

10th Quarterly Program Progress Performance Report
for
National University Rail (NURail) Center:
Tier 1 University Transportation Center



National University Rail Center - NURail

USDOT OST-R 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.

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1. Accomplishments

a. What are the major goals of the program?

The NURail Center is a rail-focused seven-university consortium led by the Rail Transportation and Engineering Center (RailTEC) at the University of Illinois at Urbana-Champaign (UIUC). NURail's principal goals were to achieve a set of Research, Education, Technology Transfer Collaboration and Leadership objectives that not only fulfilled center objectives, but supported and assisted achievement of goals beyond the consortium members. These included rail industry, AAR and FRA research and workforce development goals. They also included 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

- Consortium partners wrote 15 final reports in the past seven months, one interim report and four research briefs. Details in section 2d.
- Between July 1, 2016 and January 31, 2017 the NURail website had almost 6,000 unique visits and over 10,500 page loads.
- NURail Center Annual Meeting held in July 2016 as part of The Railway Academic Conference (TRAC) on the UIUC campus.
- Three NURail students were presented with honors on January 7, 2017 during the CUTC Awards Banquet at the 96th Transportation Research Board Meeting in Washington, D.C.

University of Illinois Urbana-Champaign

- **Railroad Capacity and Optimization:** Completed a NURail Final Report based on a PhD preliminary dissertation document. Although the research is complete, it is anticipated that the final written dissertation will be defended and deposited by mid-2017.
- **Hay Seminar Series:** Hosted four on-campus seminars from industry experts that were also broadcast online. Total both online and in person attendees for the seminars was 702 participants.
- **Railway Maintenance Planning:** Completed a NURail Final Report based on a PhD preliminary dissertation document. Although the research is complete, it is anticipated the final written dissertation will be defended and deposited by mid-2017.
- **TRAC:** Event brought railway academics and industry practitioners together to discuss current and future challenges related to workforce development, student recruiting and collaborative research for the railway industry. Also served as the 2016 Railway Engineering Education Symposium (REES) to train other university professors on railway engineering concepts and principles related to railway operations.

- K-12: Twenty one students, grades 3- 5, from a science, technology, engineering, art and math (STEAM) summer camp spent the day on the UIUC campus focusing on railroad planning, construction and safety, as well as investigating the physics of rail transportation.

University of Illinois Chicago

- Connector Transitway: Whitepaper completed in August of 2016.
- Off Peak Delivery Pilot Project: Final report completed in August of 2016.
- CTA Pedestrian/Cyclist Safety: Final report completed in late 2015, but finalized in mid-2016.

Massachusetts Institute of Technology

- Completed integration of new students who began in September 2016 and they are working productively. Includes work on the NEC, CA HSR, Midwest HSR (Chicago to Urbana/Champaign) and the relation of HSR to urban transportation systems (case study of Penn Station and Hudson River Tunnels in NY City).
- Weekly meeting at which the various members present their work. Meeting gives NURail students a chance to meet with other students working on related work.
- Participated in several outreach meetings on the NEC and made useful contributions to the discussions based on the NEC work by the research team.
- Jayne Chang (CEE SB '16) a Regional Transportation and High-Speed Rail (R/HSR) alumna completed her internship at East Japan Railway Company (JR East) in December 2016. She spearheaded a project entitled "Examining the Provision of Railway Transit Information to Foreign Visitors in the Tokyo Metropolitan Area and Strategies for Improvement."
- Joanna Moody of the R/HSR research group was selected to receive the 2016 Charley V. Wootan Memorial Award for outstanding Master's Thesis in Policy and Planning, given annually by the Council of University Transportation Centers (CUTC). The thesis was titled: "Development of a Predictive Coalition building Analysis for Stakeholders of Sociotechnical Systems." The award was presented at the CUTC reception at the 96th annual meeting of the Transportation Research Board in Washington D.C. on January 7, 2017.

