



USDOT Tier 1 University Transportation Center Final Report

NURail2012-MTU-E02

## **Railroad Engineering Education Symposium (REES) 2012 and 2014**

By

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## **DISCLAIMER**

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### TECHNICAL SUMMARY

NURail Project No. 2012-MTU-E02

Final Report Jan 25, 2016

#### **Title**

Railroad Engineering Education Symposium (REES) 2012 and 2014

#### **Introduction**

Since its initial offering in 2008, the objective of the Railroad Engineering Education Symposium (REES) has been to develop interest among university faculty in railroad transportation engineering, with the goal of facilitating and supporting their interest in adding railroad engineering content to their engineering courses and curricula. In 2012 and 2014, NURail members worked closely with the American Railway Engineering and Maintenance of Way (AREMA) Committee 24 (Education and Training), leading the preparation and presentation of much of the course material. REES 2012 and 2014 were held at the Johnson County Community College (JCCC) in Overland Park, KS.

#### **Description of Activities**

REES is a two and a half day event that .....Early offerings included only basic railroad information (REES 1), but in 2012 additional material (REES 2) was added to support returning professors in continuing to build their programs. In 2014 a third track (REES 3) was added, primarily focused on building student involvement with developing rail programs. An attempt was made in 2014 to record the REES 1 material for later distribution to universities interested in developing rail content for their curriculums. A general table that summarizes the development of REES content and structure from 2008 to 2014 is presented in Appendix 1, followed by REES 2012 Agenda in Appendix 2, and REES 2014 in Appendix 3. Appendix 4 is the 2013 Joint Rail Conference Paper, *Railway Engineering Education Symposium (REES) – Universities and Industry Collaborate to Develop Railway Education*.

## Outcomes

In 2012, 28 total professors participated in the event, with 20 professors new to the program and 8 professors returning (for REES 2). REES 2014 had 28 new professors, and 5 returning. Of the 50 individuals attending either or both REES 2012 or 2014, 8 now represent universities that belong to the NURail Affiliate University Program, and 9 have active AREMA student chapters. According to latest statistics, 29 of the 48 schools represented at REES 2012 and 2014 now have rail content included in courses, and 10 offer specific rail courses. .



Figure 1 - REES 2012 Introduction with Chris Barkan



Figure 2 - REES 2012 Instructors and Staff



Figure 3 - REES 1 Class with Dave Clark



Figure 4 - Field Trip to Argentine Yard

## Recommendations

REES 2016 is already in the planning stages and it will transform REES from distribution and review of lecture materials to a more user and program development centered conference. . . . Lecture materials developed for earlier REES events will be made available through the recordings created at the REES 2014 event and distributed 24/7 at an online site, <http://rail-learning.mtu.edu/>. The REES 2016 event will be conducted as part of The Railway Academic Conference (TRAC) in conjunction with the NURail Annual Meeting.



Figure 5 - REES 2014 Presenters and Staff

**Publications and Presentations** – (R) Peer Reviewed Conference Paper (P) Peer Reviewed Journal Publication

Lautala, P., Dick, T., Rizos, D., Clarke, D., *Toward Next Generation of Railroad Professionals – Collaboration by NURail and Rail Industry*, Railway Interchange, Minneapolis, MN, Oct 4-7, 2015

(P) Lautala, P.T., *Meeting the Needs – What Does the Railroad Industry Need and Expect from Higher Education?*, Transportation Research Record No. 2328, Transportation Research Board of the National Academies, 2013

(R) Lautala, P., Haas, P., *Identifying and Meeting Challenges to Securing and Educating the Next Generation of Rail Industry Workforce in the U.S.*, Proceedings of 2<sup>nd</sup> UIC World Congress in Rail Training, St. Polten/Vienna, Austria, April 24-26, 2013.

(R) Lautala, P., Dick, T.C., McKinney, J.L, Clarke, D.B., *Railway Engineering Education Symposium (REES) – Universities and Industry Collaborate to Develop Railway Education*, proceedings of ASME/ASCE/IEEE 2013 Joint Rail Conference, Knoxville, TN, April 16-18, 2013.

Lautala P., *Meeting The Needs – What Does The Railroad Industry Need And Expect From Higher Education?*, National Transportation Workforce Summit, Washington, DC, April 24-26, 2012.

## Contacts

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**Appendix 1 – REES Summary**

<b>LOCATION</b>	<b>REES 2008</b>	<b>REES 2010</b>	<b>REES 1 - 2012</b>	<b>REES 2 - 2012</b>	<b>REES 1 - 2014</b>	<b>REES 2 - 2014</b>	<b>REES 3 - 2014</b>
	U of Illinois Urbana-Champaign, IL	Johnson County Community College - Overland Park, KS	Johnson County Community College - Overland Park, KS		Johnson County Community College - Overland Park, KS		
<b>No. Faculty Participants</b>	<b>32 (33)</b>	<b>26</b>	<b>21</b>	<b>11</b>	<b>28</b>	<b>33</b>	
<b>No. of Universities Represented</b>	<b>28</b>	<b>26</b>	<b>28</b>		<b>26</b>	<b>30</b>	
<b>Course Modules</b>	Intro Railroad Engineering	Intro Railroad Engineering	Intro Railroad Engineering	Vehicle Train Dynamics	Intro Railroad Engineering	Dynamic Models of Railway Systems	Railway Course/Program Develop and Coord
	Intro Railroad Infrastructure	Intro Railroad Infrastructure	Intro Railroad Infrastructure	Train Performance	Intro Railroad Infrastructure	Train Performance	Raising Student Interest and Recruiting through Student Chapters
	Railroad Power, Acceleration & Traffic Control	Train Energy, Power & Traffic Control	Train Energy, Power & Traffic Control	Advanced Train Control	Train Energy, Power & Traffic Control	Intro to Railroad Capacity	Railroad Engineering Design Case Studies
	Railroad Intermodal Transportation	Railroad Intermodal Transportation	Railroad Intermodal Transportation	Intro Railroad Capacity	Railroad Intermodal Transportation	Advanced Train Operations	Intro to Rail Software 1
	Transit Commuter Intercity Rail Transportation	Transit Commuter Intercity Rail Transportation	Transit Commuter Intercity Rail Transportation	High Speed Rail Planning	Railroad Alignment Design & Geometry	High Speed Rail Design	Intro to Rail Software 2
	Railroad Capacity	Railroad Alignment Design & Geometry	Railroad Alignment Design & Geometry	Railroad Engineering Software	Transit Commuter Intercity Rail Transportation	Shared Corridor Challenges	Current Research Programs and Needs
	Railroad Engineering Design Project	Railroad Engineering Design Case Studies	Railroad Engineering Design Case Studies	Shared Corridor Challenges			
<b>Keynote Speaker</b>	Sergi Pecori - Hanson Professional Services	Robert Boileau - BNSF RR	William Van Trump - UP RR		James Carter - NS Chief Engineer, Bridges and Structures		
<b>Industry Presentations</b>	AMTRAK	Kansas City Terminal RR	FRA		Panel discussion - Engineering Education and Recruitment Needs		
	CN RR	FRA	BNSF		Arthur Charrow	BNSF	
	FRA	AAR/TTCI	UIUC		Jacqueline Patterson	J.L. Patterson Associates	
	AAR/TTCI		AAR		Michael Pochop	Hanson Professional Svcs	
			Michigan Tech				
<b>FIELD TRIP</b>	NS Decatur Yard - Decatur, IL	BNSF Argentine Yard - Kansas City, KS	BNSF Argentine Yard - Kansas City, KS		BNSF Argentine Yard - Kansas City, KS/ Kansas City Intermodal Facility, Edgerton KS		

