

2nd Quarterly 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 that reads "Chris Barkan". The signature is fluid and cursive, with the first name "Chris" and last name "Barkan" clearly legible.

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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? .....	7
d. What do you plan to do during the next reporting period to accomplish the goals? .....	8
2. Products: What has the program produced .....	10
a. Publications, conference papers, and presentations .....	10
b. Journal publications: .....	11
c. Books or other non-periodical, one-time publications: .....	11
d. Other publications, conference papers and presentations: .....	12
e. Website(s) or other Internet site(s): .....	13
f. Technologies or techniques: .....	13
g. Inventions, patent applications and/or licenses: .....	14
h. Other products: .....	14
3. Participants and Other Collaborating Organizations .....	15
a. Partners .....	15
b. Additional collaborators .....	16
4. Impact .....	17
a. What is the impact on the development of the principal discipline(s) of the program? .....	17
b. What is the impact on other disciplines? .....	18
c. What is the impact on the development of transportation workforce development? .....	19
d. What is the impact on physical, institutional and information resources at the university or other partner institutions? .....	20
e. What is the impact on technology transfer? .....	21
f. What is the impact on society beyond science and technology? .....	21
5. Changes/Problems .....	22
a. Changes in approach and reasons for change .....	22
b. Actual or anticipated problems or delays and actions or plans to resolve them .....	23
c. Changes that have a significant impact on expenditures .....	24
d. Significant changes in use or care of human subjects, vertebrate animals and/or biohazards .....	24
e. Change of primary performance site location from that originally proposed .....	25

## 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?

#### NURail Consortium

**Vehicle and Infrastructure Modeling:** The first NURail collaborative workshop to implement the Strategic Development Plan in the area of Rail Vehicle/Track Interaction and Dynamics was held on the Sunday of the AREMA conference (16 Sept. 2012) in the facilities of the Electronic Visualization Laboratory (EVL) in the UIC College of Engineering. Introductions, overviews, and technical papers on problems of Vehicle/Track interaction were presented by representatives of UIUC, UIC, and UKY. There was also a demonstration of the EVL's new CAVE2 3D virtual reality theater, which can be used to visualize and interpret the results of railroad vehicle and track dynamic simulations. The workshop was attended by approximately 30 participants, including representatives of industry (Amtrak and Enesco), non-NURail universities (Northern Illinois University and Penn State University), and federal agencies (FRA) in addition to professors and graduate students from the three NURail universities that provided presentations. **Outreach and Education:** In September, the NURail Center participated in the 2012 American Railway Engineering and Maintenance-of-Way Association Annual Conference trade show with a booth display that allowed NURail faculty and students to interact with railway industry representatives and promote the center and its educational and research projects. **Technology Transfer & Leadership:** The NURail Center agreed to co-sponsor the **2013 Joint Rail Conference** which is the largest annual rail research conference in North America. It will be held at the University of Tennessee at Knoxville. Prof. David Clarke is leading the conference organizing committee. Several NURail faculty members are also participating on the Conference Organizing Committee and as Technical Program Chairs. NURail Center members are also involved in the review and approval process for conference abstracts and papers.

#### University of Illinois Urbana-Champaign

**Research: High Speed Rail Feasibility Study:** NURail faculty, staff, and students are part of a team conducting 220 MPH HSR Feasibility Study for the Illinois Department of Transportation (IDOT). The project scope addresses a proposed 220 MPH high-speed rail (HSR) corridor from Chicago-O'Hare International Airport to Champaign, IL with connecting links to St. Louis, MO and Indianapolis, IN. The project team is analyzing a number of factors in the study including route selections, engineering, capital costs, operations and maintenance costs, ridership, economic impacts and financing and implementation strategies. During this reporting period, the project team completed Phase 2 with a focus on integration issues involving the various teams, modeling, and the final results submitted in a report to the Illinois Department of Transportation (IDOT). **Railroad Capacity and Optimization Strategic Development Plan:** A series of

