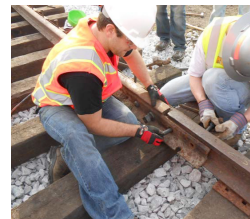
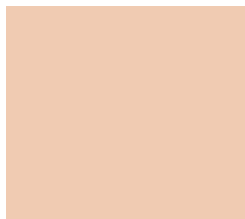


National University Rail Center

2013 Annual Report

University of Illinois at Urbana-Champaign
University of Illinois at Chicago
Massachusetts Institute of Technology
Michigan Technological University
University of Kentucky
University of Tennessee, Knoxville
Rose-Hulman Institute of Technology



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This publication is a report of the NURail Center's transportation research, education and workforce development, and technology transfer activities for January 1, 2013 – December 31, 2013.

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The National University Rail (NURail) Center is a Tier-1 University Transportation Center (UTC) focused on rail transportation and funded by the U.S. Department of Transportation (US DOT) Office of the Assistant Secretary for Research and Technology (OST-R) UTC program. The NURail Center is a seven-university consortium led by the Rail Transportation and Engineering Center (RailTEC) at the University of Illinois at Urbana-Champaign (UIUC) and hosted by the Department of Civil and Environmental Engineering at UIUC.



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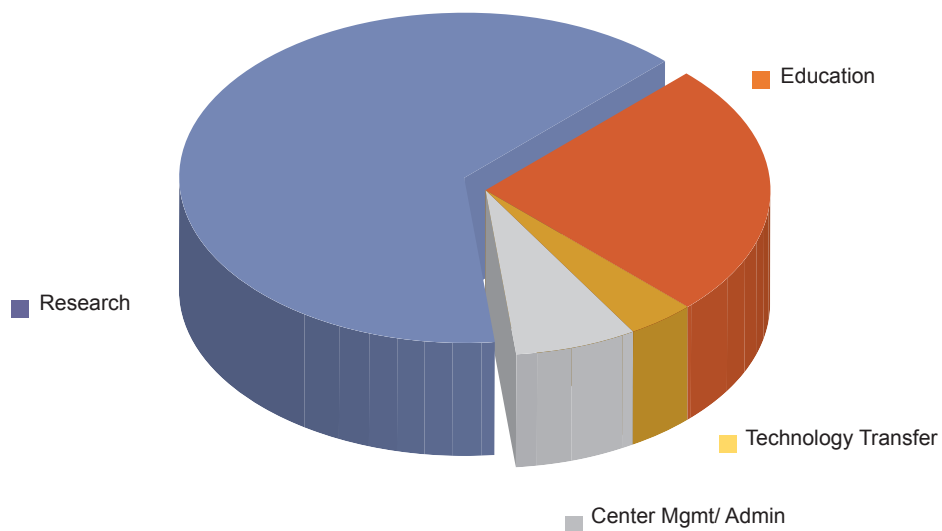
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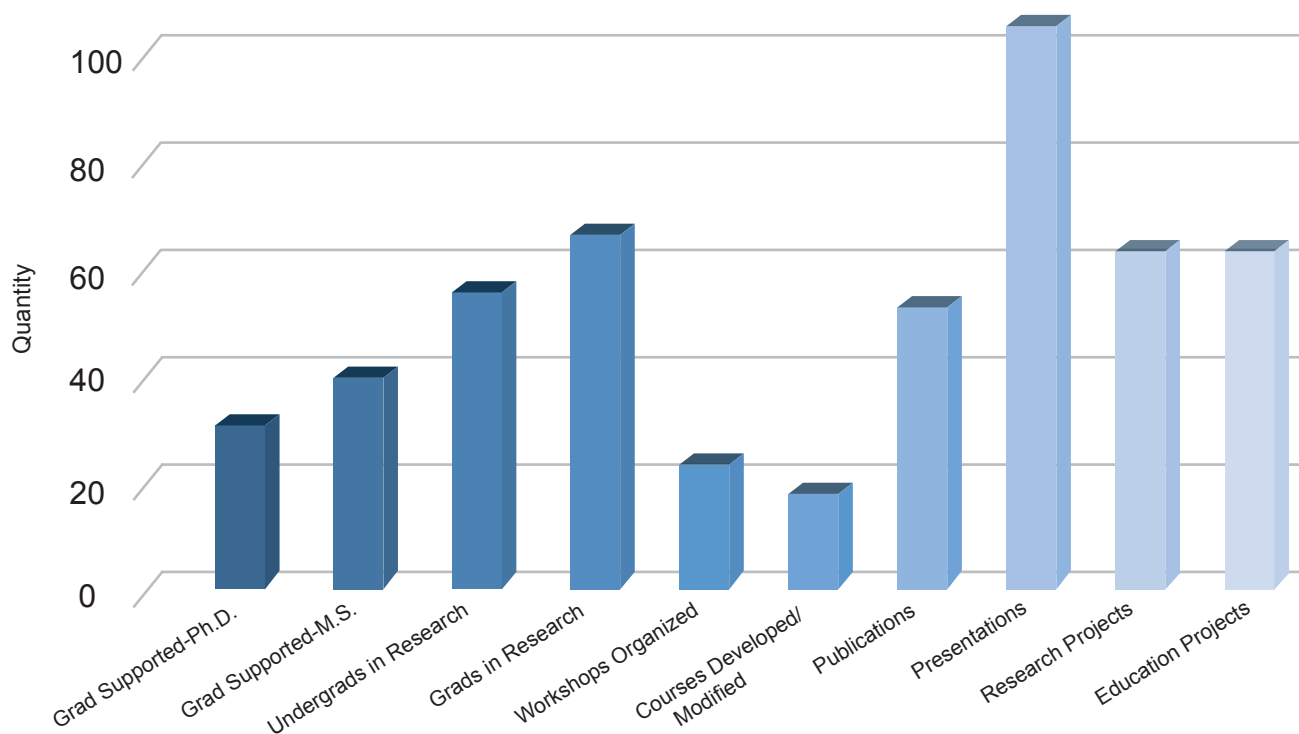
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2013 Funds Distribution



The total funding for NURail Center activities in Year 2 (shown in the figure above) was 64% for research, 25% for education, 4% for technology transfer, and 7% for Center management and administration.