## Appendix 2 – REES 2012 Agenda



# #REES RAILROAD ENGINEERING #2012 EDUCATION SYMPOSIUM

## June 11-13, 2012 • Overland Park, KS Schedule

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<b>Sunday, June 10</b>	<b>Arrive in Overland Park, KS</b>
<b>4:00pm</b>	<b>Check-In at Hawthorne Suites by Wyndham Overland Park</b>
<hr/>	
<b>Monday, June 11</b>	<b>REES 1 &amp; 2</b>
<b>7:15 am</b>	<b>Continental Breakfast at Hotel</b>
<b>8:00 am</b>	<b>Check-in and Binder Distribution at the Johnson County Community College (JCCC)</b> <i>All events will be held in Room 44 of the ITC Building</i>
<b>8:30 am</b>	<b>Welcome, Introductions and Course Outline</b> <i>Dr. Charles H. Emely, AREMA Executive Director and CEO</i> <i>TBD, BNSF TTC at JCCC</i> <i>Michael Pochop, PE, Hanson Professional Services Inc., REES 2012 Committee Chair</i>
<b>8:45 am</b>	<b>Vision for Importance of Providing Railway Engineering Education</b> <i>Dr. Christopher P. Barkan, University of Illinois at Urbana-Champaign</i>
<b>9:15 am</b>	<b>Roundtable Discussion on Engineering Course Offerings and Research Programs</b> <i>Dr. Christopher P. Barkan, University of Illinois at Urbana-Champaign</i> <i>Dr. Pasi Lautala, Michigan Technological University</i> <i>Dr. James McKinney, Rose-Hulman Institute of Technology</i> <i>Dr. Jerry G. Rose, University of Kentucky</i>
<b>10:15 am</b>	<b>Break</b>
<b>10:45 am</b>	<b>Federal Railroad Administration Railway Work Force Presentation</b> <i>Monique Stewart - Federal Railroad Administration</i>
<b>11:15 am</b>	<b>Panel Discussion on Railway Engineering Education and Recruitment Needs</b> <i>Courtney Johnson – BNSF Railway</i> <i>Dan MacKay – Norfolk Southern Corporation</i> <i>Steve Tholkes – Professional Employment Group</i> <i>Tony Shirk – Herzog Railroad Services, Inc.</i>
<b>Noon</b>	<b>Lunch &amp; Networking</b>
<b>1:00 pm</b>	<b>REES 1: Module 1-A: Introduction to the Railway Industry and Railway Engineering</b> <i>Dr. Christopher P. Barkan, University of Illinois at Urbana-Champaign</i>  <b>REES 2: Module 2-A: Dynamic Models of Railway Systems</b>

*Dr. Dimitrios C. Rizos, University of South Carolina*

**2:15 pm**

**REES 1: Module 1-B: Introduction to Railway Infrastructure**

*Dr. Jerry G. Rose, University of Kentucky*

**REES 2: Module 2-B: Train Performance**

*Dr. David B. Clarke, University of Tennessee – Knoxville*

**3:30 pm**

**Break**

**4:00 pm**

**REES 1: Module 1-C: Train Energy, Power and Traffic Control**

*Riley Edwards, University of Illinois at Urbana-Champaign*

**REES 2: Module 2-C: Advanced Train Operations (Such as PTC)**

*Dave Hamson, Union Pacific Railroad*

**5:15 pm**

**Adjournment**

**7:00 pm**

**Welcome Dinner and Railway Keynote Address**

*Capital Federal Room, Regnier Center, JCCC*

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**Tuesday, June 12**

**7:15 am**

**Continental Breakfast at Hotel**

**8:00 am**

**REES 1: Module 1-D: Railway Intermodal Transportation**

*Dr. David B. Clarke, University of Tennessee – Knoxville*

**REES 2: Module 2-D: Introduction to Railroad Capacity**

*Samuel Sogin, University of Illinois at Urbana-Champaign*

**9:15 am**

**REES 1: Module 1-E: Railway Alignment Design and Geometry**

*Dr. Pasi Lautala, Michigan Technological University*

**REES 2: Module 2-E: High Speed Rail Engineering**

*T.C. Kao, University of Illinois at Urbana-Champaign*

**10:30 am**

**Break**

**10:45 am**

**REES 1: Module 1-F: Transit, Commuter and Intercity Passenger Rail Transportation**

*Dr. William J. Sproule, Michigan Technological University*

**REES 2: Module 2-F: Introduction to Rail Software**

*InRail and MicroStation – Dr. Pasi Lautala, Michigan Tech University*

*Kentrack – Dr. Jerry G. Rose, University of Kentucky*

*RTC – Samuel Sogin, University of Illinois at Urbana-Champaign*

**Noon**

**Lunch & Networking**

**12:45 pm**

**REES 1: Module 1-G: Railway Engineering Design Case Studies**

*Dr. Hesham Mahgoub, South Dakota State University*

**REES 2: Module 2-G: Shared Corridor Challenges**

*Dr. Christopher P. Barkan, University of Illinois at Urbana-Champaign*

**1:30 pm**

**Federal Railroad Administration Current Research Programs and Needs**

*Monique Stewart - Federal Railroad Administration*

**2:15 pm**

**AAR / BNSF Railway Current Research and Development Programs and Needs**

*Presenter: TBD, BNSF Railway (Tentative)*

**3:00 pm**

**Break**

**3:15 pm**

**Raising Student Interest and Recruiting Through Student Chapters**

*Discussion lead: Riley Edwards, University of Illinois at Urbana-Champaign*

**3:45 pm**

**Research Funding and Publication**

*Discussion lead: Dr. Christopher Barkan, University of Illinois at Urbana-Champaign*