brainstorming sessions have been conducted to refine elements of the capacity and optimization strategic development plan and develop a set of projects and deliverables to be advanced in 2013. **Outreach and Education: Lecture Series:** UIUC faculty contributed four rail lectures to the “Issues in Future U.S. Rail Transportation” lecture series hosted by Saint Louis University and hosted a documentary film crew from SLU in support of their in-production “*Renewal of Rail*” television documentary. Segments filmed at UIUC included faculty and students in interviews and explaining laboratory and field rail engineering equipment, concepts and research. **Hay Seminar Series:** During the Fall 2012 semester, UIUC hosted five on-campus seminars from industry experts that were also broadcast online. **High Speed Rail Planning Course:** Profs. T.C. Kao and Rapik Saat developed and taught a new course in the Fall 2012 semester that encompassed the planning, engineering, capital and operating cost, ridership, economic impacts, and financing of a high-speed rail system. The major class project yielded a feasibility study of a HSR line between Chicago and Milwaukee. The class included online students from industry in North America and also from other countries. **High Speed Rail Construction Management Course:** Profs. T.C. Kao and Rapik Saat began development of a new course to be taught in Spring 2013 that will cover the management of HSR construction through the various phases and processes of constructing, procuring, monitoring, testing and commissioning a HSR system. **Railway Transportation and Engineering Course Updates:** Professor Chris Barkan and Tyler Dick revised and updated approximately one-third of the lecture content in the introductory Railway Transportation and Engineering Course taught in the Fall 2012 semester and developed several new assignments. The remaining content will be updated and revised in time for the Fall 2013 semester. **Railway Project Design and Construction Course Updates:** Lecturer Riley Edwards and Tyler Dick began the planning and developing new and expanded content for the Railway Project Planning and Design Course to be taught in the Spring 2013 semester. The new content will expand coverage of detailed railway geometric design, construction phasing considerations and considerations for utilities. **Technology Transfer:** In October, the 2012 **Railroad Environmental Conference** was hosted at UIUC. Over 500 attendees exchanged views, learned about new techniques and technologies, and were updated on the direction of the railroad industry’s environmental programs through over 70 spoken presentations. UIUC also hosted the **Canada-U.S. Workshop on Reducing Locomotive Emissions** organized by Transport Canada and the US EPA to assess current, emerging and advanced technologies and practices intended to reduce GHG and CAC emissions from railway locomotives and railway operations. **International Cooperation:** A key element of the NURail Center is establishing collaboration with overseas rail organizations to exchange information and foster research that takes advantage of mutual expertise in freight and passenger rail engineering and transport. In addition to international participation at the above conferences, NURail collaboration has been advanced in Europe and Asia. **Rail Research and Educational Cooperation with KTH (Swedish Royal Institute of Technology):** KTH students participated as online students in the UIUC HSR Planning course. Planning was completed for a Rail Vehicles Dynamics class to be taught at UIUC in the Spring 2013 semester by visiting KTH faculty and NURail faculty. **Asian Rail Institutes Cooperation:** NURail Center principals made a two-week trip to China, South Korea and Japan to meet with government agencies, railroad companies, rail suppliers, rail research organizations and university rail engineering and transport programs to establish cooperative research and educational relationships. This trip also included meetings supporting the US DOT/CARS cooperative efforts referenced above.

## University of Illinois Chicago – COE

**Vehicle and Infrastructure Modeling:** A linear elastic finite element (FE) model of the track and substructure (ties, ballast, subballast, and subgrade) has been created and a modal analysis of this model has been performed. The modes have been imported into the Multibody system (MBS) code SAMS/Rail for the dynamic analysis of an idealized suspended wheel set, which is a standard academic test for new software. The output of this model has been successfully exported to a 3D visualization platform (CAVE2; below). The models have designed to make it easy to export new finite element models to SAMS/Rail for new conditions, and generate new outputs for visualization. Work has begun on an advanced nonlinear soil model for more sophisticated modeling of the substructure, which will lead to practical studies of how substructure problems can contribute to derailments. **Visualization:** A standardized process to convert simulation data types into visualizations has been developed (under NSF funding) and is now operational within the state-of-the-art CAVE2 Hybrid Reality Environment of the UIC Electronic Visualization Laboratory (EVL). Data types supported include the Absolute Nodal Coordinate Formulation (ANCF) as well as Floating Frame of Reference (FFR). **Railway Infrastructure Materials and Design:** (1) A literature review of High Speed Rail (HSR) structures has been completed including rail pads, cross-ties, and fastening systems. (2) Experimental fixtures have been set up for recycled plastic composite rail ties. A static test with three-point load is underway to determine mechanical properties such as flexural modulus of elasticity, flexural stiffness, and modes of failure. This will be followed by cyclic loading of the plastic ties and tests of complete track assemblies using plastic ties. (3) Interaction of HSR tracks with elevated structures (bridges, etc.) is being modeled by ANSYS to determine lateral stiffness of the bridge-track interface, which could affect the probability of rail buckling and vehicle derailment. **Railroad Systems:** The Rail Traveler Assistant (RTA) smartphone application helps passengers make modal transitions in and out of the rail mode, e.g. by a parking navigator, “Phone Park.” Current research focuses on algorithms that will estimate the average number of parking slots on each city block.