2013 Accomplishments



This figure displays a graphical representation of some of the NURail Center's 2013 accomplishments.



JANUARY

13TH

A Concrete Crosstie and Fastening Systems Workshop was conducted by NURail faculty at the Transportation Research Board Annual Meeting in Washington, D.C.



MARCH

8TH-9TH



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

MAY

13TH-15TH

Five RailTEC representatives attended "Rail-Copenhagen 2013," the 5th International Seminar on Railway Operations Modeling and Analysis, organized by the International Association of Railway Operations Research and hosted by the Technical University of Denmark. They presented three papers, and two of the representatives were among five nominated for the best young researcher prize at the conference.

FEBRUARY

4TH-6TH



Papers and presentations on research supported by the NURail Center were delivered at the International Heavy Haul Association (IHHA) Conference in India.

19TH

Michigan Tech held Railroad Night which highlighted NURail student and research project posters to rail industry companies and professionals.

Despite the fact there was an official blizzard, this event drew over 100 attendees of 175 registered.



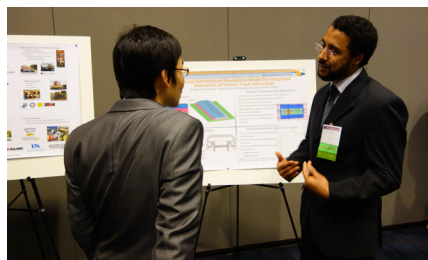
APRIL

5TH

David Clarke gave an invited presentation to the L&N STEM Academy in Knoxville, TN on "High-Speed Rail: A Technology Overview."

15TH-18TH

The Joint Rail Conference, held in Knoxville, TN, provided a great opportunity for showcasing NURail research and technology. Approximately 75 NURail researchers attended the conference, including over 50 undergraduate and graduate students sponsored by NURail and ASME scholarships.



JULY

3RD-5TH

Professor TC Kao, from UIUC, was invited by the National Science & Technology Ministry and Chulalongkorn University of Thailand to give a three-day seminar on the high-speed rail system in Bangkok.



20TH-25TH

Joseph Sussman visited the University of Coimbra and the Institute Superior Tecnico (IST) in Portugal to discuss NURail research activities with faculty and students and to hear about their related research.



FALL SEMESTER 2013

The new building housing the Civil/Environmental and Industrial/Systems Engineering Departments at the University of Tennessee, Knoxville opened fall semester 2013. These facilities were immediately put to use in ongoing NURail research. A hybrid composite beam has already been moved to the lab for testing. UTK and UK are exploring collaborative geotechnical and materials projects for these new labs.

SEPTEMBER

10TH-11TH

Reg Souleyrette presented a short course on NHI Highway-Rail Grade Crossing Improvement Program in St. Louis.

11TH-12TH

The first NURail Annual Meeting was held on the UIUC campus. The meeting included participation of the NURail Technical Advisory Committee and the Executive Advisory Board. Both of these committees, along with the Student Leadership Council, in addition to faculty and students from NURail partner institutions, industry partners, and the FRA participated in the Annual Meeting.



NOVEMBER

3RD-6TH

Jerry Rose presented "Highway-Railway At-Grade Crossing Rehabilitation Practices to Enhance Long-Term Performances: Criteria and Evaluations" at the National Highway-Rail Grade Crossing Safety Conference in Fort Worth, TX.

5TH-6TH

Over 500 attendees were updated on the direction of the railroad industry's environmental programs through more than 70 spoken presentations at the 2013 Railroad Environmental Conference (RREC) at UIUC.

14TH

MIT hosted three representatives from JR East, who visited their NURail Center research group to discuss various research activities.



AUGUST 27TH



Nearly 150 individuals gathered at the Lansing Community College West Campus for the 1st annual Michigan Rail Conference. Participants enjoyed presentations related to rail activities in Michigan and breakout sessions for passenger and freight activities. Conference proceedings were also web-cast.

OCTOBER 6TH-9TH

A special session on NURail Systems Research was held at the 2013 INFORMS Annual Meeting in Minneapolis, MN, featuring presentations from UIUC, UIC, and MTU researchers.

15TH-17TH

Sam Beck, a Rose-Hulman senior, ME student and AREMA Student Chapter vice president, was awarded an Undergraduate Student Conference Scholarship to attend the ASME Rail Transportation Division Fall Technical Conference in Altoona, PA.



23RD

David Clarke was invited to give a presentation on China's railways to the AREMA Student Chapter at the University of South Carolina in Columbia, SC.

DECEMBER 8TH



Dr. Anthony Perl, Professor of Urban Studies Science at Simon Fraser University, gave one of nine NURail sponsored William W. Hay Railroad Engineering Seminar lectures of the year. His topic was "Global Lessons in High-Speed Rail and Their Relevance for North America". Eighty participants attended the talk and there were over 50 on-line listeners.

18TH

A stakeholder meeting was held to solicit comments and feedback on the research results of the Analysis of Environmental Impacts of Rail Development (Geographic Information System) team from UIC.

University of Illinois at Urbana-Champaign

Project: Construction of the Research and Innovation Laboratory (RAIL) at the University of Illinois at Urbana-Champaign

In 2013, UIUC embarked on a mission to design and construct a laboratory with the primary objective of improving upon the mechanics, performance, and the design of railway infrastructure components. To achieve this objective, the 3,500 square foot Research and Innovation Laboratory (RAIL) was conceived. RAIL is now in the final stages of construction and is located in Champaign, Illinois on the campus of the U.S. Army Corps of Engineers Construction Engineering Research Laboratory (CERL). RAIL will provide researchers with the necessary tools to study various infrastructure components at material, component, and system levels.



The Research and Innovation Laboratory (RAIL) and its various equipment.

RAIL currently houses multiple testing frames that provide the ability to conduct a variety of industry standard and custom experiments on railway infrastructure and mechanical components including crossties and fastening systems. The cornerstone of RAIL is a full-scale track loading system which provides researchers with the ability to perform static and dynamic experimentation on railway superstructure and rolling stock mechanical components, full-depth track sub-structures, as well as the development and validation of new and previous railway infrastructure models. The full-scale track loading system is constructed with a full-depth subgrade and loaded via hydraulically controlled actuators attached to a wheelset.

