievement of goals beyond the consortium members. These include rail industry, AAR and FRA research and workforce development goals. They also include working with other colleges and universities, both domestically and internationally to advance academic rail education and research quality and quantity.

b. What was accomplished under these goals?

University of Illinois Urbana-Champaign

Research:

Concrete Crossties and Fasteners:

- Continued to develop an analytical model focused on the track infrastructure, focusing on the concrete crosstie and elastic fastening system.

Safety and Hazardous Materials Risk:

- Causal analysis of train accidents on shared rail corridor was completed.
- Potential railroad transportation risk reduction strategies were identified. Initiated work to optimize broken rail prevention.

Railroad Capacity and Optimization Strategic Development Plan:

- Capacity and optimization strategic development plan was further refined and formal work on projects began. Monthly teleconferences were established between UIUC, National Taiwan University and KTH (Swedish Royal Institute of Technology).
- Planning began for the Capacity Workshop to be organized by NURail for the TRB Annual Meeting in January 2014.

Outreach and Education:

Engineering Open House:

- Together with the UIUC AREMA Student Chapter, the NURail Center sponsored railway engineering exhibits at the UIUC Engineering Open House event that was attended by 20,000 people, including over 12,000 primary and secondary students.

Hay Seminar Series:

- During the Spring 2013 semester, UIUC hosted five on-campus seminars from industry experts that were also broadcast online.

High Speed Rail Construction Management Course:

- Developed and taught a new course in Spring 2013. The major class project yielded a project charter and project management plan for construction of a HSR line between Chicago and Milwaukee. Class included online students from industry in North America and as well as other countries.

Railway Vehicle Dynamics Course:

- Visiting KTH faculty and UIUC faculty taught a graduate-level Railway Vehicle Dynamics course during the Spring 2013 semester.

Railway Project Design and Construction Course Updates:

- New and expanded content for the Railway Project Planning and Design Course taught during the Spring 2013 semester.

Transportation Safety and Risk Course Development:

- Began developing course on Transportation Safety and Risk to be taught Fall 2013.

Technology Transfer:

- **Concrete Crosstie and Fastening Systems Workshop** conducted by NURail faculty at the TRB Annual Meeting in Washington D.C. in January.
- Planning began and a Call for Papers issued for the 2013 **Railroad Environmental Conference** in November 2013.
- Planning began for the **13th Global Level Crossing and Trespass Symposium (GLXS 2014)** to be held on the UIUC campus in August 2014. NURail is a co-sponsor.

International Cooperation:

- **Rail Research and Educational Cooperation with KTH:**
 - Completed MoU to allow for student exchange via online rail courses.
 - Began exploring options for more formal joint railway courses and programs.
 - UIUC and KTH faculty and student researchers participated in a **Railway Capacity Seminar** staged on the KTH campus in May 2013.
 - KTH students participated online in the UIUC HSR Planning course.
 - Completed planning for a Rail Vehicles Dynamics class taught in the Spring 2013 semester at UIUC by visiting KTH faculty and NURail faculty.
- **International Collaboration High Speed Rail Planning Classes:** For the third time two NURail professors gave a summer class on “High Speed Rail Planning” at Hong Kong Polytechnic University. Hong Kong Polytechnic University is requesting more railroad classes be taught or transferred to them. The same class was also taught at Beijing Jiaotong University this summer.
- **International Collaboration Southwest Jiaotong University:** Two UIUC professors participated in the 3rd Rail Transit International Academic Forum.
- **International Collaboration National Science & Technology Ministry Thailand:** Professor TC Kao was invited by the Ministry and Chulalongkorn University of Thailand to give a 3 day seminar on high speed rail systems in Bangkok on July 3- 5, 2013.

University of Illinois Chicago – COE

Vehicle and Infrastructure Modeling:

- **Wheel-rail contact.** Study conducted on wheel climb and derailment at a large angle of attack. It was discovered that forces developed at point of contact cannot be captured by a planar force balance. Additional research is needed to understand wheel-climb derailments for complex geometries.
- **Coupled track and infrastructure model.** Study conducted on “Railroad Substructure/Foundation Model for Integrated Simulation of Vehicle-Track Interaction.”
 - Created linear elastic finite element (FE) model of track and substructure.
 - Modal analysis performed. Modes have been imported into the multi-body system code SAMS/Rail for the dynamic analysis of an idealized suspended wheel set. Output of this model has been successfully exported to a 3D visualization platform, CAVE2, at the UIC Electronic Visualization Laboratory.

Railway Infrastructure Materials and Design. In collaboration with the Chicago Transit Authority (CTA) transit rail system, a next generation design of fiberglass reinforced plastic rail ties (made by Tangent Corp.) was compared to unused decommissioned plastic ties which had not performed well for the CTA in the past. New ties were found to have superior performance to the old in standard static and dynamic mechanical tests.

University of Illinois Chicago – CUPPA

- **Value Capture Coordination (VC):**
 - Finished all reading and annotation work associated with the literature review phase.
 - Completed two of four case study site visits.