## University of Illinois Chicago – CUPPA

There are four research projects within UIC-CUPPA. Those projects are listed as follows with abbreviations in parentheses: Value Capture Coordination (VC), Rail Crossing Safety (Rail Safety), GIS Analysis of Environmental Impacts of Rail Development (GIS), and Economic Impacts of Freight Mode Choice (Freight). **VC:** Staff and Research Assistants have commenced a literature review of pertinent value capture, transit planning, and coordination materials. An annotated bibliography is currently being developed into a full literature review report. **Rail Safety:** Nothing to report. **GIS:** A preliminary “Illinois Sustainable Rail Scorecard” was drafted to incorporate the environmental, ecological, economic, and social impacts of rail transportation. It has integrated the existing and latest development in rail legislation, academic research, professional reports, as well as the Illinois Livable and Sustainable Transportation Rating System and Guide (I-LAST). This Scorecard provides the basis for the environmental GIS database development. In correspondence to the sustainability indicators, multi-disciplinary data have been collected and assessed with an emphasis on the indicators that can be spatially represented. Potential collaborators and partners were identified for the stakeholder meeting to be held in spring 2013. **Freight:** For the Freight Development project, a graduate research assistant was hired and began a literature review on the development impacts of freight centers. The coding of a Computable General Equilibrium (CGE) model that can be used to simulate the economic impact of shifts in

freight activities has begun by modifying an existing CGE model for the Chicago region. UIC-CUPPA has also engaged in education-related activities. A proposal for establishing a Public Transit Planning and Management Campus Certificate was approved by the College Education Policy Committee.

### **Massachusetts Institute of Technology**

Project Initiation: MIT successfully recruited three excellent graduate students to work on its two NURail projects. They all spent time reviewing the literature in related areas and in developing a preliminary paper specifying their initial work, working directly with Professor Sussman. The group has weekly meeting at which the various members present their work. This meeting gives the NURail students a chance to meet with other students working on related work (e.g. the MIT-Portugal Program, Productivity Program). The team had the opportunity to participate in an outreach meeting on the NEC held in Boston in December 2012 and made some useful contributions to the discussions based on the NEC work by the research team.

### **Michigan Tech University**

***Michigan Tech-Education and Workforce Development:*** The third annual Rail and Intermodal Transportation Summer Youth Program was conducted for high school students at Michigan Tech, in collaboration with the University of Wisconsin-Superior. Ten high school students from around the nation spent one week in hands-on transportation related learning modules as well as field visits to rail and intermodal sites encouraging a stronger interest in rail related study and careers. Two transportation related university Senior Design projects are on-going with NURail or matching funds. Matching funds and scope of with Michigan Dept. of Transportation confirmed and awarded.

### **University of Kentucky**

One semester course was taught by Professor Rose, CE433 railroad Operations. Some of the materials were developed under the NURail umbrella. Nineteen students took the class. Two professors (Souleyrette, Rose) guest lectured at another NURail school (UT Knoxville) in their Railroad class (taught by Prof. Clarke).

### **University of Tennessee, Knoxville**

During the reporting period, UTK started two NURail research projects. Students were hired for assistantship positions and initial research activities initiated. Two research projects were approved and initiated, but will not start in earnest until Spring semester 2013. One education project was also started. UTK developed short courses on railroad track engineering and railroad track geometry analysis. One session of the track engineering class and three sessions of the track geometry analysis class have been offered to industry personnel. Ninety persons attended the four sessions. UTK also offered three classes on track inspection during the period, with total attendance of 72 persons.

### **Rose-Hulman Institute of Technology**

Education Projects: Rose-Hulman Institute of Technology (RHIT) faculty and students (17) attended the 2012 AREMA Conference and Exposition in Chicago. Work continues on the development of a RHIT undergraduate interdisciplinary rail road engineering

course. A senior design team is working with the Indiana Railroad Company and the City of Terre Haute for the design of the expansion of the Deming Park Spirit of Terre Haute Rail Road. A RHIT AREMA Student Chapter was organized and approved and is actively offering a number of student field trip opportunities and guest speakers from the rail road industry. Peter Ray, Vice President Engineering, Indiana Railroad Company, is the AREMA Student Chapter Industry Liaison.