Michigan Tech University

- The Effects of Auditory Warnings and Driver Distraction on Rail Crossing Safety (by Dr. "Philart" Jeon); Project completed and MS Thesis submitted to the University. Results suggest that auditory alerts designed and tested in the study improved the visual scanning behaviors of the pilot participants, as well as encouraged more compliant driving behavior on approach to RR crossings. Manuscript for journal publication is under development.
- Alloy Design and Testing of Austempered Ductile Iron for Rail Wheels (by Dr. Paul Sanders); Completed research work and submitted final report.
- Rail Embankment Stabilization for Cold Climate Railroads – Case of Hudson Bay Railway (by Dr. Thomas Oommen); Completed research work and developed draft final report for Omnitrax, Inc. review (pending). Published paper in *AIMS Geosciences Journal*.

c. How have the results been disseminated?

NURail Consortium

- In the August 2016 issue of Railway Track & Structures (RT&S), AREMA President Brian A. Lindamood discussed his attendance at The Railway Academic Conference (TRAC), a combination of the Railway Engineering Education Symposium (REES) and the NURail Annual Meeting, held on the UIUC campus in July.
- The final reports for projects were posted on the NURail website.

University of Illinois Urbana-Champaign

- Conference Presentations: Papers and presentations were delivered at:
 - The Railway Academic Conference in Urbana, Illinois in July.
 - AREMA Annual Meeting in Orlando in August.
 - INFORMS Annual Meeting in Nashville in November.
 - TRB Annual Meeting in Washington D.C. in January.
- NURail Final Reports:
 - Railroad Decision Support Tools for Track Maintenance
 - Capacity Evaluation and Infrastructure Planning Techniques for Operation of Freight and Higher-Speed Passenger Trains on Shared Railway Corridors
 - Mechanistic Design of Concrete Crossties and Fastening Systems
 - “Grow Our Own” Minority STEM Initiative: Partnering in Outreach.
 - New Semester Course in Railway Terminal Design & Operations
 - Railway Transportation Engineering (CEE 408) Course Updates and Online Conversion

University of Illinois Chicago

- For each project, a news story was prepared and disseminated to a wide range of national and local transportation and general interest writers and bloggers.
- News story for the CTA Safety Report was distributed further by the UIC Public Affairs department.
- Each news story and a related abstract with a link to the complete report was posted on separate pages on the UTC website.
- Short news items on each report was posted on the UTC website News page; and the UTC employed social media channels to further spread the news.

Massachusetts Institute of Technology

- Results continue to be disseminated through professional publications and presentations, as noted below.
- Participated in several NEC public participation meetings at which our results were discussed or were implicit in our comments.
- Much of our work appears on the following website:
<http://web.mit.edu/hsr-group/index.html>

Michigan Tech University

- The Effects of Auditory Warnings and Driver Distraction on Rail Crossing Safety (by Dr. “Philart” Jeon); Submitted a paper; Jeon, M., Landry, S., Lautala P.,

Nelson, D., Design and Assessment of In-Vehicle Auditory Alerts for Highway-Rail Grade Crossings, Transportation Research Part F: Psychology and Behaviour (under review since October, 2016). Also, Steven Landry presented the work at the ABH 060 Highway Rail Grade Crossing Committee meeting as part of the 2017 TRB Annual Meeting.

- Computer Vision and Machine Learning Method for Detection and Assessment of Wheel Anomalies Using Sensor Fusion of Thermal and Visible Spectrum Cameras (by Dr. Tim Havens); Submitted a paper; Deilamsalehy, H. Havens, T., Lautala P., Sensor Fusion of Wayside Visible and Thermal Imagery for Rail Car Wheel and Bearing Damage Detection, ASME/ASCE/IEEE 2017 Joint Rail Conference, Philadelphia, PA, April 4-7, 2017 (accepted for presentation).
- Rail Embankment Stabilization for Cold Climate Railroads – Case of Hudson Bay Railway (by Dr. Thomas Oommen); Published a paper; Addison, P., Lautala, P., Oommen, T., Using Track Surface Roughness as a Quality Measure for Railway Maintenance in a Permafrost Region, Transportation Geotechnics (2016) <http://www.aimspress.com/article/10.3934/geosci.2016.4.329>.