**4:30 pm**

**Railway Course/Program Development and  
Collaboration**

*Discussion lead: Dr. Pasi Lautala, Michigan Technological University*

**5:15 pm**

**Break**

**5:30 pm**

**Feedback Session and Closing Remarks**

**6:00 pm**

**Dinner (at discretion of attendee)**

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**Wednesday, June 13**

**6:30 am**

**Depart for Field Trip**

**7:30 am**

**Safety Briefing and Introductions**

**8:00 am**

**Field Visit**

*Tour of BNSF's training facilities on the grounds of the JCCC and portions of BNSF's large Argentine Yard complex (40 minutes from the JCCC)*

**12:00 pm**

**Drop off at Hotel, Lunch (at discretion of attendee)**

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## Appendix 3 – REES 2014 Agenda



American Railway Engineering and  
Maintenance-of-Way Association

# #REES 2014 RAILWAY ENGINEERING EDUCATION SYMPOSIUM

June 23-25, 2014 • Overland Park, KS  
Schedule

Sunday, June 22	Arrive in Overland Park, KS
<hr/>	
Monday, June 23	REES 1
6:30 am	<b>Breakfast:</b> <i>Hot Breakfast available at Hawthorn Suites</i>
7:45 am	<b>Check-in and Binder Distribution at Johnson County Community College (JCCC)</b> <i>All REES 1 events will be held in Room 44 of the ITC Building</i>
8:15 am	<b>Welcome, Introductions and Course Outline</b> <i>Dr. Charles H. Emely, PhD, AREMA Executive Director and CEO</i> <i>Mr. Alexander Franco, Jr., BNSF Railway Technical Training Center at JCCC</i> <i>Mr. Michael A. Pochop, PE, Hanson Professional Services Inc., REES 2014 Committee</i>
	<i>Chair</i>
8:30 am	<b>Vision for Importance of Providing Railway Engineering Education</b> <i>Dr. Christopher P. Barkan, University of Illinois at Urbana-Champaign</i>
9:00 am	<b>REES 1-A: Introduction to the Railway Industry and Railway Engineering</b> <i>Dr. Christopher P. Barkan, University of Illinois at Urbana-Champaign</i>
10:15 am	<b>Break</b>
10:30 am	<b>REES 1-B: Introduction to Railway Infrastructure</b> <i>Dr. Jerry G. Rose, PE, University of Kentucky</i>
11:45am	<b>Lunch &amp; Networking</b>
12:15pm	<b>REES 1-C: Train Energy, Power and Traffic Control</b> <i>Dr. James L. McKinney, PE, Rose-Hulman Institute of Technology</i>
1:30 pm	<b>REES 1-D: Railway Intermodal Transportation</b> <i>Dr. David B. Clarke, PE, University of Tennessee – Knoxville</i>
2:45 pm	<b>Break</b>

- 3:00 pm**                    **REES 1-E: Railway Alignment Design and Geometry**  
*Mr. Tyler Dick, PE, University of Illinois at Urbana-Champaign*
- 4:15pm**                    **REES 1-F: Transit, Commuter and Intercity Passenger Rail Transportation**  
*Dr. William J. Sproule, PE, Michigan Technological University*
- 5:30 pm**                    **Social Period**  
*Nerman Atrium, Regnier Center, JCCC*
- 6:30 pm**                    **Welcome Dinner and Railway Keynote Address**  
*Room 101, Capitol Federal Conference Center, Regnier Center, JCCC*  
  
*Keynote Speaker: Mr. James N. Carter, Jr., PE, Chief Engineer – Bridges & Structures, Norfolk Southern Railway*
- 7:30pm**                    **Panel Discussion – Engineering Education and Recruitment Needs**  
*Capital Federal Room, Regnier Center, JCCC*  
  
*Mr. Arthur M. Charrow, PE, Director Engineering Planning, BNSF Railway*  
*Ms. Jacqueline L. Patterson, PE, President, J.L. Patterson & Associates, Inc.*  
*Mr. Michael A. Pochop, PE, Vice President, Hanson Professional Services Inc.*  
*TBD, CSX Transportation*
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- Tuesday, June 24**                    **REES 2 and 3**
- 6:30 am**                    **Breakfast:** *Hot Breakfast available at Hawthorn Suites*
- 8:00 am**                    **Welcome and Schedule for the Day**  
*Room 44 of the ITC Building at JCCC*
- 8:15 am**                    **REES 2-A: Dynamic Models of Railway Systems**  
*Dr. Dimitrios C. Rizos, University of South Carolina*
- REES 3-A: Railway Course/Program Development and Coordination**  
*Moderator: Dr. James L. McKinney, PE, Rose-Hulman Institute of Technology*  
  
*Dr. Kate Hunter-Zaworski, Oregon State University*  
*Dr. Hai Huang, PE, Penn State Altoona*  
*Dr. William J. Sproule, PE, Michigan Technological University*
- 9:30 am**                    **REES 2-B: Train Performance**  
*Dr. David B. Clarke, University of Tennessee – Knoxville*
- REES 3-B: Raising Student Interest and Recruiting Through Student Chapters**  
*Moderator: Dr. William J. Sproule, PE, Michigan Technological University*  
  
*Dr. James L. McKinney, PE, Rose-Hulman Institute of Technology*  
*Dr. Kate Hunter-Zaworski, Oregon State University*  
*Dr. Hai Huang, PE, Penn State Altoona*  
*Dr. Dimitrios C. Rizos, University of South Carolina*
- 10:45 am**                    **Break**

<b>11:00 am</b>	<p><b>REES 2-C: Introduction to Railroad Capacity</b> <i>Mr. Tyler Dick, PE, University of Illinois at Urbana-Champaign</i></p> <p><b>REES 3-C: Railway Engineering Design Case Studies</b> <i>Dr. Hesham Mahgoub, South Dakota State University</i></p>
<b>12:15 pm</b>	<b>Lunch &amp; Networking</b>
<b>12:45 pm</b>	<p><b>REES 2-D: Advanced Train Operations (Such as PTC)</b> <i>Mr. Tom Bartlett or Mr. Dave Hamson, Union Pacific Railroad</i></p> <p><b>REES 3-D: Introduction to Rail Software 1</b> Kentrack – <i>Dr. Jerry G. Rose, University of Kentucky</i></p> <p>InRail and MicroStation – <i>Mr. Tyler Dick, PE, University of Illinois at Urbana-Champaign</i></p>
<b>2:00 pm</b>	<p><b>REES 2-E: High Speed Rail Design</b> <i>Mr. Conrad Ruppert, University of Illinois at Urbana-Champaign</i></p> <p><b>REES 3-E: Introduction to Rail Software 2</b> RTC – <i>Mr. Tyler Dick, PE, University of Illinois at Urbana-Champaign</i> Vehicle-Track Dynamics (VTI) – <i>Mr. Cory Hogan, TUV Rheinland Rail Services, Inc.</i></p>
<b>3:15 pm</b>	<b>Break</b>
<b>3:30 pm</b>	<p><b>REES 2-F: Shared Corridor Challenges</b> <i>Dr. Christopher P. Barkan, University of Illinois at Urbana-Champaign</i></p> <p><b>REES 3-F: Current Research Programs and Needs</b> <i>Mr. Conrad Ruppert, University of Illinois at Urbana-Champaign</i> TBD, BNSF Railway TBD, Michigan Technological University</p>
<b>5:00 pm</b>	<b>Closing Remarks</b>
<b>5:30 pm</b>	<p><b>Dinner Workshop – Continued Discussion of REES Topics</b> <i>Location and Topics To Be Determined</i></p>