**c. How have the results been disseminated?**

**NURail Consortium**

**University of Illinois Urbana-Champaign**

***Railroad Capacity and Optimization Strategic Development Plan:*** Preliminary results of ongoing capacity research were presented to the Association of American Railroads and to various industry representatives at the RTC User's Group Conference. ***Concrete Crosstie Fastener Sub-System Testing and Modeling:*** Results of ongoing research work were presented to a gathering of Industry Partners and to the AREMA Tie Committee (Committee 30) in Tampa, FL. Presentations were also made at the 2012 AREMA Technical Conference in Chicago, IL and at the 2012 ASME RTD Conference in Omaha, NE.

**University of Illinois Chicago – COE**

The capabilities of the UIC EVL CAVE2 to visualize high speed rail vehicle and track dynamics were featured on a recent NSF press video:  
<http://news.science360.gov/archives/20121214>.

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

Nothing to report

**University of Kentucky**

A presentation was given at an NTSB GIS for Transportation Safety Conference. We included information on the rail crossing 3D sensor we are building for NURail. NURail research at UK was also described in the guest lectures at UTK. Outreach was conducted to UNC Charlotte to potentially develop collaboration on Rail Energy research. Presentation was given to the Iowa DOT.

**University of Tennessee, Knoxville**

The research and education projects are in early stages and no results have yet been produced.

**Rose-Hulman Institute of Technology**

Nothing to report

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

**NURail Consortium**

**Technology Transfer & Leadership:** The NURail Center will host as a co-sponsor the 2013 Joint Rail Conference at the University of Tennessee at Knoxville during the next reporting period. Prof. David Clarke is leading the conference organizing committee (with participation of other NURail faculty) that is now tasked with final program planning and session development of the largest annual rail research conference in North America. NURail consortium faculty will host the second NURail collaborative workshop to implement the Strategic Development Plan in the area of Rail Vehicle/Track Interaction and Dynamics at the University of Illinois Urbana-Champaign in the Spring of 2013.

**University of Illinois Urbana-Champaign**

**Research: Railroad Capacity and Optimization Strategic Development Plan:** To complement ongoing research, formal work on projects related to components of the capacity and optimization strategic development plan will be initiated in 2013. **Outreach and Education: Hay Seminar Series:** During the Spring 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. **High Speed Rail Construction Management Course:** Profs. T.C. Kao and Rapik Saat will complete development and teach a new course in Spring 2013 that will cover the management of constructing, procuring, monitoring, testing and commissioning a HSR system. **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. **Railway Project Design and Construction Course Updates:** New lecture content and assignments will be included in the Railway Project Planning and Design Course to be taught in the Spring 2013 semester. **Engineering Open House:** Together with the UIUC AREMA Student Chapter, the NURail Center will sponsor railway engineering exhibits at the Engineering Open House event that is attended by 20,000 people, including over 12,000 primary and secondary students. **Technology Transfer:** Planning will begin and a Call for Papers issued for the 2013 **Railroad Environmental Conference** to be hosted by UIUC. **Concrete Crossties and Fastening Systems Workshop:** A workshop on Concrete Crosstie and Fastening Systems will be conducted by NURail faculty at the Transportation Research Board Annual Meeting in Washington D.C. in January. **Conference Presentations:** Papers and presentations on research supported by NURail will be 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, and International Association of Railway Operations Research Conference in Denmark in May. **International Cooperation: Rail Research and Educational Cooperation with KTH (Swedish Royal Institute of Technology):** The Rail Vehicle Dynamics course will be taught at UIUC in the Spring 2013 semester by NURail faculty and visiting faculty from the Swedish Royal Institute of Technology (KTH).

**University of Illinois Chicago – COE**



**Vehicle Dynamics and Infrastructure Modeling:** During the next six months we will verify our coupled vehicle-infrastructure model against examples in the literature, and then proceed to model more realistic and practical simulations, such as a bogey or rail vehicle design (as distinct from the current theoretical suspended wheel set). We also plan to study and optimize the number of mode shapes necessary to obtain an accurate solution. We will continue to develop and implement nonlinear soil models for future coupling with multibody codes, and will initiate greater collaboration with UIUC on this topic. **Railroad Systems:** Algorithms for “Phone Park” (part of Rail Traveler Assistant) rely on smartphone sensors (e.g. Bluetooth, GPS, and accelerometer), map information, and historical information about parking availability on city blocks. The next task is to design and evaluate algorithms that combine real-time observations of smartphones and historical statistics of parking availability. **Railway Infrastructure Materials and Design:** Tasks include: (1) Complete the lab tests on composite plastic ties and track assemblies; (2) Develop simulation models of High Speed Rail elevated structures using ANSYS; (3) Apply developed models of existing rail bridges for parametric calibrations and validations; (4) Model and implement the recycled plastic material as tie beams; (5) Determine the extent of the track-bridge interactions; (6) Assess the performance and feasibility of the new plastic materials in HSR applications.