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

University of Illinois Chicago

- Complete the Phase 2 of the Value Capture research; target date is late First Quarter 2017. Identify other opportunities to disseminate completed research findings.

Massachusetts Institute of Technology

- Will continue to achieve substantial progress in our research efforts.

Michigan Tech University

- Submit final report of “Rail Embankment Stabilization for Cold Climate Railroads – Case of Hudson Bay Railway”

2. Products: What has the program produced

a. Publications, conference papers, and presentations

University of Illinois Urbana-Champaign

- Wang, Z. and C.P.L. Barkan. 2016. Statistical Modeling of Freight Train Accident Estimation. Presented at the 2016 INFORMS Annual Meeting, Nashville TN, November 2016.
- Shih, M-C. and C.T. Dick. 2016. Capacity Screening Tool for Mixed Operations. Presented at the 2016 INFORMS Annual Meeting, Nashville TN, November 2016.
- Kippen, F.B. and C.T. Dick. 2016. Siding Length, Train Length and Traffic Capacity of Single-Track Lines. Presented at the 2016 INFORMS Annual Meeting, Nashville TN, November 2016.

- Lovett, A.H. and C.T. Dick. 2016. Estimating the Probability and Impact of Track Defects on Rail Maintenance Planning. Presented at the 2016 INFORMS Annual Meeting, Nashville TN, November 2016.

Michigan Tech University

- Warsinski, K., Application of Differential Scanning Calorimetry for the Determination of ADI Service Temperature Limits, World Conference on Austempered Ductile Iron, Oct. 27-28, 2016, Atlanta, GA

b. Journal publications:

University of Illinois Urbana-Champaign

- Lautala, P. and C.T. Dick. 2017. Railway Engineering Education Symposium: Evolving to rebuild a growing rail academic community. Accepted, Transportation Research Record: Journal of the Transportation Research Board.

Massachusetts Institute of Technology

- Westrom, R.J. and J.M. Sussman, HSR as Transit: The continuing transportation-driven evolution of metropolitan form (.pdf ESD-WP- 2014-24) Submitted to the Journal of the Transportation Research Forum.
- Levy, S., A. A. Faulkner and J. M. Sussman, Challenges and Opportunities in Implementation of Future California Rail Network, Transportation Research Record: Journal of the Transportation Research Board, Volume II, Issue Number 2546. <http://trrjournalonline.trb.org/doi/abs/10.3141/2546-09>.

Michigan Tech University

- Jeon, M., Landry, S., Lautala P., Nelson, D., Design and Assessment of In-Vehicle Auditory Alerts for Highway-Rail Grade Crossings, Transportation Research Part F: Psychology and Behaviour (under review since October 2016).
- Addison, P., Lautala, P., Oommen, T., Using Track Surface Roughness as a Quality Measure for Railway Maintenance in a Permafrost Region, Transportation Geotechnics (2016) <http://www.aimspress.com/article/10.3934/geosci.2016.4.329>.

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

University of Illinois Chicago

- CTA Pedestrian/Cyclist Safety research reported in September 14 issue of “UIC News.”

d. Other publications, conference papers and presentations:

NURail Consortium:

- Final Report. Pravera, K., NURail2012-UIC-E01, METRA Management Training.
- Final Report. Dick, C.T., NURail2013-UIUC-E05, “Grow Our Own” Minority STEM Initiative: Partnering in Outreach.