The construction of RAIL would not have been possible without the financial and in-kind support of the NURail Center as well as the Federal Railroad Administration (FRA), Amsted Rail, Amsted RPS, CN, CXT Concrete Ties, Hanson Professional Services, and UIUC.



Engineers discuss the full-scale track loading system.

Alexander Lovett

Originally from Albuquerque, NM, Alexander Lovett earned a B.S. degree at BYU in 2010 and an M.S. degree at UIUC in 2013 both in Civil Engineering. He is currently working on a joint MBA/Ph.D. at UIUC where his research focuses on optimizing railroad track maintenance. The combined business and engineering perspective of this degree will provide unique insight into railroad engineering. His research objectives include identifying and quantifying costs and benefits to performing maintenance. These can be used to objectively prioritize maintenance activities and select optimal maintenance activities for a specific area. He has presented his research at conferences and published his work in peer-reviewed journals. Alexander has served as treasurer of the AREMA Student Chapter at UIUC where he participated in educating students about possible careers in railway engineering.

He also teaches the Railroad merit badge, which includes teaching youth about the importance of the railroads and how to safely interact with them. He is a recipient of the Eisenhower Transportation Fellowship, which provides stipend and tuition assistance to transportation students in an effort to keep educated and motivated professionals in the transportation industry. After completing his degree, Alexander plans to work at a Class 1 railroad where he can continue improving the economics of railroad transportation, while being active in educating the community about railroads.



University of Illinois at Chicago

Project: Performance Assessment of High Density Polyethylene (HDPE) Railroad Crossties

Recently, several concerns, including higher speeds, heavier loads, longevity and environmental effects, have piqued the railway industry's interest in alternative infrastructure materials. Currently, several manufacturers offer alternative solutions using different recycled plastic composite materials. Several researchers have been studying and testing these new materials, specifically High Density Polyethylene (HDPE); however their behavior when subjected to rail loading is not fully understood yet. More research is required to properly characterize, describe and model the behavior of these materials as well as assess the feasibility of implementing them in railway applications.

A study assessing the feasibility of implementing recycled (HDPE) plastic rail crossties was conducted by the University of Illinois at Chicago.



Long term performance cyclic testing of HDPE crosstie with the rail system installed.

The study included both experimental testing and computational analyses. The experimental testing aimed to assess the mechanical and physical properties of the HDPE crossties along with each individual component of the rail and fastening system separately. The behavior of the HDPE crossties with the rail and fastening system installed was also investigated when subjected to dynamic loading. An analytical finite element model, constructed using calibrated material model to accurately portray the crossties' behavior was implemented in railroad bridge applications difficult to test at the laboratory scale. The results obtained from this study illustrates the potential of this new line of recycled plastic crossties in terms of performance, environmental benefits and life-cycle economy.

Transit Value Capture Coordination: Best Practices and Recommendations

For the past several years, public transit has proven to have the potential to boost the value of some nearby properties, leading to more attractive development opportunities. Planners and policy makers have started to work with local governments to allocate a portion of the value gained by transit lines to funding system expansion and improvement. Called "value capture," the process can be used to help fund new transit systems, expand existing ones and modernize stations and terminals. A UIC research team recently completed site visits to three cities and plans to finalize case studies that will be presented at the American Public Transportation Association 2014 Annual Meeting & Expo in Houston, Texas. Research included studying trends between local governments and the private development sector to identify best practices. A literature review and preliminary research showed that sound models for value capture still need to be developed.

Jenny Kane

Participation in transit-oriented research studies and time spent as a Congressional staff member have given Jenny Kane the practical skills and experience needed to pursue career aspirations in transportation project management. Starting in late 2013, Jenny participated in the "New Starts Ranking" research, a study to identify a method to rank proposed transit expansion projects in Northeast Illinois and nationwide.



The study, funded by the Illinois Department of Transportation, focuses on how other states and non-governmental organizations evaluate and prioritize capital projects. She also contributed to research on "Transit Value Capture," an effort to track and evaluate financing mechanisms between planners, taxing bodies and developers. Jenny, who earned a Master's degree in Urban Planning and Policy from UIC, maintains that her years as a legislative aide on Capitol Hill—she served on the staffs of two members of Congress and a Senator—will prove valuable throughout her career. She is passionate about bike sharing, transit and inter-city passenger rail, and will tell anyone who will listen that Amtrak is the best way to see America.

Massachusetts Institute of Technology

Projects: Railroad Strategy for the Transport of Energy Resources and HSR as a Complex Sociotechnical System

The MIT Regional Transportation Planning and High-Speed Rail research group under the direction of Professor Joseph Sussman, continues to do work in a variety of areas. Two recent key initiatives illustrate the depth and breadth of this ongoing academic research.

First, students are examining Railroad Strategy for the Transport of Energy Resources. The transport of energy resources is a large part of the business of North American freight railroads, with coal making up 22 percent of the gross revenue of Class 1 railroads (Source: AAR). In addition, since 2009, there has been a significant growth in the transport of crude oil by rail, notably from the Bakken-formation region in North Dakota, and more recently from the oil sands of Alberta, Canada. However, given the

importance of conflicting issues such as climate change, energy security, environmental impact, relations between Canada and the U.S. economic development, and safety, there are opportunities to take a systems approach. A method of choice to study these issues is the CLIOS

(Complex, Large-Scale, Interconnected, Open, Sociotechnical) Process developed at MIT. Using the CLIOS Process and other techniques dealing with uncertainty, the objective of this project is to develop appropriate railroad company strategies for engaging in the energy resource transport market.

The second project involves continuing to study HSR as a Complex Sociotechnical System. The intent is to bring a

variety of quantitative and qualitative tools that will shed more light on decision making in the high-speed rail context. There are technological issues, system architecture issues, and institutional issues that must be dealt with as a function of the particular implementation and of the nation within which it is taking place.

One of the particular areas of focus in 2013 was on the productivity of HSR services. Improvements in transportation productivity have helped fuel U.S. economic growth and wealth. With a focus on the Northeast Corridor, studies have analyzed the past productivity in rail passenger transportation and

have suggested how future configurations of high-speed rail might increase productivity. International HSR experiences in Japan and the European Union are also analyzed from a productivity perspective.