- ***Rail Crossing Safety (Rail Safety):***
 - Pedestrian safety at rail grade crossings webinar offered in April through the Illinois Center for Transportation (ICT) at UIUC.
- ***GIS Analysis of Environmental Impacts of Rail Development (GIS):***
 - Refined “Illinois Sustainable Rail Scorecard” in spring 2013.
 - Developed a four-step analytical process of emission impacts.
 - Began to investigate noise impacts of rail impacts.
 - Interactive web platform is under development.
- ***Economic Impacts of Freight Mode Choice (Freight):***
 - Draft literature review report has been completed.
 - Sought involvement of UIC Library Data Archivist to formulate data items that can be used to quantify the land price impacts of BNSF’s Logistics Park Chicago.
 - Sent request to American Association of Railroads for rail cost data for major city pairs
 - Research assistant for the project, Alexandra McNally, has started an internship at Chicago Transit Authority.

Massachusetts Institute of Technology

- Completed master’s thesis on HSR productivity in the NEC.
- Completed master’s thesis on regional and urban development associated with HSR deployment.
- Continued work on representations and models of the NEC, aimed at providing additional insights into effective means of deploying HSR in that region.

Michigan Tech University

- Teacher workshop for more than 20 teachers in rail transportation taught in Detroit in collaboration with CFIRE UTC.
- Seven students and one faculty from Michigan Tech presented at JRC 2013.

University of Kentucky

- 3D structured light data acquisition system has been built, calibrated and tested.
- Vehicle rideability measurement at a rail highway crossing has been tested.
- Document literature related to rideability, roughness measurement and 3D imaging analysis applicable to rail crossing; identify and assess current rail crossing roughness evaluation methods and data.
- Collected data necessary to calibrate 27 TekScan sensors and based on these calibration data a novel and reliable calibration method was proposed for TekScan sensors.

University of Tennessee, Knoxville

- Continued two NURail research projects and began two new projects.
- Students hired for assistantship positions and initial research activities initiated.
- One education project continued.
- Developed short courses on railroad track engineering and railroad track geometry analysis.
- One session of the new track engineering class, two track inspection classes, and a bridge inspection class were offered to industry personnel, with total attendance of 89 persons.
- UTK hosted the 2013 Joint Rail Conference, with attendance of 200 persons.
- Two railway teaching modules have been developed in two broad categories: (1) railroad material characterization modules and (2) railroad analysis and design modules.

Rose-Hulman Institute of Technology

- Developed CE 490 Railroad Engineering - a ten week, 40 class period interdisciplinary railroad engineering course. Spring enrollment was 10 Students: 8 Senior CE, 1 Junior CE and 1 Junior ME.
- Since its founding in December 2012 the AREMA Student Chapter has held 7 meetings and conducted 7 rail industry field trips.

c. How have the results been disseminated?

NURail Consortium

Research and Education: The *2013 Joint Rail Conference* (JRC) April 15 – 18, 2013 in Knoxville, TN featured two special sessions dedicated to student presentations on NURail research and education projects. Total of 16 presentations made by students from all the NURail partner institutions. In addition to spoken lectern presentations, posters for each of the projects were displayed throughout the conference.

University of Illinois Urbana-Champaign

Conference Presentations: Papers and presentations were delivered at:

- Transportation Research Board Annual Meeting in Washington D.C. in January.
- International Heavy Haul Association Conference in India in February.
- Joint Rail Conference in Knoxville in April.
- International Association of Railway Operations Research Conf. in Denmark in May.

Railroad Capacity and Optimization Strategic Development Plan:

- Preliminary results of ongoing research were summarized in a progress report for the Association of American Railroads and presented at the KTH Railway Capacity Seminar.
- Informal presentations on the research were made to representatives from CSX, Union Pacific Railroad and Illinois Department of Transportation.

Safety and Hazardous Materials Risk:

- Besides conference presentations, informal presentations on the research were made to representatives from CSX, SNCF and Illinois Department of Transportation.
- Professor Saat was invited to present research at Zhejiang University and Beijing Jiaotong University in China.

University of Illinois Chicago – COE

Results of the above research (point 1b) were disseminated in part through three presentations JRC 2013. See below, item 2d.

University of Illinois Chicago – CUPPA

Rail Safety:

- Previous webinar was posted onto the UIUC/ICT website for later viewing.

GIS:

- Presentations were given at both the Joint Rail Conference in Knoxville, TN as well as the Transport Chicago Conference in Chicago, IL. Additional details under section 2a.

Massachusetts Institute of Technology

- Two poster presentations at the 2013 TRB meeting. These were included in the TRB paper compendium.

Michigan Tech University

- Presentation at the TRB annual meeting on demands for railroad workforce.
- Organized two dedicated sessions to NURail activities as part of JRC 2013. One on

- educational and student projects and the other on research projects.
- Other NURail projects and activities presented at JRC plenary and technical sessions.
- Paper presented on rail industry workforce demands at the 2nd World Congress for Railway Education and Training on April 26, in St. Polten, Austria.
- Internally completed two NURail or industry match sponsored senior design projects.
- Michigan Tech Railroad Day on February 19th, 2013 highlighted NURail student and research project posters to several rail industry companies.

University of Kentucky

- Student poster “3D Methodology for Evaluating Rail Crossing Roughness” exhibited at JRC 2013.
- Presentations and information exchanges with three Universities (Lanzhou Jiaotong University, Changan Jiaotong University and Beijing Jiaotong University), one state DOT (Gansu DOT) and China Railroad First Survey & Design Institute Group during a trip to China in March 2013.

University of Tennessee, Knoxville

- Several student presentations at the JRC 2013 on research results to date.
- Course modules incorporated in two courses: CE321 – Construction Materials (undergraduate course) and CE522 - Asphalt and PCC Mix Design (graduate course).