- Final Report. Dick, C.T., NURail2013-UIUC-E06, New Semester Course in Railway Terminal Design & Operations.
- Final Report. Dick, C.T., NURail2012-UIUC-E07, Railway Transportation Engineering (CEE 408) Course Updates and Online Conversion.
- Final Report. Dick, C.T., NURail2012-UIUC-E08, Railway Project Design and Construction (CEE 411) Course Updates.
- Final Report. Warsinski, K. and P.G. Sanders, NURail2012-MTU-R01, Austempered Ductile Iron (ADI) for Railroad Wheels.
- Final Report. Lautala, P. and H. Pouryousef, NURail2013-MTU-R07, Rescheduling/ Timetable Optimization of Trains along the U.S. Shared-use Corridors.
- Final Report. Wolfson, O., B. Xu, L. Stenneth, P.S. Yu and J. Yang, NURail2012-UIC-R03, The Informed Railroad Traveler (Smartphone application).
- Final Report. Zotti, E., NURail2013-UIC-R14, Connector Transitway White Paper.
- Final Report. LaBelle, J.C. and S.F. Freve, NURail2015-UIC-R15, Efficient Goods Movement / Off Peak Delivery Pilot Project.
- Final Report. Shih, M-C. and C.T. Dick, NURail2012-UIUC-R05, Capacity Evaluation and Infrastructure Planning Techniques for Operation of Freight and Higher-Speed Passenger Trains on Shared Railway Corridors.
- Final Report. Andrawes, B., NURail2014-UIUC-R09, Numerical Investigation of Impact Load Effects on Railroad Track Systems.
- Final Report. Souleyrette, R.R. and T. Wang, NURail2015-UKY-R10, Implementation of a rail crossing condition index: A) Rideability Assessment and B) Hump Crossing Evaluation.
- Final Report. Ma, Z.J. and D. Clarke, NURail2012-UTK-R01, Assessment of Existing Railroad Bridges to Accommodate a Higher Speed Considering Chinese Practices.
- Final Report. Edwards, J.E. and M.S. Dersch, NURail2014-UIUC-R11. Mechanistic Design of Concrete Crossties and Fastening Systems.
- Research Brief. NURail2012-UIC-07. Pedestrian/Bicyclist Warning Devices and Signs at CTA Rail-Highway Grade Crossings.
- Research Brief. NURail2012-MTU-E03. Intelligent Railroad Crossing Maintenance Jumper.
- Research Brief. NURail2013-MTU-R06. Computer Vision and Machine Learning Method for Detection and Assessment of Wheel Anomalies Using Sensor Fusion of Thermal and Visible Spectrum Cameras.
- Research Brief. NURail2012-MTU-R05. Improving Rural Freight Rail in the State of Michigan.
- Interim Report. NURail2012-UIUC-R03. Improving Track Substructure Designs and Settlement due to Complex Dynamic Loads from High-Speed Passenger and Freight Trains

Massachusetts Institute of Technology

- Pena-Alcaraz, M., M. Webster and J.M. Sussman, Analysis of Capacity Pricing and Allocation Mechanisms in Shared Railway Systems: Lessons for the Northeast Corridor, Engineering Systems Division Working Paper (.pdf ESD-WP-2015-04).
- Heywood, Rebecca and Joseph Sussman, Regional Governance and Hub Stations: The Impact of Development and Transport Connections, accepted for the ASCE 2016 International Conference on Transportation and Development, Houston, TX, June 2016 – to be submitted to follow-on journal based on the conference proceedings.
- Masdar Institute of Science and Technology Various progress reports: Sridhar and Sussman, Draft working paper on Transportation Investment and Economic Development.

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

University of Illinois Urbana-Champaign

- UIUC maintains the NURail Center website: <http://www.nurailcenter.org/index.php>. To enrich our outreach effort, each month in 2016 we released a new short video with a member of our NURail leadership team answering one of a variety of questions about the railroad industry.

University of Illinois Chicago

- CTA Pedestrian/Cyclist Safety reported in online reports in the August 15 Chicago Tribune and Daily Herald newspapers.

Massachusetts Institute of Technology

- Much of our work appears on the following website:
<http://web.mit.edu/hsr-group/index.html>

f. Technologies or techniques:

Nothing to report.

g. Inventions, patent applications and/or licenses:

Nothing to report.

h. Other products:

Nothing to report.