The 2012-2013 MIT Regional Transportation Planning and High-Speed Rail research group are shown here: Upper row (from left): Iori Mori, Ryan Westrom, Joseph Sussman, and Andrés Archila Lower row (from left): Naomi Stein, Soshi Kawakami, Joel Carlson, and Maite Peña. (Photo: Andrés Archila)

Ryan Westrom

Ryan is a second year Master of Science in Transportation (M.S.T.) student at the Massachusetts Institute of Technology. He grew up in the northwest corner of Minnesota, in Crookston. He has re-entered the academic world after over a decade spent working as an engineering and planning consultant for Patrick Engineering Inc. in Chicago. That work followed his undergraduate work at the University of Illinois at Urbana-Champaign (Class of 2001) where he received degrees in both Civil and Environmental Engineering and Urban and Regional Planning.

Ryan arrived at MIT in August 2012. He works in Professor Joseph Sussman's Regional Transportation Planning and High-Speed Rail Research Group and is focusing on issues of livability, sustainability, placemaking, and policymaking within the realm of regional transportation planning, urban centers, and integrated transportation and land use coordination. Topics of research exploration have included

the future of transportation in an increasingly digital and urban world as well as local and regional impacts from large transportation infrastructure investments.

During his first summer term after beginning at MIT, Ryan worked at the Volpe National Transportation Systems Center,

in Cambridge, MA for several months. There, he worked on a significant research project on the future of transportation. Ryan is currently completing work on his thesis, in which he is undertaking a comparative analysis of the impact of HSR on the cities of Coimbra and Leiria in Portugal and Champaign-Urbana and Kankakee in Illinois.



Michigan Technological University

Undergraduate Student Projects

NURail undergraduate student projects and research are an important approach to engage and educate new students at Michigan Tech. Projects commonly last two academic semesters, have strict deliverable requirements, and are advised collaboratively by NURail faculty and industry stakeholders. In addition to tangible industry benefits in the form of new methods, designs, or tools, the projects result in collaboration across disciplines, and increased rail research exposure for students with practical and hands-on components. Seven student research projects were made possible by NURail and matching industry funding in 2013. The following listing includes project title, student major(s), funding source(s), and project year.

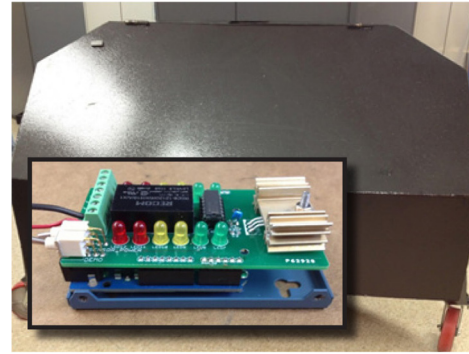
- Railcar Coupler Redesign (ME, MSE, CE), NURail, 2013
- Locomotive Sand Tank Level Sensor System (EE), NURail, UP, 2013
- Rail Program Promotional Video, (HU, SBE), NURail, 2013
- Highway-Rail Grade Crossing Surface Evaluation, (CE, CM), NURail, MDOT, 2013-2014
- Centerbeam Car Repurposing (ME), NURail in collaboration with E&LS Railroad, 2013-2014
- Grade Crossing Jumper Cable (EE), NURail, UP, and Norfolk Southern, 2013-2014
- Balise and Train Control System Market Study (EE, SBE), NURail and Tech Expert Network, 2013-2014



*Balise and Train Control System Market Study team:
From Left to Right Michael Roskelley (EE), James Shamel (EE), Ran Sui (EE), Yiheng Yan (EE), Chuan-sheng Chang (EE).*

Student Project Highlights: Locomotive Sand Tank Level Sensor (September, 2012 – May, 2013)

Locomotives have no system in place to safely and accurately measure the level of sand in the on-board sanding containers, used to improve traction during acceleration. A group of Michigan Tech Electrical Engineering students designed a sensor system that remotely monitors the sand levels and displays the information to personnel in a safe, accurate and easy-to-read format.

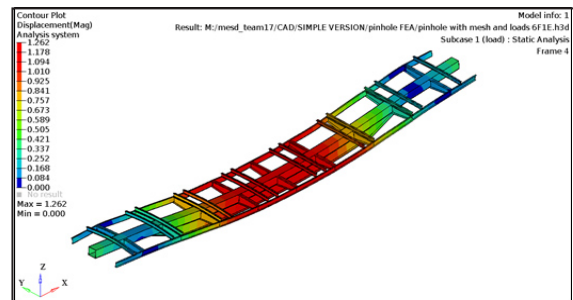


*Replica
tank from
GE AC4400
Locomotive
and LED
display
board with
level display.*

After evaluating several alternatives, the research and testing results suggested that the best solution was an ultrasonic sensor placed in a perforated PVC pipe to provide an ultrasonic waveguide, together with an LED display board designed on Arduino protoshield platform. For testing, the team built a full scale sand tank in the laboratory, based on GE 4400 AC locomotive. This system could be cost effectively integrated into new locomotives, including the communication integration with existing systems.

Centerbeam Project (September, 2013 – May, 2014)

Six undergraduate students from the Mechanical Engineering department embarked on a project to find a potential re-use for a centerbeam rail car. There is an abundance of such cars with low demand, so the decision was made to make cars capable of hauling frac sand in “pods.” The project included removing the old centerbeam spine, and replacing the lost load capacity with structural members under the deck. Due to challenges in securing the design details of the original car, conceptual sketches, hand calculations, and finite element analysis were required to develop the conversion plan. Under advice from Escanaba and Lake Superior (E&LS), the team used AAR standards, 3D CAD design, and FEA modeling to develop the new design for the car. Finally, a scale prototype beam section was constructed and tested to verify the FEA results. The team is finalizing their analysis and completing cost estimates for the conversion process. As a follow-up to the project, Michigan Tech will work with E&LS to complete an AAR car modification submittal package.