Rose-Hulman Institute of Technology

- Two presentations at the JRC 2013.

d. What do you plan to do during the next reporting period to accomplish the goals?

NURail Consortium

Call for Project Proposals: A call for the next round of research and education project proposals will be conducted during summer 2013. This round of project selection will include external review of all proposals where practical.

Research: Strategic Development Planning: The NURail Strategic Development Plan working groups will prepare status reports for the NURail Annual Meeting and use the meeting as an opportunity to further refine project scopes and timelines. On a rotating basis, each SDP group will also present research progress during weekly center management teleconferences.

Technology Transfer & Leadership: The NURail Center will sponsor and organize the Hay Seminar Series during the Fall 2013 semester, with UIUC hosting five or six on-campus seminars from industry experts that will also be broadcast online.

Management: The first NURail Annual Meeting will be held on the UIUC campus, September 11-12, 2013. The meeting will include participation of the NURail Technical Advisory Committee and an extended closed discussion of long-term center objectives with the Executive Advisory Committee. Both of these committees, along with the Student Leadership Council, will be formed prior to the Annual Meeting.

University of Illinois Urbana-Champaign

Research:

Concrete Crossties and Fasteners: Moving forward, we will continue refining the FEM and validating the FEM using laboratory and field experiments. Additionally, we are working to develop a simplified analytical tool that will incorporate the FEM output and provide interpolation of performance data for a variety of loading and design scenarios.

Safety and Hazardous Materials Risk: Future direction of shared rail corridor safety and risk research will be identified. This may include adjacent track derailment risk modeling. Work to optimize rail transportation risk reduction strategies will continue focusing on broken rail prevention and tank car safety design enhancement.

Railroad Capacity and Optimization Strategic Development Plan: Formal work on projects related to shared corridor capacity model components of the capacity and optimization strategic development plan will continue. In Fall 2013, work will be initiated on the yard-mainline capacity interaction model component.

Outreach and Education:

Hay Seminar Series: During the Fall 2013 semester, UIUC will host five to six on-campus seminars from industry experts that will also broadcast online with the NURail Center as the primary sponsor.

Transportation Safety and Risk Course Development: Complete development and teach a new course on Transportation Safety and Risk during the Fall 2013 semester.

Railway Transportation and Engineering Course Updates: The remaining two-thirds of the lecture content in the introductory Railway Transportation and Engineering Course will be updated and revised in time for the Fall 2013 semester.

Advanced Track Engineering Course: Begin development of course curriculum for a new course on Advanced Track Engineering to be offered during the 2014-2015 academic year. The course will build on the basic Track Engineering course currently being taught each fall.

Technology Transfer:

In November, the 2013 Railroad Environmental Conference (RREC) will be hosted at UIUC. Planning will continue for the Capacity Workshop to be organized by NURail for the TRB Annual Meeting in January 2014. Conference Presentations: Papers and presentations on research supported by NURail will be delivered at the American Railway Engineering and Maintenance-of-Way Association Annual Meeting in Indianapolis in September, Institute for Operations research and Management Science Annual Meeting in Minneapolis in October, ASME Rail Transportation Division Conference in Altoona in October, RREC at UIUC in November, and World Congress of Railway Research in Australia in November.

International Cooperation:

Rail Research and Educational Cooperation with KTH (Swedish Royal Institute of Technology): KTH students will participate as online students in two UIUC railway engineering courses during the Fall 2013 semester. Planning will begin for another KTH railway engineering course to be taught at UIUC in the Spring 2014 semester by NURail faculty and visiting faculty from the Swedish Royal Institute of Technology (KTH).

International Collaboration: High Speed Rail System Education Center. We are currently discussing with Southwest Jiaotong University of China to develop high speed rail curriculum jointly.

University of Illinois Chicago – COE

Wheel Climb Derailment will continue the investigation because this is a dangerous derailment scenario and needs further investigation to be fully understood.

Railroad Substructure/Foundation Model for Simulation of Vehicle-Track Interaction will next employ an advanced viscoplastic material model to include inelastic deformation of the soil. This model will be used to investigate complex problems such as ballast degradation.

Testing and Performance Simulation of Plastic Rail Ties (in collaboration with the CTA) will continue with the following tests: Fastener Uplift – AREMA Part 2- 2.6.1; Fastener Longitudinal Restraint – AREMA Part 2- 2.6.2; Fastener Repeated Load – AREMA Part 2- 2.6.3; Wear and abrasion Test – AREMA Part 2- 2.7, as well as thermal testing and further computer modeling.

University of Illinois Chicago – CUPPA

VC: Final draft of literature review will be developed along with final reports for case studies and synthesis of case studies and literature review items.

Rail Safety: A presentation about pedestrian safety at rail grade crossings is scheduled for October at the 62nd Illinois Traffic Engineering and Safety Conference at UIUC.

GIS: The team will be refining and validating location-specific models of environmental emissions by exploring multiple approaches. Initial results of emission impact analysis in web GIS platform will be discussed at the stakeholder meeting to be held in fall 2013. The meeting will help fine tune the "Illinois Sustainable Rail Scorecard" as well as the data inputs for the environmental GIS database.

Freight: Expect to receive data from the UIC data archivist in the next few weeks. Then, we will begin the analysis of data to quantify impacts of Logistics Park Chicago.