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 of Porto	Porto, Portugal	Contributions from students visiting MIT Joint proposal to FCT in Portugal	University of Porto
IST (University)	Lisbon, Portugal	Contributions from students visiting MIT Joint proposal to FCT in Portugal	IST (University)
University of Coimbra	Coimbra, Portugal	Contributions from students visiting MIT Joint proposal to FCT in Portugal	University of Coimbra
East Japan Railway Company	Tokyo, Japan	Research sponsor; sponsors graduate students in residence	East Japan Railway Co
Central Japan Railway Co	Tokyo, Japan	Sponsors graduate students in residence	Central Japan Railway Co
Region 1 UTC	MIT, Cambridge, MA	Research sponsor	Region 1 UTC
Pontificia Universidad Católica Argentina	Buenos Aires, Argentina	Developing joint project with YPF, a major energy provider based in Argentina	Prof. Roberto Agosta
Chicago Central Area Committee	Chicago, IL	Led Connector Transitway Research	Ed Zotti
Supply Chain Innovation Network	Chicago, IL	Support for Off Peak Delivery Research	
Center for Urban Transportation Research	Tampa, FL	Provided funding for	University of South Florida
MDOT	Lansing, MI	Financial and Collaborative	Tim Hoeffner, Nikkie Johnson

Omnitrax	Colorado/Canada	Financial & Collaborative	Ken Koff/Zachary Vallos
American Association of Railroads	Washington, DC	Executive Advisory Board member	Michael J. Rush
Amtrak	Chicago, IL	Executive Advisory Board member	Michael W. Franke
Canadian National Railway Company	Homewood, IL	Executive Advisory Board member	David W. Ferryman
Railway Supply Institute	Washington, DC	Executive Advisory Board member	Thomas D. Simpson
Hanson Professional Services, Inc.	Springfield, IL	Executive Advisory Board member	Serio "Satch" Pecori
Michigan Department of Transportation	Lansing, MI	Executive Advisory Board member	Timothy H. Hoeffner

b. Additional collaborators

University of Illinois Chicago

- Connector Transitway:
 - Chicago Central Area Committee: Greg Hummel – Bryan Cave, Chairs
 - Kelly O'Brien, Executive Director
 - Ed Zotti, Project Manager and Principal Author
 - Steve Fifield, Fifield Companies
 - Stephen Friedman, S.B. Friedman Development Advisors
 - Avi Lothan, Lothan Van Hook DeStefano Architects
 - Doug Voigt, Skidmore Owings & Merrill
 - Mark Walbrun, Mott MacDonald
- Pedestrian/Cyclist Warning Devices and Signs at CTA Rail-Highway Grade Crossings:
 - Paul Metaxatos, UIC
 - Anne Diffenderffer, Project Coordinator Survey Research Laboratory, UIC College of Urban Planning and Public Affairs
- Exploring the Potential for Off Peak Delivery in Metropolitan Chicago
 - James LaBelle, Sheena F. Frève and Ellen Gottschling, UIC

Massachusetts Institute of Technology

- Year-long visit from an Indian Railways technical staff member as a Humphrey fellow (Brijesh Dixit).

4. Impact

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

University of Illinois Chicago

- Connector Transitway: Whitepaper addressed the fundamental planning components required to advance the proposed central area transit Connector line: Identifying the challenge, citing the service area of the proposed transit line, proposing funding sources and stating the next steps required – approval from the public and landowners.
- Pedestrian/Cyclist: Research led to conclusions and recommendations that may have implications about the design and placement of signs and warning systems at CTA pedestrian-rail grade crossings, as well as provide education and enforcement initiatives. May also lead to great government compliance of Manual on Uniform Traffic Control Devices (MUTCD) standards.
- Off Peak Delivery: Study presented research and implementation options to consider and adopt strategies and methods to shift more deliveries to off-peak times. Benefits include: reduced congestion, greater efficiency and lower emissions.