#### University of Illinois Chicago – CUPPA

**VC:** The research team will focus on completing the literature review while engaging in a site selection and preliminary interview process for the case study portion of the project. **Rail Safety:** The research team has identified a student and has offered an assistantship for that individual to start work in the spring 2013 semester. We are currently looking at other candidates to fill the other position. **GIS:** Neighborhood-specific impact data will be modeled and added to the environmental impact database. A stakeholder meeting is planned and will be held in spring 2013. The meeting will help fine tune the “Illinois Sustainable Rail Scorecard” as well as the data inputs for the environmental GIS database. **Freight:** The coding of the CGE model will continue. The key milestone will be the identification of “closure” rules in the model that can reflect the impacts of changes in transportation sectors in appropriate manner. Literature review will focus on the CGE literature. Education: The Public Transit Planning and Management Campus Certificate will continue to move through the approval process while a workforce development initiative with Metra will continue to be developed.

#### Massachusetts Institute of Technology

With graduate students recruited and underway in their research, we are aiming substantial progress in research efforts. For each area of research we plan to complete the recruit undergraduates who will work as part of the MIT Undergraduate Research Opportunities Program (UROP). In several months, we expect each graduate student to complete an initial paper that reflects their research to date. Also, many of our students will participate in the TRB annual meeting in January 2013 in Washington. Our students have always benefitted from this exposure to practicing professions also.

#### Michigan Tech University

The 1<sup>st</sup> round of Student Senior Design Research Projects will be completed. Four MDOT projects (Upper Peninsula Freight Rail Study, Aggregate evaluation for ballast, Grade crossing surface evaluation and Michigan Rail Transportation Conference coordination) will be started.

### **University of Kentucky**

Continue work on 3D rail sensor and tie-ballast interaction. Also begin work on lock and dam closure impact. All other projects completed.

### **University of Tennessee, Knoxville**

Research and education projects will progress. Additional sessions of the railroad track engineering and track inspection workshops have been scheduled. A course on railroad bridge inspection is also scheduled.

### **Rose-Hulman Institute of Technology**

Education Projects: Continued development of the RHIT undergraduate interdisciplinary rail road engineering course. Dr. William Eccles is completing two electrical engineering/signaling modules. The recently formed AREMA student chapter has an interdisciplinary makeup and is active in campus and area activities.

## **2. Products: What has the program produced**

### **a. Publications, conference papers, and presentations**

#### **University of Illinois Urbana-Champaign**

***Railroad Capacity and Optimization Strategic Development Plan:*** Preliminary results of ongoing capacity research were presented to the Association of American Railroads and to various industry representatives at the RTC User's Group Conference. ***Conference Presentations:*** A presentation titled "Putting People First: A Systems Perspective on rail Safety" was given at the 1<sup>st</sup> International Symposium on High Speed rail Safety and Reliability Design and Management at the City University of Hong Kong in December.

#### **University of Illinois Chicago – COE**

Nothing to report

#### **University of Illinois Chicago – CUPPA**

Nothing to report

#### **Massachusetts Institute of Technology**

Nothing to report

#### **Michigan Tech University**

Nothing to report

#### **University of Kentucky**

A presentation was given at an NTSB GIS for Transportation Safety Conference that included information about the rail crossing 3D sensor (Opening remarks, Reginald Souleyrette, NTSB Conference on GIS for Transportation Safety, Dec 4, 2012, Washington, D.C.). An informal presentation was given to the Iowa DOT on the UK NURail research program. A presentation entitled "Rehabilitation Techniques to

Improve Long-Term Performances of Highway-Railway At-Grade Crossings was presented at the 2012 Southeastern Rail-Highway Safety Conference in Charlotte, NC in November by Jerry Rose.