Massachusetts Institute of Technology

Continue NEC work with emphasis on flexible implementation strategies to cope with the exceptional level of uncertainty in that region. Anticipate making progress in the area of "complex real options" where the ability to justify real option expenditures in earlier years is limited by political considerations *and* where the ability to deploy those options even if appropriate in the out years, is again constrained by political issues.

Michigan Tech University

Two on-going student projects, Grade Crossing Evaluation and Promotional Rail Transportation Program video will be completed. Round 1 research projects will all be close to completion by the end of next period. Michigan Rail Transportation Conference will be conducted in collaboration with MDOT and next round of student projects will be initiated. Summer Youth Program in Rail and Intermodal Transportation will be conducted in July, 2013.

University of Kentucky

Continue work on 3D rail sensor data analysis, Correlate 3D points cloud to quantitative (acceleration) and qualitative (rideability) data. Establish thresholds for repair.

Rose-Hulman Institute of Technology

CE 490 Railroad Engineering

Student evaluations of CE 490 are being reviewed with recommended changes/enhancements studied for incorporation in the class. All class modules will be reviewed and updated as appropriate. Mike Moorhead, Professor of Mechanical Engineering will be reviewing the mechanical engineering course modules. The class will be promoted as a viable technical elective for Civil/Mechanical/Electrical Engineering students.

Senior Capstone Design Project

Several rail sponsored Senior Design Projects are being solicited for the 2013/2014 academic year.

RHIT AREMA Student Chapter Outreach

The student chapter will continue to offer a monthly program of meeting and field trips to promote railroad engineering to the RHIT student body. The Chapter will also develop an outreach program for area K-12 students.

2. Products: What has the program produced

a. Publications, conference papers, and presentations

University of Illinois Urbana-Champaign

- **Conference Presentations:** Papers and presentations on UIUC research supported by NURail were delivered at the
 - Transportation Research Board Annual Meeting in Washington D.C. in January.
 - International Heavy Haul Association Conference in India in February,
 - Joint Rail Conference in Knoxville in April,
 - Int'l Association of Railway Operations Research Conf. in Denmark in May.
- **Railroad Capacity and Optimization Strategic Development Plan:** Preliminary results of ongoing capacity research were summarized in a progress report for the Association of American Railroads and were presented at the KTH Railway Capacity Seminar.

University of Illinois Chicago – CUPPA

- Ning Ai, Marcella Bondie and Anthony Grande. "Community-Specific Environmental Impact Assessment of Rail Infrastructure in Chicago," Transport Chicago Conference, Chicago, IL, 6/7/13.
- Ning Ai, Anthony Grande and Marcella Bondie. "Environmental Impact Assessment Of Rail Infrastructure In Illinois", Paper presentation at the National University Rail Center Joint Rail Conference 2013. Knoxville, TN, 4/16/13.
- Ning Ai, Anthony Grande and Marcella Bondie. "Environmental Impact Assessment Of Rail Infrastructure In Illinois," Poster presentation at the National University Rail Center Joint Rail Conference 2013. Knoxville, TN, 4/16/13.

Massachusetts Institute of Technology

- ESD-WP-2012-23 "Analysis of High-Speed Rail Implementation Alternatives in the Northeast Corridor: the Role of Institutional and Technological Flexibility," poster presented at the Transportation Research Board 92nd Annual Meeting in Washington, D.C., January 13-17, 2013. Included in TRB paper compendium
- ESD-WP-2012-22 "Discontinuous Regions: High-Speed Rail and the Limits of Traditional Governance," poster presented at the Transportation Research Board 92nd Annual Meeting in Washington, D.C., January 13-17, 2013. Included in TRB paper compendium.

University of Kentucky

- A student poster "3D Methodology for Evaluating Rail Crossing Roughness" was exhibited at 2013 Joint Rail Conference at Knoxville, TN during April 15-18, 2013. Travis Greenwell, Peng Xu, Mike McHenry, Reginald R. Souleyrette, Jerry G. Rose, 2014.
- A novel and reliable calibration method for TekScan sensor to measure tie-ballast interaction. 2014 Annual meeting of TRB, (drafting).

b. Journal publications:

University of Illinois Urbana-Champaign

- Chadwick, S.G., N. Zhou and M.R. Saat. Highway-Rail Grade Crossing Safety Challenges for Shared Operations of High-Speed Passenger and Heavy Freight Rail in the U.S. *Safety Science (in-press)*.
- Rapp, C.T, R.G. Kernes and M.R. Saat. Overview of Issues and Research Related to Special Trackwork for Shared High-Speed-Rail Passenger and Heavy-Axle-Load Freight Operations. *Proceedings of The Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit (in-press)*.

- Liu, X., M.R. Saat, X. Qin, C.P.L. Barkan, 2013. Analysis of U.S. Freight-Train Derailment Severity using Zero-Truncated Negative Binomial Regression and Quantile Regression. *Accident Analysis and Prevention* 59: 87–93.
- Liu, X., M.R. Saat, C.P.L. Barkan, 2013. Integrated Risk Reduction Framework to Improve Railway Hazardous Materials Transportation Safety. *Journal of Hazardous Materials* 260: 131-140.