Massachusetts Institute of Technology

- The kinds of issues we are researching are inherently interdisciplinary in content and approach. So while we advance the field of transportation, it is done in a context of a deeper understanding of regional economics, land use planning, engineering systems and other related fields.

b. What is the impact on other disciplines?

University of Illinois Chicago

- Connector Transitway: The Connector would help Chicago's central area continue to meet transit demands of the growing downtown employment and permanent residential populations.
- Pedestrian/Cyclist: Study's objective was to contribute to the still limited research on pedestrian and cyclist safety at rail grade crossings by expanding the scope of a previous study (Metaxatos and Sriraj, 2013) to include rail grade crossings in metropolitan Chicago operated by the Chicago Transit Authority.
- Off Peak Delivery: Instead of this report serving as the basis for launching a pilot program now, the study serves as a foundation for future efforts by interested Chicago organizations.

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

University of Illinois Urbana-Champaign

- UIUC taught four rail courses in Fall 2016. The total enrollment was 78 undergraduate and graduate students including eight online 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

- Connector Transitway: Should the project be undertaken, it would create thousands of part-time construction jobs and many permanent jobs. It also would: Increase the efficiency and reach of the existing rail system and improve distribution of workers within the enlarged central business district; and extend rail service to historically neglected communities, enhancing access to jobs, schools and amenities.
- Pedestrian/Cyclist: One finding was to expand Manual on Uniform Traffic Control Devices (MUTCD) compliance on all warning signs and devices and develop methods to determine the effectiveness of warning signs and devices utilized. This could lead to installation of new signage and additional training for operators and other stakeholders.
- Off-Peak Delivery: New positions could be created for carriers, receivers, shippers, customers and within the community to launch and maintain an OPD program.

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

University of Illinois Chicago

- Connector Transitway: Whitepaper provided the initial “first step” in the planning process for the proposed 14-mile grade separated rail line.
- Pedestrian/Cyclist: Study continued previous on railroad grade crossing safety research and may lead other researchers to pursue this scope of work.
- Off-Peak Delivery: Organizations in metropolitan Chicago now have a resource that can lead to development of an OPD pilot and perhaps more encompassing program.

e. What is the impact on technology transfer?

University of Illinois Chicago

- All research completed will remain in the public domain through the news story and abstract/complete reports posted on the UTC website. Any inquiries related to these reports will be followed up promptly.

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

University of Illinois Chicago

- Connector Transitway: This paper could be the catalyst to initiate a new public transit system to help Chicago manage growth in the central area and enhance mobility.
- Pedestrian/Cyclist: The results add to the conversation regarding the promotion of safety at railroad grade crossings during a time when many are distracted with handhelds and headphones.
- Off-Peak Delivery: The study may build awareness among business and civic leaders for the potential value of an OPD program in terms of improved efficiency and reduced congestion. These stakeholders will need to encourage OPD and lobby City officials to make it a priority.

Massachusetts Institute of Technology

- MIT's NURail research directly affects mobility, economic development, and potentially environmental impact and global climate change, all vital critical contemporary issues. Through MIT's connection to the Institute for Data, Systems and Society, this work contributes to methods to study Complex Sociotechnical Systems (CSS). The impact on society of this research beyond science and technology can be profound. Economic growth, environmental protection and social equity will all advance if the results of this study – concerned with intercity rail access and its interface to urban transportation -- leads to implementation. In the U.S. people tend not to think of trains as the intercity mode of choice, but perhaps this research can help change that. Understanding how policies and decisions are made in both the private and public sector – using this research as a case study – can advance public knowledge attitudes, skills and abilities.

5. Changes/Problems

a. Changes in approach and reasons for change

Nothing to report.

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

Michigan Tech University

- Delay in publishing the final report for "Rail Embankment Stabilization for Cold Climate Railroads – Case of Hudson Bay Railway", due to request for extended review by Omnitrax, Inc.

c. Changes that have a significant impact on expenditures

Nothing to report.

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

Nothing to report.

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

Nothing to report.