**University of Tennessee, Knoxville**

Nothing to report

**Rose-Hulman Institute of Technology**

Nothing to report

**b. Journal publications:**

**University of Illinois Urbana-Champaign**

Nothing to report

**University of Illinois Chicago – COE**

Nothing to report

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

Nothing to report

**University of Kentucky**

Nothing to report

**University of Tennessee, Knoxville**

Nothing to report

**Rose-Hulman Institute of Technology**

Nothing to report

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

**University of Illinois Urbana-Champaign**

A final report for the high-speed rail (HSR) feasibility project was produced IDOT. A draft MS thesis on mechanisms of concrete tie wear and abrasion was completed.

**University of Illinois Chicago – COE**

Nothing to report

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

Nothing to report

**University of Kentucky**

Nothing to report

**University of Tennessee, Knoxville**

Clarke, David B., “Railway Engineering”, McGraw-Hill Encyclopedia of Science and Technology, 11th Edition, McGraw-Hill, New York, NY, September 2012.

**Rose-Hulman Institute of Technology**

Nothing to report

**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**

José L. Escalona, Hiroyuki Sugiyama, and Ahmed A. Shabana, “Effect of Structural Flexibility in Railroad Vehicle Systems,” Technical Report # MBS2012-4-UIC, Department of Mechanical and Industrial Engineering, University of Illinois at Chicago, December 2012. This internal UIC report will form the basis for peer-reviewed publications in 2013.

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

Nothing to report

**University of Kentucky**

A presentation was given at an NTSB GIS for Transportation Safety Conference. We included information on the rail crossing 3D sensor we are building for NURail. NURail research at UK was also described in the guest lectures at UTK. Outreach was conducted to UNC Charlotte to potentially develop collaboration on Rail Energy research. Presentation was given to the Iowa DOT.

**University of Tennessee, Knoxville**

Nothing to report

**Rose-Hulman Institute of Technology**

Nothing to report

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

**NURail Consortium**

The listing of initial research and education projects was uploaded to the NURail Center website and the TRB RiP database.

**University of Illinois Urbana-Champaign**

UIUC has developed a plan to refresh and expand content on the RailTEC website.

**University of Illinois Chicago – COE**

Nothing to report

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

We are undertaking a substantial upgrade of our “high speed rail/ regions” websites

**Michigan Tech University**

Nothing to report

**University of Kentucky**

A website for the UK Railroad student group was developed.  
<http://railcats.engineering.uky.edu/>

**University of Tennessee, Knoxville**

Nothing to report

**Rose-Hulman Institute of Technology**

Nothing to report

**f. Technologies or techniques:**

**University of Illinois Urbana-Champaign**

Nothing to report

**University of Illinois Chicago – COE**

Nothing to report

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

Developed and tested a method to measure railroad wheel temperatures wirelessly.

**University of Kentucky**

The “structured light” technique is being used to develop the rail crossing 3D sensor. A prototype sensor has been developed and is being tested. Tekscan sensors are being deployed to measure tie-ballast interaction.

**University of Tennessee, Knoxville**

Nothing to report

**Rose-Hulman Institute of Technology**

Nothing to report

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

**University of Illinois Urbana-Champaign**

Nothing to report

**University of Illinois Chicago – COE**

Nothing to report

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

Nothing to report

**University of Kentucky**

Nothing to report

**University of Tennessee, Knoxville**

Nothing to report

**Rose-Hulman Institute of Technology**

Nothing to report

**h. Other products:**

**University of Illinois Urbana-Champaign**

Nothing to report

**University of Illinois Chicago – COE**

The Vehicle and Infrastructure dynamic modeling group is developing techniques for incorporating infrastructure vibration mode information into the existing Multibody System code SAMS/Rail. This will result in new integrated vehicle-plus-infrastructure modeling software which can be transferred to other groups.

**University of Illinois Chicago – CUPPA**

Nothing to report

### Massachusetts Institute of Technology

Nothing to report

### Michigan Tech University

Nothing to report

### University of Kentucky

Information has been collected and compiled for the six modes of transportation including motor trucking, air, water, rail, pipelines, and overland conveyors. Information for each mode includes topics such as industry overviews, vehicle types, industry structures, and intermodal aspects. Curriculum has been developed which can be used to teach a multi-modal transportation course, including power point presentation and accompanying texts and references. A Draft Final Report was completed for A SURVEY OF U.S. COMMUTER RAIL by Timothy J. Brock, M.A., Research Associate, Kentucky Transportation Center, University of Kentucky, and Reginald R. Souleyrette, Ph.D., P.E., Professor of Transportation Engineering and Commonwealth Chair, College of Engineering, University of Kentucky