University of Illinois Chicago – COE

- José L. Escalona, Hiroyuki Sugiyama, and Ahmed A. Shabana, “Modeling of structural flexibility in multibody railroad vehicle systems,” *Vehicle System Dynamics*, Special Issue: State of the Art Papers of the 23rd IAVSD Symposium, Vol. 51.7, 2013, pp. 1027-1058.

Michigan Tech University

- Paper in Publication for the Transportation Research Record (TRR): Meeting the Needs – What does the Railroad Industry Need and Expect from Higher Education? Pasi T. Lautala, Ph.D., P.E.

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

University of Illinois Urbana-Champaign

- Completed MS thesis “Development of an Accident Database for Quantitative Safety and Risk Analysis of Highway Bulk-Package Transportation of Hazardous Materials”.
- Draft MS thesis on capacity of mixed-use passenger rail corridors was substantially completed.
- Draft MS thesis on optimized project selection for rail corridor performance improvement was substantially completed.
- Draft MS thesis on risk of derailments due to highway-rail grade crossing incidents was substantially completed.

Massachusetts Institute of Technology

Two MS theses completed.

d. Other publications, conference papers and presentations:

University of Illinois Urbana-Champaign

On several dozen occasions, NURail principals from UIUC delivered a briefing on the NURail Center to representatives from the railway industry or international railway research institutes.

University of Illinois Chicago – COE

- PhD students made presentations at the special NURail session at JRC 2013:
 - (1) James J. O’Shea (with Prof. Ahmed A. Shabana), “Large Angle of Attack Wheel Climb,”
 - (2) Ahmed El-Ghandour (with Prof. Craig Foster), “Railroad Substructure/ Foundation Model for Integrated Simulation of Vehicle-Track Interaction,”
 - (3) Ibrahim Lotfy, Maen Farhat, Mostafa Al-Obaidi (with Prof. Mohsen Issa), “Testing and Performance Simulation of Plastic Rail Ties.”
- Paper based on the first study above has been accepted for presentation at a future conference, Ahmed A. Shabana and James J. O’ Shea, “Large Angle of Attack Wheel Climb,” Proceedings of the ASME 2013 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, IDET/CIE 2013

(DETC2013-12382), August 4-7, 2013, Portland, Oregon, USA

Michigan Tech University

- Evaluating the Results and Features of Two Capacity Simulation Tools on the Shared-use Corridors. Pasi Lautala, PhD, P.E. and Hamed Pouryousef. Proceedings of 2013 Joint Rail Conference (JRC).
- Railway Engineering Education Symposium (REES) - Universities and Industry Collaborate to Develop Railway Education, Pasi Lautala, David Clarke, Tyler Dick and Jim McKinney, Proceedings of the 2013 Joint Rail Conference (JRC).
- Creating Scanning Pattern Maps of Driver Fixations During Hazards, Alexander Hardy, Proceedings of the 2013 Joint Rail Conference (JRC).
- Identifying and Meeting Challenges to Securing and Educating the Next Generation of Rail Industry Workforce in the U.S., Pasi Lautala and Peter Haas (Mineta Transportation Institute), Proceedings of the 2nd World Congress in Railway Training, St. Polten, Austria, April, 2013.

University of Kentucky

Plan to submit paper of 3D sensor application for TRB 2014.

University of Tennessee, Knoxville

- Clarke, D.B., “High-Speed Rail: A Technology Overview,” Invited Presentation, L&N STEM Academy, Knoxville, TN, April 5, 2013.
- Clarke, D.B., “Don’t Fool Around With A Model Railroad—Build A Real One!,” Invited Presentation, Bluegrass Railroad Club, Lexington, KY, April 12, 2013.
- Jing, Yuan, “Lateral Impact of Railroad Bridges with Hybrid Composite Beams,” 2013 Joint Rail Conference, Knoxville, TN, April 16, 2013.
- Shu, Xiang, “Emulsified asphalt cement mortar for ballastless high speed rail slab cushion materials,” 2013 Joint Rail Conference, Knoxville, TN, April 16, 2013.
- Clarke, D.B., “Running the Virtual Railroad—Using Simulation to Teach Railway Operations,” Invited Presentation, 2013 Joint Rail Conference, Knoxville, TN, April 18, 2013.
- Clarke, D.B., “A Vision for High-Speed Rail Development in the Southeast,” Invited Presentation, InnoVenture 2013 Conference, Greenville, SC, May 9, 2013.
- Lautala, Pasi T., Clarke, D.B., Dick, C.T., and McKinney, J.A., “Railway Engineering Education Symposium (REES) – Universities and Industry Collaborate to Develop Railway Education,” Proceedings-2013 Joint Rail Conference. American Society of Mechanical Engineers, 2013.
- Zheng, Jinzi and Clarke, D.B., “Analysis and Evaluation of Hazardous Material Transportation by Railroad,” Proceedings-2013 Joint Rail Conference. American Society of Mechanical Engineers, 2013.
- Khaled, Abdullah A., Jin, Mingzhou, Clarke, D.B., and Hoque, M.A., “Determination of Criticality of Freight Railroad Infrastructure Based on Flow Optimization under Heavy Congestion”, 92nd Annual Meeting of the Transportation Research Board, January 2013.