**Wednesday, June 25**

<b>6:30 am</b>	<b>Breakfast:</b> <i>Hot Breakfast available at Hawthorn Suites</i>
<b>8:00 am</b>	<p><b>Field Visits</b></p> <p><i>Group meets at 8:00am sharp at the ITC Building at JCCC, Room To Be Announced</i></p> <p><i>Assignment of bus groups:</i>  <i>Bus 1: BNSF's Argentine Yard Complex, Kansas City, KS</i>  <i>Bus 2: BNSF's Kansas City Intermodal Facility, Edgerton, KS</i></p>
<b>12:00 pm</b>	<b>Drop off at Hawthorn Suites, Lunch</b> <i>(at discretion of attendee)</i>

## JRC2013-2449

### RAILWAY ENGINEERING EDUCATION SYMPOSIUM (REES) – UNIVERSITIES AND INDUSTRY COLLABORATE TO DEVELOP RAILWAY EDUCATION

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#### ABSTRACT

The national emphasis on highway transportation and a lack of demand for graduates in rail related fields led to a decades long neglect of rail transportation and engineering education by universities in the United States (U.S.). However, the vitality of the private sector freight railroads, along with a growing interest in rail passenger transportation is creating a strong demand for graduates with rail expertise, particularly in engineering and related technical fields. This has re-energized the academic community, and several universities are currently either investigating or implementing rail-related programs. They are finding, however, that the information and knowledge needed for railway engineering course development in the civil, mechanical and electrical fields is hard to find. It has been so long since most U.S. universities offered rail related courses that few present day faculty have expertise in the subject.

The American Railway Engineering and Maintenance of Way Association (AREMA) has teamed up with academia to address the problem through an innovative Railway Engineering Education Symposium (REES). This program brings university professors together to learn the basics of rail transportation and railway civil engineering and to return with materials that can be used for course implementation. REES has been organized biannually since 2008 and is considered a great success, making it a model for extension to railway mechanical and electrical engineering. This paper describes the reasoning behind development of REES, content and organization of the symposium, and its evolution. It also describes REES outcomes based on participant surveys conducted after each event and

provides examples showing how universities have used REES to launch railway focused classes.

*Keywords: Higher education, University-industry collaboration, Railway engineering, Education development*

#### BACKGROUND AND CHALLENGE

The historical relationship between railroads and higher education in the U.S. reached a high point during the early 20<sup>th</sup> century. At this time, railroad engineering and economics comprised significant portions of university curricula in civil, mechanical and electrical engineering. Indeed, railway transportation had been a major force in the development of these disciplines within universities. Several institutions had entire departments dedicated to railway engineering, along with specialized laboratory facilities to study track, locomotives, wheels and other railcar components. A few even owned their own dynamometer cars to conduct mainline field testing on train resistance [1].

Starting at least in the early 1950s, when air and highway transportation rapidly surpassed railways as preferred passenger transportation modes in the U.S., the university-railway relationship began to weaken. The rapid expansion of infrastructure to support these modes, coupled with continued vehicle development, created design and research challenges. With the accompaniment of liberal funding, this attracted university attention. The development of these modes also created a strong demand for graduate engineers, and university faculty focused their courses accordingly.

During the same period, railroads began a period of retrenchment. Increased competition for both freight and passenger traffic eroded revenues. In response, railroads began a process of consolidation and rationalization with few new lines constructed but thousands of miles of track abandoned. Under financial pressures that ultimately led to the bankruptcy of a substantial portion of the industry, railroads deferred maintenance and slashed investment, including research and development. Railroads also cut costs by reducing employment, including many engineering functions. The intercity rail passenger business, with its once vast supporting infrastructure and supplier base, virtually disappeared, leaving only a skeleton system after 1971.

Under these circumstances, academia began to view the railway as a mature industry on the verge of obsolescence with little future opportunity for students. As professors retired and new faculty focused on other modes, railroad engineering programs, classes, and research were dropped [1]. Courses in transportation engineering once dominated by railroad subject matter were now almost entirely devoted to highway engineering. Most engineering graduates in the latter decades of the 20<sup>th</sup> century would obtain their degrees without any exposure to railroads. A 2005 survey of 500 engineers with five years or less of rail industry experience revealed that 84 percent had not received any college exposure to rail topics [2].

By the start of the 21<sup>st</sup> century, only a handful of institutions maintained courses in railway engineering. A slightly larger number of institutions still conducted railway research, largely due to the support of the Association of American Railroads (AAR) Affiliated Laboratory Program. However, the research was often conducted sporadically by faculty with interests tangential to the rail industry and by students who did not desire future careers in the industry, but rather encountered a rail application for their main focus area. Without consistent railroad research and educational activities, the University of Illinois at Urbana-Champaign became the sole U.S. university that has continuously maintained its railroad engineering program.

Against this academic backdrop, the fortunes of the freight railway industry had completely reversed. The latter two decades of the 20<sup>th</sup> century found the freight railroads in a period of growth and expansion. Emerging international markets served through containerized freight and high demand for bulk commodities such as coal drove rail traffic to record levels. Between 1980 and 2008, Class I railroad revenue ton-miles would nearly double and the railroad share of all freight ton-miles would increase significantly to 42 percent [3]. Within the industry, higher axle loads increased railroad productivity, at the cost of additional demands on infrastructure.

Although railroad efficiency and productivity continued to increase, many key mainline corridors neared capacity. After 1990, the freight railroads entered a new era of expansion with capital improvement projects designed to add capacity to meet the growing traffic demand. Studies of future traffic growth indicated that a capital investment of \$148 billion (2007 dollars) in freight railroad infrastructure will be required to meet demand through 2035 [4].

With downsizing, railways had outsourced much of their traditional engineering capability. The task of engineering new railroad capacity projects fell to senior project managers in consulting firms. Many of these persons were of an age to have had railroad engineering in their academic programs or to have worked in railway engineering departments earlier in their careers. As this last group of classically trained railroad engineers nears retirement age, the railroad industry faces the prospect of all future rail design being inherited by a young generation of designers who have little, if any, academic background and domain knowledge of railroads [1,2].