### University of Tennessee, Knoxville

Nothing to report

### Rose-Hulman Institute of Technology

Nothing to report

## 3. Participants and Other Collaborating Organizations

### a. Partners

<b>Organization Name:</b>	<b>Location of the Organization:</b>	<b>Partner's contribution to the Project:</b>	<b>Name (First and Last)</b>	<b>University</b>
Indiana Railroad	Indianapolis, IN	In-kind, Collaborative Support, Technical Assistance, Mentorship to Students	Jim McKinney	Rose-Hulman
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
CN	Montreal, Quebec	Financial support	Stephen Schlickman	University of Illinois-Chicago

Nothing to report				MIT
Nothing to report				UIC-COE
Michigan Dept. of Transportation	Lansing, MI	Financial and collaborative support	Mark Polsdofer	Michigan Tech
Union Pacific Railroad	Omaha, NE	Financial and collaborative support	Mike Iden	Michigan Tech
Lake Superior & Ishpeming Railroad	Ishpeming, MI	Collaborative support and facilities	James Scullion	Michigan Tech
University of Wisconsin-Superior	Superior, WI	Collaborative support	Dr. Richard Stewart	Michigan Tech
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 Taiwan University	Taipei, Taiwan	Collaborative Support	Yung-Cheng (Rex) Lai	UIUC
KTH (Royal Institute of Technology)	Stockholm, Sweden	Collaborative Support, Joint Class Development	Sebastian Stichel	UIUC

**b. Additional collaborators**

**University of Illinois Urbana-Champaign**

Nothing to report

**University of Illinois Chicago – COE**

Nothing to report – UIC COE

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

Nothing to report



### **Michigan Tech University**

A contract was established between Michigan Tech and the Michigan Department of Transportation (MDOT) for collaborative research including:

- Rural Freight Rail and Multimodal Transportation Improvements Research Project
- Infrastructure Evaluation of Available Ballast Material in Michigan Quarries Research Project
- Undergraduate Student Enterprise Project on grade crossing surface performance Michigan Rail Transportation Conference

### **University of Kentucky**

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

### **University of Tennessee, Knoxville**

Dept. of Civil and Environmental Engineering, UTK, In-kind support, facilities  
Dept. of Industrial Engineering, UTK, In-kind support

### **Rose-Hulman Institute of Technology**

Nothing to report

## **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). The Rail Traveler Assistant advances the techniques for crowd-sourcing of travel information within Computer Science (distributed and mobile computing). 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.

**Massachusetts Institute of Technology**

No change

**Michigan Tech University**

Educational modules and other supporting materials developed to REES event are the primary resource for participating professors to introduce rail transportation/ engineering to their classrooms. These apply mainly to civil engineering discipline.

**University of Kentucky**

Civil Engineering, impact is on curriculum.

**University of Tennessee, Knoxville**

Research program activities are not far enough advanced for impacts to be assessed.

**Rose-Hulman Institute of Technology**

Nothing to report

**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 – COE**

Nothing to report

**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

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.

#### **Massachusetts Institute of Technology**

Nothing to report

#### **Michigan Tech University**

Some REES materials also address topics related to electrical and mechanical engineering.

#### **University of Kentucky**

Electrical Engineering, impact is on the application of sensors to the rail industry.

#### **University of Tennessee, Knoxville**

Research program activities are not far enough advanced for impacts to be assessed.

#### **Rose-Hulman Institute of Technology**

Expectations for CE/EE/ME students to be exposed Railroad Engineering as a viable technical elective in their individual plan of study

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

#### **University of Illinois Urbana-Champaign**

UIUC taught three rail courses in Fall 2012, one of which was a new class, *High Speed Rail Planning* has never before been taught at UIUC or elsewhere. The total enrollment in these three classes was over 120 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. UIUC faculty is working closely with railroads and other rail transportation firms and organizations to assist with student placement in summer internships and full-time jobs at the conclusion of the 2012-2013 academic year.

#### **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), and rail traveler smartphone applications. 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

(Mexican-American). Freight: This tool can estimate the job creation impacts, by economic sector, of mode shifts from truck to rail or vice versa.

#### **Massachusetts Institute of Technology**

Nothing to report

#### **Michigan Tech University**

Summer Youth Program in Rail and Intermodal Transportation provided industry exposure to high school students. Incorporation of REES materials exposes more university students to the field.