*Students use FEA modeling to develop new design
for centerbeam cars.*

Project: Rail-Highway Grade Crossing Roughness Quantitative Measurement Using 3D Technology

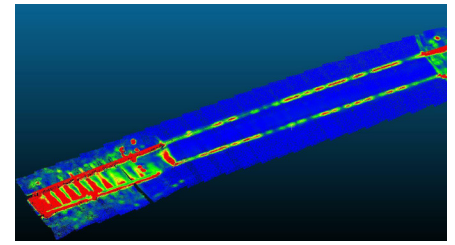
Quality of surface is an important aspect affecting both the safety and the performance of at-grade rail-highway crossings. Roughness may increase the risk of crashes for both trains and automobiles. No quantitative method currently exists to quickly and economically assess the condition of rail crossings in order to 1) evaluate the long-term performance of crossings, and 2) set a quantitative trigger for their rehabilitation.



Research team with the scanner on track in low light conditions.

The conventional method to measure the surface quality of crossings is based on expert judgment, whereby crossing surfaces are classified as poor, fair or good after an inspector visits and drives over the crossing. However, actual condition of the crossing may be quite different from the subjective rating. Objective/quantitative measures based on vehicle accelerations would be more desirable. To date, however, there is no cost effective way for inspectors to quantify performance at the nation's more than 300,000 at-grade crossings. Poor condition rating crossings may not always be the most cost-effective locations for preventive maintenance to lower overall life-cycle costs. With rapid advances in computer science, 3D sensing and imaging technologies, it seems that a cost-effective method could be developed to determine the need to rehabilitate rail crossings and assess long-term performance.

The project focuses on the development of an accurate, low cost and readily deployable sensor capable of rapid collection of this 3D surface. The research team has



3D crossing image map.

collaborated with the UK EE department to develop a large-scale “structured-light” sensor. This type of sensor, typically applied for smaller scale use (fingerprinting, dental, manufacturing, etc.) finds rail as one of its larger applications. Low cost, fast and portable, the sensor has several advantages over more expensive mobile LIDAR technologies. The research team is also investigating the use of other, low cost sensors such as Microsoft's Kinect and Occipital's new iPad-based structure sensor.

The UK team is also working with Professor Ahmed Shabana and his students at UIC to develop vehicle dynamics models based on vehicle and surface conditions to discover the relationship between vehicle performance and crossing roughness. 3D models from the structured light sensor feed into the vehicle dynamic models developed by UIC and can be used to approximate readings obtained by field accelerometer tests. Position and speed of vehicle crossing the tracks is clearly an important determinant in the estimation of accelerations. Dr. Eric Fitzsimmons from the University of Kansas helped on the development and setup of Z-tube configuration to record the vehicle wheel path on the crossing by detecting the vehicle lateral placement. Combining the crossing 3D surface cloud with the vehicle wheel path and vehicle dynamic models, this research is a first step toward automating the crossing inspection process, ultimately leading to the quantification and estimation of future performance of rail crossings.

Alex Wang

Teng “Alex” Wang is a Ph.D. candidate in the Department of Civil Engineering at the University of Kentucky. Alex hails from the Gansu Province of western China where rail transportation is critical to economic development of the region. Alex's familiarity with the outstanding technologies being implemented today in China (Tibet railway, high-speed networks) is a real benefit to the UK team.

Alex received both his B.S. and M.S. in Civil Engineering from Iowa State University where he conducted research on transportation safety, planning, data and GIS



applications. Today, his research focuses on railroad engineering, rail-highway grade crossing and remote sensing and image analysis by GIS. His dissertation relates to 3D methodology for evaluating rail crossing roughness, and is funded by the NURail Center and Kentucky Transportation Cabinet.

Alex served as President of the Transportation Student Association (TSA) and ITE student chapters at Iowa State University. Today Alex is an active member of several professional organizations and the AREMA student chapter at UK (RailCats).

University of Tennessee, Knoxville

Project: Lateral Impact on Railroad Bridges with Hybrid Composite Beams

One of the key elements to improving safety along High-Speed Rail (HSR) routes will be additional grade separation to eliminate dangerous at grade crossings. With these additional bridges comes the concern of damage due to lateral impact to the bridge superstructures by over-height vehicles. This is already a concern with existing bridges that is conspicuously overlooked by standard bridge code provisions. The safety of passengers traveling across railway bridges as well as the traveling public below represents a major concern with respect to lateral impact from over-height vehicles.

Another objective of HSR is to offer more sustainable solutions for the construction of new and replacement bridges on the rail infrastructure. One such technology is the Hybrid-Composite Beam (HCB) that was developed through funding from the High-Speed Rail IDEA Program at the Transportation Research Board (TRB) and which has been under evaluation at the Transportation Technology Center Inc., since 2007. This bridge technology combines advanced composite materials with conventional concrete and steel to create a bridge that is lighter, stronger and more resistant to corrosion than conventional materials. This project's use of experimental and analytical study of lateral impact to an HCB bridge will help provide data to satisfy concerns regarding safety of these bridges. It will also help to identify inspection and evaluation methods with respect to State of Good Repair of these structures, and it will serve to help further facilitate and promote the use of these environmentally sustainable structures on our nation's rail infrastructure.

Commercial software ABAQUS has been used to set up the finite element model of an HCB bridge; the technique was

validated by a set of static test data. The preliminary dynamic results of HCB when subjected to lateral impact loading were also obtained. The setup and data acquisition of the impact test have been studied during the first few months of 2014. The impact test will be conducted in summer 2014.

UTK's NURail bridge research team is already benefiting from the modern structural laboratory facilities in the new John D. Tickle Building, which opened in August 2013. The building has a high-bay research area with reaction wall and floor, overhead crane, and load applicators of various types. The laboratory is less than 150 feet from an active rail spur, making it practical to bring large components and equipment by rail to the lab.



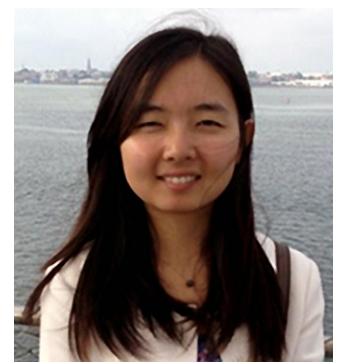
Field personnel with a prototype HCB bridge span at the Transportation Technology Center in Colorado. UTK personnel will test the behavior of this bridge span type under various impact loadings.