As increased axle loads and record traffic levels placed new demands on railway infrastructure, the industry and government agencies identified research issues and increased funding to investigate these issues. Academia has responded favorably, with numerous applications of new and emerging technology to address rail research needs.

The academic community has been slower, however, to respond to the railroad renaissance on the education front. The American Railway Engineering and Maintenance Association's (AREMA) Education and Training Committee ("Committee 24") conducted a survey, finding that railroad engineering is included as a topic in general transportation courses at less than 15 percent of North American universities and offered as a separate course at approximately three percent [2]. A separate survey of freight railways and major railway engineering consultants revealed that annual recruitment of railway engineers increased over 300 percent between 2002 and 2005 and was forecast to continue for at least the following ten years [5]. Although Michigan Technological University had joined the University of Illinois, University of Kentucky and University of Delaware in offering rail courses, it was clear that the demand for young engineers with railroad knowledge would continue to grow, exceeding the limited supply of graduates from these institutions.

Based on these trends, AREMA made addressing the gap in knowledge and the need for more engineering graduates trained in the fundamentals of railroad design, maintenance and operations a priority. A Committee 24 survey of civil and transportation engineering professors found interest in incorporating railroad engineering material into current transportation courses and development of new courses devoted to the subject [6]. The survey also identified barriers to an

increase in railway education activity: primarily a lack of available lecture content and an academic community without enough critical mass to sustain continued development and exchange of ideas, students and research [1].

To address these issues, AREMA developed the “10 x 10 Plan”, a vision to have 10 universities offering full semester courses on railway engineering topics by the year 2010. To support this plan, AREMA helped universities obtain guest speakers on railway topics. AREMA also prepared and disseminated some railway engineering lecture materials, but with varying degrees of success. It became clear that AREMA could not meet the “10 x 10” goals simply by offering materials to academia via the AREMA website. The new generation of civil and transportation engineering professors had to be taught, in a classroom and “hands-on” setting, the fundamentals of railroad engineering that they had missed during their own engineering education. Only after this experience and with the right lecture materials would engineering faculty be comfortable incorporating new railroad content into their existing transportation engineering classes or develop new railway engineering courses.

The Railway Engineering Education Symposium (REES) was conceived as an innovative way to provide engineering faculty with the necessary concepts and course content to teach railroad engineering. The first REES, held in 2008, was highly successful, leading to the event being staged again in 2010 and 2012. The 2012 REES offered additional content for previous attendees. The following sections describe the REES program.

## **REES ORGANIZATION**

REES is a distinct partnership between industry (railroads and engineering consultants), academia, and AREMA, the leading railroad engineering professional organization. AREMA and its industry members provide financial and administrative support for the event and academia bears main responsibility for the academic content. The stakeholders are involved through the full process of event planning and staging—a factor that has been one of its keys to success.

One goal of REES is to bring engineering professors together with peers already specializing in railway engineering and with railway engineering professionals who work for railroads, governments, consultants and research facilities. The symposium provides the professors with lecture materials for incorporation into transportation classes. Through presentations and discussions, they learn basic railroad engineering concepts which enable them to use the lecture materials effectively. REES also exposes the professors to various facets of the railway industry, including its recruitment and research needs. Supported by Table 1, the following discussion summarizes the structure and participation of each REES and shows how the event has evolved.

**Table 1. Summary of REES Events**

	<b>REES 2008</b>	<b>REES 2010</b>	<b>REES 1 - 2012</b>	<b>REES 2 - 2012</b>
<b>LOCATION</b>	U of Illinois Urbana-Champaign, IL	Johnson County Community College - Overland Park, KS	Johnson Count Community College - Overland Park, KS	
<b>No. Faculty Participants</b>	<b>32 (33)</b>	<b>26</b>	<b>21</b>	<b>11</b>
<b>No. of Universities Represented</b>	<b>28</b>	<b>26</b>	<b>28</b>	
<b>Course Modules</b>	Intro Railroad Engineering	Intro Railroad Engineering	Intro Railroad Engineering	Vehicle Train Dynamics
	Intro Railroad Infrastructure	Intro Railroad Infrastructure	Intro Railroad Infrastructure	Train Performance
	Railroad Power, Accelertion & Traffic Control	Train Energy, Power & Traffic Control	Train Energy, Power & Traffic Control	Advanced Train Control
	Railroad Intermodal Transportation	Railroad Intermodal Transportation	Railroad Intermodal Transportation	Intro Railroad Capacity
	Transit Commuter Intercity Rail Transportation	Transit Commuter Intercity Rail Transportation	Transit Commuter Intercity Rail Transportation	High Speed Rail Planning
	Railroad Capacity	Railroad Alignment Desing & Geometry	Railroad Alignment Design & Geometry	Railroad Engineermg Software
	Railroad Engineering Design Project	Railroad Engineering Design Case Studies	Railroad Engineering Design Case Studies	Shared Corridor Challenges
<b>Keynote Speaker</b>	Sergi Pecori - Hanson Professional Services	Robert Boileau - BNSF RR	William Van Trump - UP RR	
<b>Industry Presentations</b>	AMTRAK	Kansas City Terminal RR	FRA	
	CN RR	FRA	BNSF	
	FRA	AAR/TTCI	UIUC	
	AAR/TTCI		AAR	
			Michigan Tech	
<b>FIELD TRIP</b>	NS Decatur Yard - Decatur, IL	BNSF Argentine Yard - Kansas City, KS	BNSF Argentine Yard - Kansas City, KS	

REES includes two days in the classroom environment and a half-day visit to railroad facilities. The classroom portion is divided evenly across two types of content: railway engineering lecture material and general railway industry presentations and discussions. The railway engineering content consists of a series of modules, each presenting a specific topic in a lecture-length format. Academic members of AREMA Committee 24 and the American Society of Civil Engineers (ASCE) Rail Transportation Committee developed the modules with the support of AREMA Committee 24. Experienced faculty from institutions offering rail courses present the lecture modules. Attendees receive the presentation files, included example problems, and speaker notes for use in course development. They also receive a copy of the AREMA Practical Guide to Railway Engineering to use as a reference text.

The REES Academic Committee selected the core module topics and content, which has remained fairly stable through the REES events. The 2012 seminar introduced a new set of advanced modules (“REES 2”) for professors who had previously attended REES and wanted to return for additional railway engineering subject matter.