Rose-Hulman Institute of Technology

- Presentation #1: “Introduction to NURail Education Activities” – James L. McKinney PhD PE at the 2013 Joint Rail Conference – Knoxville, TN.
- Presentation #2: “RHIT AREMA Student Chapter: Formation /Presentations/Field Trips” – Greg Frech, President; Sam Beck, Vice President; and Zach Ehlers, Secretary/Treasurer at the 2013 Joint Rail Conference – Knoxville, TN.

e. **Website(s) or other Internet site(s):**

University of Illinois Urbana-Champaign

- Listing of initial research and education projects uploaded to the NURail Center website and the TRB RiP database.
- Implemented a plan to refresh and expand content on the RailTEC website.

f. **Technologies or techniques:**

University of Illinois Urbana-Champaign

- Draft guidebook for using Rail Traffic Controller simulation software for research in the academic environment was authored by systems and capacity student researchers.

University of Kentucky

- Large scale 3D structured light scanner application to scan railroad and railroad highway crossing at relative low cost (\$5000 hardware) and high precision (0.1inch per pixel)

g. **Inventions, patent applications and/or licenses:**

Nothing to report

h. **Other products:**

University of Illinois Chicago – COE

Vehicle and Infrastructure dynamic modeling group:

- Developing techniques for incorporating infrastructure vibration mode information into the existing Multibody System code SAMS/Rail. Will result in new integrated vehicle-plus-infrastructure modeling software which can be transferred to other groups.

University of Illinois Chicago – CUPPA

Rail Safety:

- Preparing database of video monitoring of non-motorist behavior at 10 selected grade crossings in the Chicago area.

Freight:

- Historical tax data for Will County has been accessed and prepared.

University of Kentucky

- 3D structured light scanner has been built with 10' x 5' scanning area with 1 MP resolution.

3. Participants and Other Collaborating Organizations

a. **Partners**

Organization Name:	Location of the Organization:	Partner's Contribution to the Project:	Name (First and Last)	University
Indiana Rail Road	Indianapolis	In-kind, Collaborative Support, Tech	Thomas Hoback Peter Ray	Rose-Hulman Institute of Technology

		Assist., Student Mentorship		
Norfolk Southern Corp.	Atlanta, GA	Data	Clark Cheng	UTK
Beijing Jiaotong University	Beijing, PRC	Exchange personnel	Minshu Ma, Jinzi Zhang	UTK
TTCI, Inc.	Pueblo, CO	Facilities	Duane Otter	UTK
Tennessee Dept. of Transportation	Nashville, TN	Financial support	Sandi Hoff	UTK
HC Bridge, Inc	Wilmette, IL	In-kind support	John Hillman	UTK
Hebei Institute of Construction and Geotechnical Investigation	Hebei, PRC	In-kind support		UTK
National Railroad Contraction & Maintenance Assoc	Washington, DC	Financial support	Chuck Baker	UTK
Southwest Jiaotong University, China	Chengdu, PRC	Collaborative Support	Weiwei Lu	
China Academy of Railway Sciences	Beijing, PRC	Collaborative Support	ShuoTing Hu	
CSX	Jacksonville, FLA	In kind, facilities	Sam Carter	Kentucky
TTCI	Pueblo, CO	In kind, facilities	Mike Brown	Kentucky
NS	Norfolk, VA	funding	NS Corporate Partnership	Kentucky
NS	Norfolk, VA	funding	NS Foundation	Kentucky
Nichols Foundation	Jacksonville, FL		Gerald Nichols	Kentucky
KY Transportation Cabinet	Frankfort, KY	Funding	Jennifer McCleave	Kentucky
IST	Lisbon, Portugal			MIT
Union Pacific Railroad	Omaha, NE	Financial and collaborative support	Mike Iden	Michigan Tech
Michigan Dept. of Transportation	Lansing, MI	Financial and collaborative support	Nikkie Johnson	Michigan Tech
Amsted Rail	St. Louis, MO	In-kind student support	Paul Wike	Michigan Tech
CN	Montreal, Quebec	Financial support	Stephen Schlickman	University of Illinois – Chicago

National Taiwan University	Taipei, Taiwan	Collaborative Support	Yung-Cheng (Rex) Lai	UIUC
Beijing Jiaotong University	Beijing, China	Collaborative Support	NEI Lei & GAO Liang	UIUC
Southwest Jiaotong University	Chengdu, China	Collaborative Support, Joint teaching program	FENG, Xiao Yuan	UIUC
Hong Kong Polytechnic University	Hong Kong	Teaching	Geoffrey Shen	UIUC
National Science & Technology Development Agency	Bangkok, Thailand	Collaborative Support	Nakorn Chantasorn	UIUC
KTH (Royal Institute of Technology)	Stockholm, Sweden	Collaborative Support, Joint Class Develop	Sebastian Stichel	UIUC

b. Additional collaborators

Michigan Tech University

- Dr. Peter Haas from Mineta Transportation Institute, co-author and co-presenter on rail industry workforce demands paper at 2nd World Congress for Railway Education and Training on April 26, in St. Polten, Austria.
- CFIRE UTC (Joan Chadde) collaboration on teacher workshop.

University of Kentucky

- Dan Lau, Dept. of Electrical Engineering, and Visualization Center, Univ. of Kentucky contributed time, technology and resources to the 3D rail crossing project.