Yuan Jing

University of Tennessee Ph.D. student Yuan Jing earned her bachelor's degree in Highway Engineering at Chang'an University in July 2012. The Highway Engineering program at Chang'an University was ranked first among the universities in China. Yuan was awarded a scholarship every year during her undergraduate study. She participated in several educational competitions and activities during her study. She was also one of the top five students in her department to have the chance to do senior design at UTK from January to May in 2012.

In August 2012, Yuan began her graduate study at UTK. Her research focused on lateral impact on hybrid composite beams by over-height vehicles. In April 2013, she presented her

research work at the Joint Rail Conference. She was recently invited to the 2014 Joint Rail Conference to accept the 2014 ASME RTD Graduate Student Conference Scholarship for her written paper "Lateral Impact of Railroad Bridges with Hybrid Composite Beams." Yuan would like to be a university professor after getting her doctoral degree from UTK and believes that she could affect young people with her knowledge, skills, and overseas experience.



Rose-Hulman Institute of Technology

Project: CE 490 Railroad Engineering

CE 490 Railroad Engineering class was offered for the first time during the 2013 spring quarter. NURail PI Jim McKinney, Emeritus Professor of Civil Engineering, developed the interdisciplinary engineering course with assistance from the Electrical and Mechanical Engineering departments. Nine Civil Engineering students and one Mechanical Engineering student enrolled in the new technical elective course (eight seniors and two juniors). Topics covered during the ten week, forty class meetings included: Introduction to the Rail Industry; Rolling Stock; Locomotives; Rail Power; Safety; Track Structure and Geometry, Turnouts and Switches; Controls and Signals; PTC; Classification Yards and Terminals; Passenger Rail; High Speed Rail; MOW; and the Future of Railroad Engineering. A number of field trips to Railway operations were conducted during the class in conjunction with the AREMA Student Chapter.

The class was well received by the students. A sampling of comments from the students:

"Field-based homework for hands-on learning was very good."

"I appreciated the focus on many different aspects-I learned a lot about the ME/EE side of things."

"Learned a ton of info from the class-would recommend it to anyone interested in transportation."

"I have learned so much with this class that I don't even mind being stuck by a train as much anymore because I am able to apply my knowledge and look at the train."

"I gained a great deal of respect for the rail industry and won't be complaining about being railroaded any more."



RHIT students at AMTRAK Beech Grove shops.

Following the completion of the course the class syllabus and content was reviewed by Electrical Engineering Professor Dr. William Eccles and Mechanical Engineering Professor Dr. Michael Moorehead. Many constructive comments and observations will be incorporated in the 2014 revised version of the course.

Zach Ehlers

Zach Ehlers is a junior Civil Engineering student from Cullom, IL. A long time rail enthusiast, he quickly discovered that he could apply his interest to his degree. He spent the summer of 2013 as a NURail Center undergraduate intern at UIUC working on the concrete crosstie project. In addition to this work, he has been an active volunteer at the Illinois Railway Museum in Union, IL, where he works in the Electric Car Department and in Train Operations. He was awarded the 2013 AREMA Canadian National Railway Company Scholarship.

Zach is a founding member of the Rose-Hulman AREMA student chapter, where he currently serves as secretary and treasurer. Through the second year, the student chapter grew to 23 members. During 2013, seven chapter meetings and eight field trips (Norfolk Southern's Decatur shops, Indiana

Railroad's Bear Run mine project, Canadian National's Kirk and Markham yards, and Amtrak's Beech Grove shops) were conducted. Twelve student members attended the 2013 AREMA Annual Conference in Indianapolis.



2013 IRM Showcase Weekend (SAT) ©2013 BJB

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University of Illinois at Urbana-Champaign

In 2013, UIUC initiated efforts to develop a coordinated curriculum in railway engineering with KTH Royal Institute of Technology in Stockholm, Sweden. During the Spring 2013 semester, UIUC hosted visiting KTH professor Sebastian Stichel to deliver a course on Railway Vehicle Dynamics. UIUC rail systems researchers also travelled to KTH in May to present NURail research at a workshop on railway capacity involving KTH, UIUC and National Taiwan University.

University of Kentucky

In an effort to establish relationships with excellent railroad and highway schools in China, UK professor, Reg Souleyrette, lectured at three Chinese universities (Lanzhou Jiaotong University, Chang 'An University in Xian, and Beijing Jiaotong University) in March. He also met with Provincial DOT's and railroad ministry to explore concerns and opportunities for collaboration with UK and NURail.



Professor Reg Souleyrette (center) is shown visiting Beijing Jiaotong University Railroad Systems Laboratory with Professor Xuedong Yan (left) and Professor Jihui Ma (right).

Michigan Technological University

Pasi Lautala and Peter Haas (Mineta Transportation Institute) co-authored and presented the paper "Identifying and Meeting Challenges to Securing and Educating the Next Generation of Rail Industry Workforce in the US" at the 2nd UIC Congress in Rail Training in St. Polten, Austria. The main purpose of the conference was to enhance workforce development through sharing best practices in rail training across the entire industry.

While in Europe, Dr. Lautala also visited the Technical University of Braunschweig, Germany, the Open Track Railway Technology Company in Zurich, Switzerland and the University of Newcastle upon Tyne in the United Kingdom. He provided a guest lecture on railway capacity in Braunschweig and conducted discussions for capacity research collaboration in Braunschweig and Zurich.

In Newcastle, he led a discussion related to railway and intermodal education and research with the faculty, staff and students of the Rail Research Laboratory and was introduced

to RiFLE, a curriculum development project intended to "... develop Rail Freight and Logistics Curriculum for a complete cycle of study by using an innovative multidisciplinary approach, equipped with curriculum modeling tools."

In May, Dr. Lautala visited the Federal University of Santa Catarina in Florianopolis, Brazil. The visit included discussions on future collaboration between Michigan Tech and Transportation and Logistics Laboratory (LabTrans), especially in topics related to multimodal freight logistics and decision support tools. Dr. Lautala also made a presentation to university students, titled "Railroads in the U.S. - History or Future of the Transportation?"

Dr. Lautala has been involved as a member of the International Union of Railways (UIC) Academic Network, and has provided valuable academic program input and guidance to this international consortium. Their focus has been rail industry education, including the Talent Project and Knowledge4Rail program.