The REES general presentations are intended to broaden the attendees’ knowledge of the railway industry and in particular,

railway engineering recruitment, education, and research needs. Presentation formats include both podium sessions and panel or roundtable discussions. A keynote address by a railway president or chief engineer serves to inspire interest in the field and highlight the ongoing engineering challenges to be met by new graduates. Attending professors also hear recent graduates discuss their experience as young engineers in the rail industry. The REES academic representatives discuss their experiences in introducing railway content at their institutions and provide a framework for establishing and expanding the railway engineering academic community. Human resources representatives from railroads and railway engineering consultants discuss recruitment needs and job opportunities for students. Finally, representatives from industry associations and government describe the industry research needs.

Industry involvement in REES also extends to the field visit, often rated as one of the most beneficial program segment. Arrangements are made with a local railroad for a behind-the-scenes and up-close view of facilities, allowing attendees to see the direct application of topics discussed in the lecture modules. For past events, REES attendees have been able to observe mainline and terminal operations and visit dispatching and communications facilities. Few REES attendees have ever had such an intimate look at railroad facilities, and all come away

highly impressed. Outstanding railroad industry cooperation makes these tours possible, and they figure highly in REES's success.

The cooperation between the stakeholders also extends to event funding. REES covers travel and other expenses for attending engineering professors from first-time institutions without existing railroad content. This support is provided by donations and sponsorship from numerous sources. Organization sponsors include major railroads and consulting firms, the Federal Railroad Administration, and University Transportation Centers. Private individuals make donations through the AREMA Educational Foundation. Faculty from institutions in the railway engineering academic community and other industry presenters support REES by funding their own travel. Event facilities have been donated by academic institutions and the railroads. AREMA and its office staff handle many of the administrative burdens.

### FOLLOW-UP SURVEY OUTCOMES AND FEEDBACK

After the 2010 and 2012 REES events, AREMA conducted extensive follow-up surveys to assess the success of the program. In addition to a general inquiry on the helpfulness of REES event, the survey addressed various topics ranging from the transferability of modules to the usefulness of other presentations and discussions. The survey also gauged the current level of rail education at participating universities and plans to incorporate REES materials in classes. The academic organizing committee has also continued informal communication with participants to determine what actions are being taken to build upon their REES experience.

The key findings from surveys are presented and discussed below. Unless otherwise indicated, all responses were rated on a scale of 1-5 with one being least favorable ranking and five the most favorable. Overall, the event activities have received high ratings, although there was a small decline in the overall ratings from 2010 to 2012. It is unclear what caused the decline, but it could be speculated that the expectations for the event have grown over time, as more faculty have become aware of the opportunity. 2012 also saw more versatile group of faculty participants with some faculty returning to REES 2. This may have affected the ratings.

Figures 1 and 2 present the overall successfulness and helpfulness rankings provided by each respondent for 2010 and 2012 REES Symposiums. *Successfulness* was based on REES meeting its objectives of introducing faculty to railway engineering technical content and providing faculty with the tools to incorporate railroad content into their courses. *Helpfulness* was based on the lecture module content in terms of its transferability into the attendees' institutions' courses and educational needs. Although the overall rankings saw a slight drop from 2010 to 2012, the events were still ranked highly in

both years.

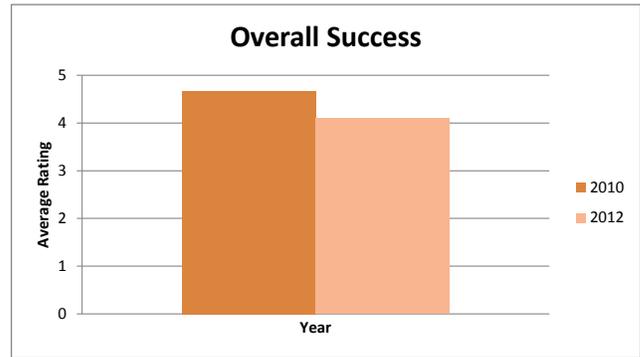


Figure 1. Overall Success Ratings

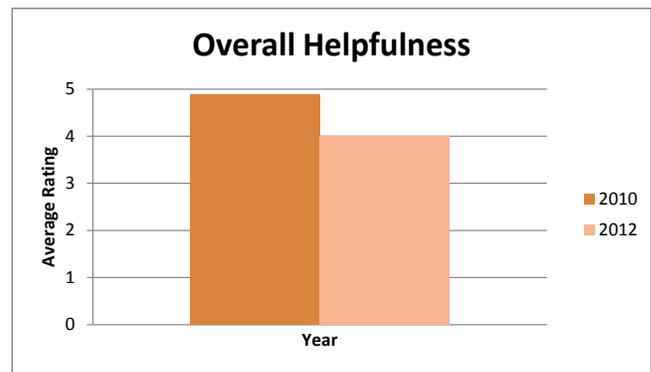


Figure 2. Overall Helpfulness Ratings

Survey respondents identified most and least helpful aspects the symposium lecture module content, materials and discussions. Common responses for most helpful included:

- networking opportunities and ability to interact with other university faculty who teach railroad related courses
- Powerpoint files, loose leaf binders, and additional provided materials
- engaging experience

The research opportunities presentation was commonly listed as least helpful. Many conference attendees have limited or nonexistent research capabilities, devaluing much of the research related content.

Overall, respondents identified REES as an excellent experience that was enjoyable and useful.

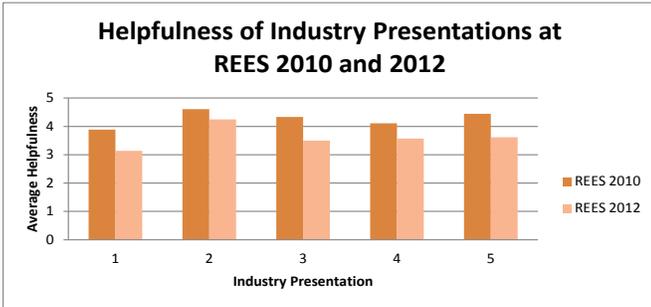
### Course Modules and Industry Presentations

Several industry presentations were in both the 2010 and 2012 REES programs. These included (refer to corresponding

numbers in Figure 3):

1. research presentations by the Federal Railroad Administration (FRA) and the Association of American Railroads (AAR)
2. field visits to observe infrastructure, operations, and other concepts
3. railroad academic roundtable discussion
4. railroad industry panel discussion
5. breakout sessions on railroad engineering teaching and research program development

Overall, industry presentations were rated high, but not as high as the educational modules. Technical facility tours were rated the highest and research presentations the lowest. Narrative survey comments for industry presentations and tours supported the high quality of the presentations and the value of the tours. Comments on the research presentation indicated that the low value was based on the attendees' limited research capabilities.



**Figure 3. Industry Presentation Ratings**

Participants rated the transferability of educational modules to their classrooms. The titles of each module are presented below, followed by the average transferability rating for each course module presented at REES 2010 and 2012 (Figure 4). Note that REES 2 modules were only presented in 2012.