University of Tennessee, Knoxville

- Dr. Antti Nurmikolu, Technical University of Tampere, Finland (potential network modeling, trackbed research)
- Dept. of Civil and Environmental Engineering, UTK, In-kind support, facilities
- Dept. of Industrial Engineering, UTK, In-kind support

Rose-Hulman Institute of Technology

- Dr. Bill Eccles PhD PE - Emeritus Professor of Electrical & Computer Eng. - RHIT
- Dr. Mike Moorhead PhD PE – Assistant Professor of Mechanical Engineering – RHIT

4. Impact

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

University of Illinois Urbana-Champaign

The research, educational, technology transfer and cooperative activities that UIUC is engaged in will all have an impact on US DOT strategic goals in terms of railroad safety, state of good repair, economic competitiveness and sustainability. The Strategic Development plans that UIUC is

involved in includes Railroad Safety and Risk, in which we intend to develop optimization approaches to identify the most-cost-effective means to maximize the reduction in risk. UIUC's work (as well as that of other NURail partners) on infrastructure specifically addresses state of good repair, as well as safety and economic competitiveness. The work that UIUC is leading on rail capacity also directly addresses economic competitiveness by helping railroads determine how to expand rail network capacity in an optimal manner that accounts for differing operational characteristics of passenger and freight trains using shared infrastructure. Sustainability is addressed through our support of technology transfer on the best current railroad environmental practices and other railroad environmental performance activities.

University of Illinois Chicago – COE

The rail vehicle and infrastructure dynamic modeling group is a new collaboration between Mechanical Engineering (multibody system dynamics) and Civil Engineering (geotechnical modeling). The coupling of these two disciplines for a holistic model of the rail vehicle and infrastructure dynamic system is a significant innovation. The recently released CAVE2 3D system to visualize these data is a next generation implementation of a previous ground-breaking product in Computer Science (graphics). Plastic rail ties are an advancement in Civil Engineering (recycling and sustainability).

University of Illinois Chicago – CUPPA

VC: Our project could assist transit and rail capital planners in making more effective decisions concerning the use and development of value capture strategies for funding.

Rail Safety: The issue of safety at rail crossings has not been studied in great detail for specific user groups such as pedestrians and bicyclists. This research project will continue the work started by the research team in the area of pedestrian safety at rail crossings and expand on it with additional data and analysis.

GIS: This project is expected to advance the existing environmental impact assessment of rail infrastructure and services by providing a system view of sustainability and one-stop database, so that life cycle impacts and the interactions among environmental, economic, social, and infrastructure systems can be incorporated in rail planning and management. **Freight:** It is widely recognized that freight activities and economic outputs are intimately connected. However, there is a dearth of tools that can quantify the impacts of increase/decrease/shifts in freight activities. This project will strive to develop such a tool based on broad assumptions of General Equilibrium of the Economy.

Michigan Tech University

Teacher workshop modules and field visit offered material and resources for teachers to take into the classroom. Mainly related to K-12 STEM education.

Rose-Hulman Institute of Technology

CE 490 Railroad Engineering – Technical elective for Civil Engineering students.

RHIT AREMA Student Chapter – Opportunity for Civil Engineering Students to learn about the rail industry and explore career opportunities in the industry.

b. What is the impact on other disciplines?

University of Illinois Urbana-Champaign

Work being conducted on statistical analysis of railroad tank car safety is being applied to highway truck hazardous materials transportation and the associated optimized risk-reduction methodology can be adapted to other transport modes as well. The Rail Vehicle Dynamics Class

is a first step towards expanding the educational aspects of the rail program at UIUC into Mechanical Engineering.

University of Illinois Chicago – CUPPA

VC: The coordination mechanisms studied under this project will apply and be of use to economic developers, municipal stakeholders, and the private development community.

Rail Safety: Issues of safety will likely lead to an impact on rail crossing design, safety 19 devices, signs, and markings. On a related note, the attitudes and behavior of the specific user groups will also be documented and extend the body of knowledge in these areas.

GIS: This project integrates safety, infrastructure, operations, planning, public transportation, and multimodal transportation into environmental impact assessment process.

Freight: This tool can be used for federal and regional transportation planning.

Michigan Tech University

Current research is conducted by faculty and students in Civil, Materials and Mechanical Engineering and in Cognitive sciences. Dialog between team members provide good opportunities for interdisciplinary learning.

University of Kentucky

Electric Engineering, using structured light to scan object at large scale.

Rose-Hulman Institute of Technology

CE 490 Railroad Engineering – Technical elective for Mechanical and Electrical Engineering students.

RHIT AREMA Student Chapter – Open to all RHIT Students to learn about the rail industry and careers opportunities in the rail industry.

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

University of Illinois Urbana-Champaign

UIUC taught four rail courses in Spring 2013, two of which were new classes, **High Speed Rail Construction Management** (the first of its kind at UIUC and internationally) and **Railway Vehicle Dynamics** (the first offering at UIUC). The total enrollment in these three classes was over 100 undergraduate and graduate students. Many of these students will be pursuing careers in rail transportation. These classes have the dual impact of motivating student interest in such careers and improving their capabilities once they enter the workforce.

University of Illinois Chicago – COE

Students are involved in all of our major research thrusts: Rail Vehicle and Infrastructure dynamic modeling and computer graphic visualization; new materials for infrastructure (recycled plastic cross-ties). In addition to these research opportunities for selected students, all students will also have access to the taught upper undergraduate and graduate course in **Railroad Vehicle Dynamics**, now a regular catalogue course (previously a Special Topic).

University of Illinois Chicago – CUPPA

Overall: The Metra management training project will focus on developing current transportation employees into more effective managers.