Massachusetts Institute of Technology

MIT has active international rail activities in Japan, Portugal, and Argentina. First, Joseph Sussman, who has a chair endowed by the East Japan Railway Company (JR East), has been working with JR East for more than 20 years. Current activities focus on the use of the CLIOS Process to help them identify international opportunities as JR East attempts to expand their high-speed rail footprint.

The second major involvement is through the MIT/Portugal Program (MPP). This program has funded Professor Sussman's group to study the potential for high-speed rail in that nation. An MIT student, Ryan Westrom, is currently working on a thesis concerned with drawing parallels between a corridor in Portugal's proposed system and a corridor in the midwestern portion of the United States. As part of this program, Professor Sussman's group hosts Ph.D. students from various universities in Portugal working on related research. Last year, Heather Jones, a doctoral student at IST in Portugal, spent considerable time with the group focusing on benefit/cost analyses and potential flaws in that methodology with respect to ascertaining the viability of high-speed rail corridors.

The third international activity is a nascent one. MIT is working with a consultancy in Argentina called YFL who has responsibility for developing and operating the infrastructure intended to support the development of a shale oil project in that nation. This opportunity creates a valuable tie to ongoing NURail research that considers the transportation of the Alberta tar sands through the proposed Keystone XL pipeline to Houston, Texas. The students involved are Bruno Agosta and S. Joel Carlson.

Note: All overseas activities mentioned in this report were supported with NURail matching funds or other sources.

Education, Workforce Development, and Technology Transfer in One Package

In addition to the classroom, NURail encourages experiential learning through internships, field visits, and industry conference attendance. The April 15–18, 2013 Joint Rail Conference (JRC), held in Knoxville, TN, provided a great opportunity to address the education, workforce development, and technology transfer components of the UTC mission at a single event. NURail's effort expanded beyond conference participation as it joined seven industry associations and organizations to cosponsor the conference. The conference organizing committee included several NURail faculty and staff, and the conference was chaired by NURail co-PI, David Clarke, Ph.D., from UTK.

Approximately 75 NURail researchers attended the conference, including over 50 undergraduate and graduate students sponsored by NURail and American Society of Mechanical Engineers scholarships. NURail students attending the conference learned about industry research and development activities while honing presentation skills and obtaining feedback on NURail research and technology projects.

Alexander Lovett, from UIUC, described his experience, "JRC is a great opportunity to meet and interact with fellow students from other NURail campuses while getting input on my research from a wide range of rail experts in academia and at major railways that will ultimately implement our findings." NURail leadership also used the conference to initiate the establishment of the NURail Student Leadership Council.



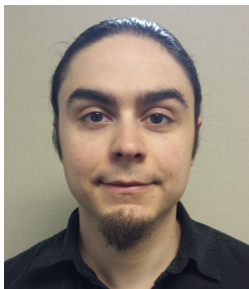
Over 75 faculty and students from NURail Center campuses attended the Joint Rail Conference in Knoxville, TN. Some of them are shown here after attending the NURail dinner on Tuesday, April 16, 2013.

A highlight of JRC was two sessions dedicated to NURail student presentations. The first featured topics related to education such as formation of the AREMA Student Chapter at Rose-Hulman and development of a multimodal transportation course at UK. The second session concentrated on NURail research, including presentations on railroad infrastructure and rolling stock components, structures, and vehicle-track dynamics. Overall, NURail partners gave 43 technical presentations at the conference, including three in the plenary session.

Showcasing NURail at JRC is just one example of how NURail faculty and students stay on the leading edge of railway technology development while furthering the educational mission of the Center to develop the next generation of railway professionals.

Student of the Year

Martin B. Hamper



Martin B. Hamper, a Ph.D. student in the Dynamic Simulation Laboratory at UIC, was the 2013 NURail Student of the Year. Martin's research is primarily focused on multibody contact problems with applications to vehicle/track interaction in railroad vehicle dynamic simulations. He has worked on two main projects in this area. In the first, a method in which rail flexibility may be modeled without the use of a finite element program was developed.

The second project is focused on the development of a representation for rails with variable cross-sectional geometry, such as switch points and frogs. The goal of this project is to allow for simple and accurate development of contact surface models for vehicle/track simulations based on input from either virtual prototyping or measured data sources.

Professor Ahmed Shabana stated: "Martin has received exemplary marks in each course taken as a graduate student.

Throughout his studies he has demonstrated excellent abilities in programming, analytical, and writing assignments. Martin has demonstrated excellent qualities through his teaching assistantship for the Mechanisms and Dynamics of Machinery course by tutoring students who voluntarily attend his office hours, frequently exceeding the allotted time in order to ensure that the students gain adequate understanding of the course materials."

Martin has published 3 peer-reviewed journal articles and 4 conference papers, is a member of the ASME student chapter and the Pi Tau Sigma mechanical engineering honor society, and a reviewer for the Proceedings of the Institution of Mechanical Engineers. He received a \$1,000.00 honorarium plus the cost of attendance to the 93rd TRB Annual Meeting, two free registrations to the CUTC Banquet, and a certificate from US DOT.

Martin will defend his thesis in May and will graduate in August 2014. He has a job at Toyota Technical Center in Ann Arbor, MI as a CAE engineer.

Workforce Development and Outreach Through AREMA Student Chapters

At five partner campuses, NURail workforce development and outreach efforts are bolstered by student chapters of the American Railway Engineering and Maintenance-of-Way Association (AREMA). Student organizations dedicated to the promotion of careers in railway engineering and transportation include the University of Illinois at Urbana-Champaign AREMA Student Chapter, Michigan Technological University Railroad Engineering and Activities Club (REAC), University of Tennessee AREMA Student Chapter, University of Kentucky RailCats, and Rose-Hulman Institute of Technology AREMA Student Chapter.

The mission of the AREMA student chapters is to bring students interested in railroading together to facilitate and advance their academic curiosity in railway engineering while having fun. Chapters seek to acquaint students with railway engineering topics and trends through speakers and field visits. Through these activities, the student groups promote the advancement of railway engineering, strengthen ties between industry and academia and even serve as a recruiting conduit for industry.