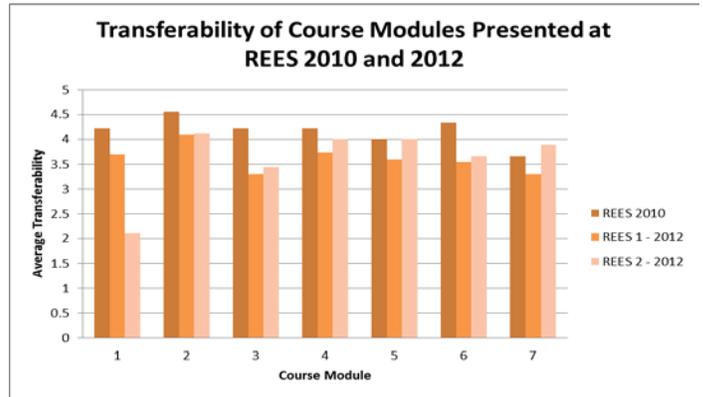
**REES 1 (2010 and 2012)**

1. Introduction to the Railway Industry and Railway Engineering
2. Introduction to Railway Infrastructure
3. Train Energy, Power, and Traffic Control
4. Railway Intermodal Transportation
5. Railway Alignment Design and Geometry
6. Transit, Commuter, and Intercity Passenger Rail Transportation
7. Railway Engineering Design Case Studies

**REES 2 (2012 only)**

1. Dynamic Models of Railway Systems
2. Train Performance
3. Advanced Train Operations (Such as PTC)
4. Introduction to Railroad Capacity
5. High Speed Rail Engineering

6. Introduction to Rail Software
7. Shared Corridor Challenges

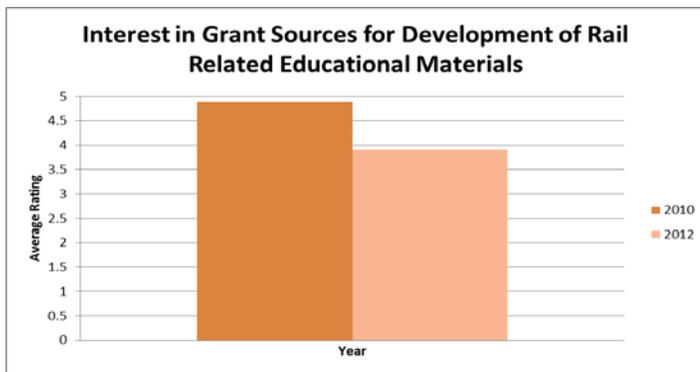


**Figure 4. Survey Results for Course Modules**

Additionally, respondents identified the least and most useful aspects of each module attended. Common responses for most helpful included unique discussions and excellent presentation materials and design examples. Common responses for least helpful included lack of technical depth and presentation pace too brisk for attendees unfamiliar with rail and related terminology.

In addition to educational module and other presentation specific evaluations, the attendees were asked about their interests to join AREMA. In 2010 a majority of REES attendees indicated that they were already AREMA members or had thought about joining AREMA when surveyed. In 2012, it was found that roughly half of the respondents were members or had thought about membership prior to attendance. After exposure to REES, twenty percent of those that had not thought about membership prior to attendance expressed a willingness to join AREMA and an additional fifty percent said that they may consider joining in the future. The last thirty percent said that they had no plans to join AREMA at that time.

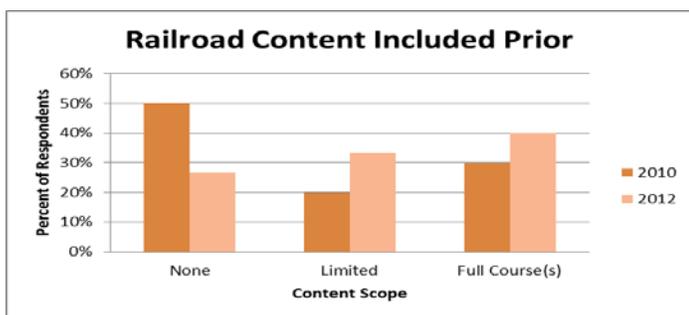
Even though research presentations ranked low, both survey groups indicated a high level of interest in grant opportunities from the National Science Foundation and other potential sources to develop railway engineering educational materials (Figure 5). This demonstrates a desire among attendees to continue rail education developments after REES.



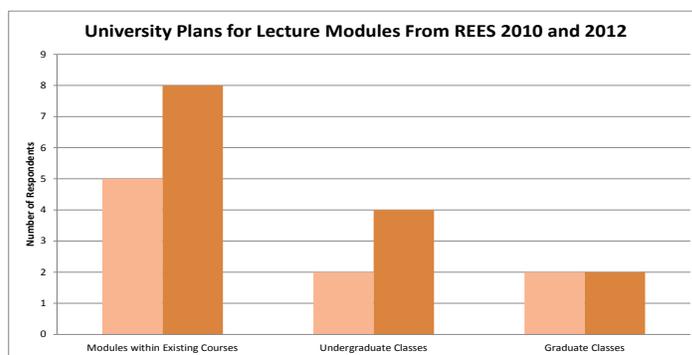
**Figure 5. Average Interest in Grant Sources for Development of Rail Related Educational Materials**

The survey also collected information on railroad engineering content (or lack of it) at attendee institutions prior to either the 2010 or 2012 REES events (Figure 6). *None* alternative indicated that no course material was available prior to REES, *Limited* indicated one time offerings or railroad material covered within the scope of another class (ie transportation engineering), and *Full course(s)* reflected at least one existing railroad engineering course. Due to the brevity of responses, no consideration was given to differences in the number of credits and lecture hours provided by each course.

The survey revealed an increase in pre-existing offerings from 2010 to 2012. The introduction of REES 2, which brought back professors from earlier REES events, offers one explanation for this increase. The returning faculty may have introduced courses at their universities following their initial REES experience. The 2012 attendees also expressed increased interest in incorporating REES provided materials into their curricula (Figure 7). The most popular method was incorporating REES content in existing courses, but interest in new courses also increased. Financial restrictions were cited as the most common challenge for new course creation.