VC: Graduate students have been and will continue to assist with research and case studies for this project.

Rail Safety: Educational tools that provide a better understanding about the risks and impacts of safety at rail crossings will likely be developed and be of use in the training of rail operators, and other stakeholders.

GIS: This project has been supporting two graduate research assistants in Urban Planning and Policy at UIC; one is a female and minority 20 (Mexican-American).

Freight: This research will provide a rich case study of the relationship between freight-related development project and the regional economy that can be used as a course material.

Massachusetts Institute of Technology

Two MS theses and one PhD dissertation in progress as well as two student internships (USDOT, SNCF) Five students sponsored at the TRB annual meeting as well as a HSR symposium. Also worked with High School students on a rail related term project.

Michigan Tech University

Several students had opportunity to visit 2013 Joint Rail Conference where they got to meet over 200 industry professionals and student colleagues. Teacher workshop highlighted future opportunities in transportation industry. Hopefully a message they will carry to their classrooms.

University of Kentucky

Educating undergraduate and graduate students in civil engineering is the principal impact.

University of Tennessee, Knoxville

The research portion of the program is presently supporting several graduate students focusing on transportation careers. The program supports the UTK AREMA student chapter, and funded the attendance of three undergraduate students to JRC 2013. The program provides speaker and chapter financial support, with speakers including Mr. James Carter, AREMA 2012-1013 President. One graduating student accepted a position with a Class 1 railroad, and another undergraduate is interning during Summer 2013 with a second Class 1 railroad.

Rose-Hulman Institute of Technology

Expectations for CE/EE/ME students to consider railroad engineering as a potential career path.

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

University of Illinois Urbana-Champaign

A new laboratory facility is being equipped to support railway research activities involving both civil and mechanical engineering. It will include a full-scale track loading test bed that will allow experimentation and testing of the complete track system (rail, ties and ballast). The facility should be operational by the end of 2013.

University of Illinois Chicago – CUPPA

Overall: This program will help us solidify research connections between internal groups at CUPPA and to develop further our CN Fellowship program.

GIS: This integrated environmental GIS database may allow the users to specify the rail facility or land area of interest, access data from multiple departments, and evaluate the multi-facet environmental impacts in one database. Essentially, this research may help facilitate the coordination among multiple departments in both rail system planning and operation processes.

University of Kentucky

Instrumentation and mobile field test equipment

University of Tennessee, Knoxville

A new building housing the Civil/Environmental and Industrial/Systems Engineering Departments opens Fall semester 2013. This building has state-of-the-art laboratories, including a high-bay structures lab with reaction walls/floor, geotechnical laboratory, and materials laboratory. These facilities will be used almost immediately in ongoing NURail research, and will greatly enhance future NURail research at UTK in these areas. The new building will also house the locomotive simulator presently in development.

e. What is the impact on technology transfer?

University of Illinois Urbana-Champaign

As projects progress, value and impact of technology transfer will increase.

University of Illinois Chicago – CUPPA

All of our projects will be in the public domain and be available for use by the public sector and rail industry.

University of Tennessee, Knoxville

Several of the research projects have potential impacts via technology transfer. One project is assessing how China improved railway infrastructure during their six speed up campaigns to boost railway operating performance and increase capacity. A second project is assessing the performance of high performance composite beams for railway bridge construction.

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

University of Illinois Urbana-Champaign

More efficient rail operations can benefit society through improved mobility; increased economic competitiveness and activity; and a more sustainable transportation system with reduced environmental impacts.

University of Illinois Chicago – COE

The holistic simulation of the rail vehicle and infrastructure system could lead to a better understanding of the safe operation of rail vehicles in mixed-use corridors that could ultimately affect regulatory policies, economic competitiveness, and livable communities. Advanced visualization of rail problems could better inform public policy decision makers. Use of recycled plastic rail ties currently being tested could increase the useful life and environmental sustainability of railroad infrastructure.

University of Illinois Chicago – CUPPA

Overall: Our research into environmental, safety, and economic issues surrounding freight and passenger rail positively impact society by trying to advance equitable and safe ideas for rail network development.

Freight: The findings from this study will influence public policy toward prioritizing various needs for public support for economic development/job creation initiatives, including intermodal terminal development.

Massachusetts Institute of Technology

Our research considers regional economic development enabled by the deployment of HSR systems. Further, there are environmental considerations given the more benign characteristics of HSR compared with alternative modes. More generally put, our research is of value when one

considers sustainable development, of great importance in contemporary society.

University of Kentucky

Safety and economy of the general public is impacted.

University of Tennessee, Knoxville

Increasing the stature and performance of rail transportation has broad potential societal benefits, including, but not limited to, economic, environmental, and quality of life. It would be immodest to state the UTK projects will themselves have significant impacts, but they will add to the cumulative body of railway knowledge that does have the potential for broad societal impacts.

Rose-Hulman Institute of Technology

Exposure of undergraduate engineering students to railroad engineering and career opportunities in the rail and related design, construction, rail support industries.

5. Changes/Problems

a. Changes in approach and reasons for change

University of Kentucky - Structured light was discovered as a promising technique for the 3D rail crossing sensor, so even though that was not in the original plan it was investigated first. Low cost commercially available sensors (Kinect) will be investigated during the next year as was in the original plan.

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

Nothing to report.

c. Changes that have a significant impact on expenditures them

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 them.

Nothing to report.