The AREMA student chapters play an important role on the front line of recruiting the next generation of railway professionals. Many undecided engineering freshmen gain their first exposure to a potential career in railway engineering through AREMA student chapter meetings or booths set up at campus engineering organization recruiting events such as “Quad Day” or “E-week.” After participating in various chapter activities, these students are more likely to enroll in a course in railway engineering, possibly leading to a railway industry internship or undergraduate and graduate railway research. This latter path is particularly beneficial for the railway industry as they receive both the advanced technology developed through research and a full-time career railway employee in the graduating student.

AREMA student chapters provide a critical railway industry outreach to other engineering disciplines and underrepresented groups. The student chapters at each campus routinely organize joint meetings, field trips and social events with mechanical, electrical and other engineering and planning societies, along with campus chapters of organizations such as the Society of Women Engineers, Society of Hispanic Professional Engineers and National Society of Black Engineers. These events introduce railway engineering concepts to groups that may not otherwise become aware of career opportunities in the railway industry.

NURail outreach to K-12 students is strongly supported by AREMA student chapter activities. Each year the AREMA student chapter at UIUC organizes a series of railway exhibits and hands-on activities for Engineering Open House. The event is attended by 20,000 people each year, including 12,000 primary and secondary students. The AREMA student chapter at the University of Tennessee participates in a similar Engineer’s Day event by making presentations to high school students on the impact of rail transportation on our nation’s infrastructure. Students at UT are also designing a locomotive simulator for use at future outreach events.

The RailCats at Kentucky deploy their own locomotive simulator on Engineering Day along with Operation Lifesaver displays to promote railway careers and increase public awareness of rail safety at the same time. The RailCats Engineering Day display also includes games and contests for children. The Michigan Tech REAC and Rose-Hulman student chapter both combine outreach with community service by volunteering at local railway museums and historic sites. Representatives from various AREMA student chapters have also made career day presentations at local high schools and organized Boy Scout Railroading merit badge clinics for local troops. NURail anticipates that efforts such as these may help spark the interest of the railway industry leaders, and NURail students, of the future.



UIUC students observe track construction for the CN Railway Kirk Yard capital expansion project near Gary, Indiana.



A small portion of the students from NURail campuses are shown here while attending at the AREMA Annual Conference in Indianapolis, Indiana in September 2013. The conference was held in conjunction with the Railway Interchange 2013 at the Indiana Convention Center.

A primary mission of the NURail Center is support and encouragement of student interest and study of rail engineering and transport. New students supported by NURail funds in 2013 are described below.

University of Illinois at Urbana-Champaign

Ivan Atanassov is an M.S. student in CE investigating the incremental capacity of the transition from single to double track on shared rail corridors.

Gio DiDomenico is an M.S. student in CE analyzing the efficiency of passenger rail systems in comparison to competing modes of passenger transportation.

Garrett Fullerton is an M.S. student in CE investigating the economic and operational impacts of introducing new low-emissions locomotive technology to freight rail transportation.

Andrew Scheppe is an M.S. student working on a project aimed at developing a mechanistic design framework for concrete crossties and fastening systems.

Samuel Sogin completed his M.S. in CE in December 2013 while investigating the reliability and delay of freight and passenger operations on shared rail corridors with single and double track.

University of Illinois at Chicago

Ahmed Aboubakr is a Ph.D. student in ME working on longitudinal train force dynamics.

Marcella Bondie is an MUPP student working on the Environmental Impact of Freight Rail GIS project. Her research interests include sustainable water systems, environmental impacts of urban and transportation developments, and financial feasibility of transportation and urban development.

Martin Hamper is a Ph.D. student in ME working on the modeling of switches and turnouts for railroad dynamic simulations.

Jennifer Kane is an MUPP student working on Value Capture Coordination. Her research interests include policy, planning and funding of transportation projects at varying jurisdictional levels.

Said Nour is a Ph.D. student in CE working on the impact of high-speed trains on short-span bridges, taking into account the effects of vehicle-structure interaction and support stiffness.

Aiman Shibli is a Ph.D. student in CE working on the effect of micro-structural parameters on the flexural behavior of recycled plastic beams. He is also studying structural adhesives to rehabilitate recycled plastic beams for use as rail crossties.

Liang Wang is a Ph.D. student in ME working on the liquid sloshing problem in rail tank cars.

Jane Wilberding is an MUPP student working on the Value Capture Coordination study. Her research interests include economic development, policy policy surrounding parks and public spaces, and

economic and environmental sustainability in parking systems.

Jillian Aurisano, Thomas Marrinan, Viktor Mateevitsi, Arthur Nishimoto, and Alex Simes are research students in the Electronic Visualization Laboratory, Department of Computer Science. They regularly demonstrate the CE Department's rail track and ballast dynamic model by means of EVL's CAVE2 immersive virtual reality 3D visualization system.

Massachusetts Institute of Technology

S. Joel Carlson is a June 2014 candidate for both the M.S. in Transportation and the ESD M.S. degree. His focus is on relating sustainable transportation to questions of providing transportation capacity for the movements of oil sands from Northern Alberta to Houston, Texas for refinement.

Rebecca Heywood is a first year M.S. in Transportation student studying the interface of high-speed rail with other regional services.

Sam Levy is a first year M.S. in Transportation student whose interests are on shared corridors for high-speed rail and other rail services focusing on the northern portion of the proposed California high-speed rail system.

University of Kentucky

Heather Hunt and Austin Dahlem are M.S. students working on a multimodal transportation class curriculum.

Macy Purcell is a senior CE student assisting research on tie4-ballast interface and bridge approaches.

University of Tennessee, Knoxville

Cody Mitchell is an M.S. student at UTK focusing on full-scale lateral impact testing setup of hybrid composite beams due to over-height vehicles.

Ying Zhang is a Ph.D. student working on railway capacity models, especially for classification yards, with help from NS and CSX.

Rose-Hulman Institute of Technology

Samuel Beck is a senior ME student and RHIT AREMA Student Chapter Founding Vice President. Samuel has accepted a position with BNSF Argentine upon graduation in 2014.

Zachery Ehlers is a junior CE student, the RHIT AREMA Student Chapter Founding Secretary/Treasurer and was an UIUC RailTEC Intern summer 2013.

Gregory Frech is a senior CE student and was the RHIT AREMA Student Chapter Founding President. Greg has accepted a position with BNSF Galesburg upon graduation in 2014.



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



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