#### **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 a number of graduate students focusing on transportation. Seven undergraduate students enrolled in “Design of Railway Transportation Systems” offered Fall semester 2012. Several of the students are interested in railway careers. The program supports the UTK AREMA student chapter, and funded the attendance of five students to the 2012 AREMA annual conference in Chicago. Besides providing speaker and chapter financial support, the program sponsored a tour of the Knoxville Locomotive Works in October 2012. Dr. David Clarke will make a presentation on High Speed Rail to students at the Knoxville STEM High School in January 2013.

#### **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 planned to support rail research activities involving both civil and mechanical engineering.

#### **University of Illinois Chicago – COE**

Research on the structural mechanics of recycled plastic rail ties continues to require equipment improvements to the Structural and Concrete Materials Research Laboratory at UIC (Prof. Mohsen Issa).

#### **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. VC: Rail Safety: Nothing to report. 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. Freight: Nothing to report.

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

Nothing to report

**University of Kentucky**

Instrumentation and mobile field test equipment (3D rail crossing sensor and tie-ballast interaction measurement test bed).

**University of Tennessee, Knoxville**

The program is working to develop a full-scale locomotive simulator for use in human factors research at UTK.

**Rose-Hulman Institute of Technology**

Nothing to report

**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 – COE**

Nothing to report

**University of Illinois Chicago – CUPPA**

Overall: All of our projects will be in the public domain and be available for use by the public sector and rail industry VC: Nothing to report. Rail Safety: Nothing to report. GIS: Nothing to report. Freight: Nothing to report.

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

Nothing to report

**University of Kentucky**

Nothing yet, but potential application in the rail industry (class I and smaller) and DOTs (3D rail crossing sensor) and rail industry (tie-ballast sensor).

**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.

**Rose-Hulman Institute of Technology**

Nothing to report

**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. Products such as the Rail Traveler Assistant could influence traveler behavior toward greater use of passenger rail.

### **University of Illinois Chicago – CUPPA**

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.

### **Massachusetts Institute of Technology**

The research being conducted under NURail directly affects mobility, economic development and potentially environmental impact and global climate change, all vital critical contemporary issues (CCI). Through our connection to the Engineering Systems Division at MIT, our work contributes to methods to study Complex Sociotechnical Systems (CSS).

### **Michigan Tech University**

Nothing to report

### **University of Kentucky**

Improvement of safety for the general public. Economic impact of more efficient rail operations.

### **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.

### **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 Illinois Urbana-Champaign**

Nothing to report

#### **University of Illinois Chicago – COE**

Nothing to report

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

Nothing to report

**University of Kentucky**

Structured light was discovered as a promising technique for the 3D rail crossing sensor, so we investigated that first (not in original plan). We will investigate low cost commercially available sensors (Kinect) during the next year (that was in the original plan).

**University of Tennessee, Knoxville**

Nothing to report

**Rose-Hulman Institute of Technology**

Nothing to report

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

**University of Illinois Urbana-Champaign**

Nothing to report

**University of Illinois Chicago – COE**

We have successfully located a supplier of structurally reinforced recycled plastic rail ties to use for testing purposes, and also have contracted services to install rails and fasteners on these ties.

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

MDOT projects significantly delayed due to contractual issues...now resolved.

**University of Kentucky**

Nothing to report

**University of Tennessee, Knoxville**

Nothing to report

**Rose-Hulman Institute of Technology**

Nothing to report

**c. Changes that have a significant impact on expenditures**

**University of Illinois Urbana-Champaign**

Nothing to report

**University of Illinois Chicago – COE**

Nothing to report

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

Nothing to report

**University of Kentucky**

Nothing to report

**University of Tennessee, Knoxville**

Nothing to report

**Rose-Hulman Institute of Technology**

Nothing to report

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

**University of Illinois Urbana-Champaign**

Nothing to report

**University of Illinois Chicago – COE**

Nothing to report

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

Nothing to report

**University of Kentucky**

Nothing to report

**University of Tennessee, Knoxville**

Nothing to report



**Rose-Hulman Institute of Technology**

Nothing to report

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

**University of Illinois Urbana-Champaign**

Nothing to report

**University of Illinois Chicago – COE**

Nothing to report

**University of Illinois Chicago – CUPPA**

Nothing to report

**Massachusetts Institute of Technology**

Nothing to report

**Michigan Tech University**

Nothing to report

**University of Kentucky**

Nothing to report

**University of Tennessee, Knoxville**

Nothing to report

**Rose-Hulman Institute of Technology**

Nothing to report