**Figure 6. Railroad Content Included in Attendees' Institutions Prior to REES 2010 and 2012**



**Figure 7. Plans for Lecture Module Use**

## SUCCESS STORIES REPORTED BY REES PARTICIPANTS

REES has been successful in promoting new railway education initiatives within universities. The following paragraphs introduce some of the best examples of growing programs and offerings:

### University of South Carolina (USC)

Dr. Dimitris Rizos, Associate Professor and Assistant Chair in the USC Department of Civil & Environmental Engineering, attended REES 2010 and 2012. Dr. Rizos specializes in structural engineering, and was quick to identify several potential areas of research interest involving railways. His coverage of railway structures, particularly the dynamic behavior, is unique within U.S. academic circles. Following REES 2010, he took aggressive steps to promote railway engineering within his department and college. Among his initial accomplishments, Dr. Rizos established the Advanced Railway Engineering Technology Group within his department. The goals of this group are to support the railroad industry and promote freight, passenger and high-speed passenger rail in SC and the U.S. Six collaborating faculty members and nine PhD, MS, and undergraduate students collaborate within the group on railway research. With Dr. Rizos' leadership, group members are developing an active research program and scholarly publication record. His efforts have promoted research, education and technology transfer in two primary areas: railway structures and infrastructure design, assessment, maintenance and safety, and operations with emphasis on multi-modal transportation networks.

Dr. Rizos has also been active in educational initiatives at his institution. His department now has four new railroad engineering courses:

- Introduction to Transportation Engineering
- Railway Engineering
- Design of Railroad Bridges and Other Structures
- Dynamics of High Speed Rail

The department's Capstone Senior Design Project has included a project in railroad engineering. USC also has a newly formed

AREMA student chapter. The program has graduated two PhD students and one MS student with a railway focus. Five undergraduate students have taken positions with Class I railroads.

### **Villanova University**

Dr. Leslie McCarthy, P.E., Assistant Professor in the Villanova University Department of Civil & Environmental Engineering, was a 2010 and 2012 REES participant. Following her initial REES experience, Dr. McCarthy took the initiative to add railway engineering to her department's curriculum. As a transportation engineer, she paid particular attention to her department's transportation related courses. Her efforts have led to the addition of railway engineering content in five undergraduate courses:

- Introduction to Transportation Engineering - 2 weeks of railroad engineering
- Advanced Transportation Engineering - senior elective
- Transportation Facilities Design - senior design elective
- Special Topics in Transportation - senior technical elective
- Undergraduate Research in Transportation - internship with rail or freight organization

Her department's semester Capstone Design Course has featured two different rail projects. A Special Topics in Transportation class addressed passenger rail. Villanova also has added two relevant graduate courses: Railway Engineering and Design of Sustainable Transportation Systems. A new full-time transportation faculty member, Dr. Seri Park, is collaborating with Dr. McCarthy on railway initiatives.

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

Dr. James McKinney, P.E. is Professor Emeritus in the Department of Civil Engineering at Rose-Hulman Institute of Technology. A REES attendee since 2008, Dr. McKinney has led his institution's initiatives in railway education. Rose-Hulman now has two undergraduate courses incorporating railway engineering:

- Introduction to Transportation Engineering - 3 weeks of Railroad Engineering
- Railroad Engineering – Interdisciplinary Course: Civil, Electrical & Mechanical Engineering (New course for Spring 2013 sponsored by the National University Rail Center)

The Civil Engineering department's senior Capstone Design class has featured three different rail projects. The freshman design class has had two different rail projects.

Rose-Hulman established the 11<sup>th</sup> AREMA student chapter. Seventeen students attended the 2012 Annual AREMA Conference & Exposition in Chicago. Rose-Hulman is also a partner in the National University Rail Center (NURail)

Consortium, a University Transportation Center lead by the University of Illinois at Urbana-Champaign.

### **University of Nevada Las Vegas (UNLV)**

Dr. Hualiang ("Harry") Teng is Associate Professor in the Department of Civil and Environmental Engineering and Construction at UNLV. A 2012 REES participant, Dr. Teng is well grounded in rail transportation as a result of his undergraduate and graduate programs at China's Northern Jiaotong University. He presently has four new railway related courses in development:

- Introduction to Railroad Transportation
- Public Transportation
- Freight Transportation
- High Speed Rail

UNLV has a new AREMA student chapter. The university has also hosted AREMA's Practical Guide to Railway Engineering workshop.

### **CONCLUSIONS AND NEXT STEPS**

Since its inception, REES has had three successful installments, and planning for a fourth is underway. Program attendance has been strong, and attendees have been overwhelmingly positive about the experience. By popular demand, the program has expanded its content to include additional subject matter in the form of REES 2 for returning professors. Industry and academic supporters remain enthusiastic, boding well for the future of the event.

Based on attendee surveys and follow-up contacts, REES is having a positive effect on the state of railway engineering education in the U.S. The four examples provided list nineteen courses either containing railway engineering content, or devoted to railway engineering. Expanded to all REES attendees, the numbers are likely far larger. Though still small in numbers by comparison to highway related courses, these courses represent a definite turnaround in the state of U.S. railway engineering education. REES has also been a factor in the growing numbers of AREMA student chapters. These organizations promote interest in and knowledge of railway engineering among students. This is vital to the sustainability of railway programs. In addition, the chapters provide opportunities for students to attend industry events and make the necessary contacts for employment.

It is less certain that REES is promoting renewed railway research interests in universities. Research requires a funding base from industry and government well beyond what is presently available in the railroad arena. Universities naturally focus their research programs towards available funding and railway research funds are not yet available to support a large community of researchers in the U.S. However, REES is making attendees more aware of railway technology and

industry research needs, increasing the pool of potential and actual railway researchers. This pool has in recent years been exceedingly small, making the conduct of railway research at universities difficult. As opportunities arise, the university research community will be better equipped to take advantage of them. In addition, creation of a peer group of researchers is important for the university tenure and promotion process and for academic publishing. Without such group, new professors could find it difficult to find reviewers to their scholarly articles and to get promoted based on a railway oriented research record—a factor that would discourage participation in such research.

Despite the many positive accomplishments of the current REES program, its present content is largely railway civil engineering, and most attendees have been civil engineering professors. While civil engineers have important roles in the railway industry, the roles of mechanical, electrical, industrial, and environmental engineers are no less critical. The same inexorable demographic trends are affecting the qualified industry workforce in these disciplines as in civil engineering and initiatives like communications based train control and high-speed rail will require professionals with skills not found in much of the existing workforce. While some civil engineering legacy programs endured the long decline, the railway content in these areas is virtually devoid. In addition, developing these professionals will require engineering curricula of a different nature than those of the old traditional programs.

Expanding REES, or developing a REES-like program, to include the other engineering disciplines is clearly needed. Much thought has been devoted to this subject, but the path forward is far from clear. AREMA, which has done so much to promote REES, is largely focused on railway civil engineering. Partnerships with other professional organizations will likely be needed to expand REES to include other disciplines. These relationships must be developed, a process that takes time and energy. Academic expertise for other disciplines must also be

recruited to develop curricula and module content. There are no extant railway electrical, industrial, or mechanical engineering programs within U.S. universities to draw such faculty from. REES benefited enormously from the pool, admittedly small, of active railway civil engineering faculty. Despite these challenges, REES promoters are optimistic that the program can and should be successfully expanded.

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