

1 **Railway Engineering Education Symposium:**
2 **Evolving to Rebuild a Growing Rail Academic Community**

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1 ABSTRACT

2 Even though there have been a decline in freight traffic in 2016, the railroads in North America
3 have been coming off of a decades-long period of growth of freight ton-miles and in the number
4 of commuter and intercity passenger rail trips. This growth, combined with the aging
5 demographics of the current railway workforce, has triggered renewed demand for university
6 graduates to enter railway careers. However, after decades of neglect, only a small number of
7 academic programs in North America are engaged in rail-related research and education. The
8 railway academic community must be rebuilt to meet the industry workforce development needs
9 of the future. To help address this situation, since 2008 the Railway Engineering Education
10 Symposium (REES) has been staged as a biannual collaboration between academia and industry
11 to expose professors to railway engineering education topics. REES has been immediately
12 successful in prompting faculty at numerous universities to expand railway content in
13 introductory transportation courses and to establish new courses on railway engineering topics.
14 Based on feedback from surveys of past attendees, REES has continually evolved to better
15 support the now-growing railway academic community. Expanding beyond its original focus on
16 new professors, REES now also serves as a user conference for returning professors already
17 engaged in railway education activities and is accompanied by a 24/7 online delivery of past
18 materials. This paper briefly reviews the decline of the relationship between railways and
19 academia, and concentrates on the role of REES in its reemergence. Evidence of REES
20 successes from participant surveys are documented and future challenges on the path forward are
21 discussed.

22

23 *Keywords:* Railway Engineering, Higher Education, Industry-University Collaboration

24

1 INTRODUCTION

2 The North American railway network provides safe, reliable and efficient movement of people
3 and products that drives economic development. In the face of increasing population, changing
4 travel patterns, shifting commodity flows, aging infrastructure, climate change and availability of
5 funds dedicated for transportation, railways must continually adapt through research and
6 innovation. A well-functioning rail transportation system is also ultimately dependent on a
7 supply of skilled rail transportation leaders to plan, design, operate, maintain and manage the rail
8 system of the future. However, only a small number of rail academic programs in North
9 America are engaged in rail-related research and teaching courses to educate the next generation
10 of railway professionals (1). This paper briefly describes how the rail industry arrived at this
11 situation and concentrates on one successful effort undertaken over the past decade to rebuild
12 and grow the railway academic community.

13 Decline of Railway Education in Academia

14 The historical relationship between North American railroads and higher education reached a
15 high point during the early 20th century (2). At this time, railroad engineering and economics
16 comprised significant portions of university curricula in civil, mechanical and electrical
17 engineering. The need for trained engineering professional to expand the North American rail
18 network had been a major force in the development of these disciplines within universities.

19 Starting at least in the early 1950s, when air and highway transportation rapidly surpassed
20 railways as preferred passenger transportation modes in the U.S., the university-railway
21 relationship began to weaken. As passenger rail service began to be discontinued on many lines,
22 fewer students used railway transportation or were exposed to active rail construction projects
23 (3). While railways were viewed as a mature technology with a shrinking network, the rapid
24 expansion of highway and airport infrastructure presented research challenges that, coupled with
25 liberal funding to address them, quickly drew the interest of transportation academics.
26 Universities eliminated railway engineering programs, faculty adjusted their university
27 transportation courses and students altered their career plans accordingly. Between 1956 and
28 1964, only 0.3 percent of the graduates from the civil engineering program at the University of
29 Illinois at Urbana-Champaign went on to employment in the rail industry; a substantial decline
30 compared to the rate of over 10 percent between 1910 and 1920 (4).

31 The relationship between universities and railways continued to decline during the 1960s
32 and 70s as railways consolidated, abandoned thousands of miles of track, deferred maintenance
33 and curtailed investment in research and development. Deregulated in 1980, railways cut costs
34 by reducing employment and outsourcing many engineering functions to consultants. By the
35 1990s, most engineering graduates would obtain their degrees without any exposure to railroads.
36 By the start of the 21st century, railway engineering was included as a topic in general
37 transportation courses at less than 15 percent of North American universities and offered as a
38 separate course at approximately three percent (5). As a result, a 2005 survey of 500 engineers
39 with five years or less of rail industry experience revealed that 84 percent had not received any
40 college exposure to rail topics (5).

41 Rejuvenation of the Rail Industry and Demand for Graduates

42 As early as 1980 it was recognized that the current level of railway engineering course content
43 would not sustain long-term demand for railway engineering professionals (6). However, it
44 would take several decades, a dramatic increase in traffic, constrained capacity, changing
45 demographics and renewed interest in passenger rail for the issue to come to the forefront.

1 As university railway educational activities dropped to their lowest point, North
2 American freight railroads were in a period of growth and expansion with record traffic levels
3 driven by containerized freight and high demand for bulk commodities such as coal. Between
4 1980 and 2008, Class I railroad revenue ton-miles would nearly double and the railroad share of
5 all freight ton-miles would increase significantly to 42 percent (7). Higher axle loads to increase
6 productivity and constrained capacity on key mainline corridors led railroads to invest hundreds
7 of billions in capital improvement projects (8). Studies of future traffic growth have indicated
8 that over \$100 billion in further improvements will be required to meet demand through 2035
9 (9).

10 This same period has been marked by renewed interest in expansion of passenger rail
11 service. Between 2002 and 2013, as various states developed regional intercity passenger
12 corridors, Amtrak ridership increased by over 50 percent and Amtrak set a new annual ridership
13 record 10 out of 11 years (10). Between 1997 and 2012, commuter rail ridership increased by 49
14 percent and eight new commuter rail systems have inaugurated service since 2004 (11).
15 Planning and design of proposed high-speed rail systems has slowly created additional demand
16 for railway engineering talent while simultaneously capturing the imagination of many students
17 (12).

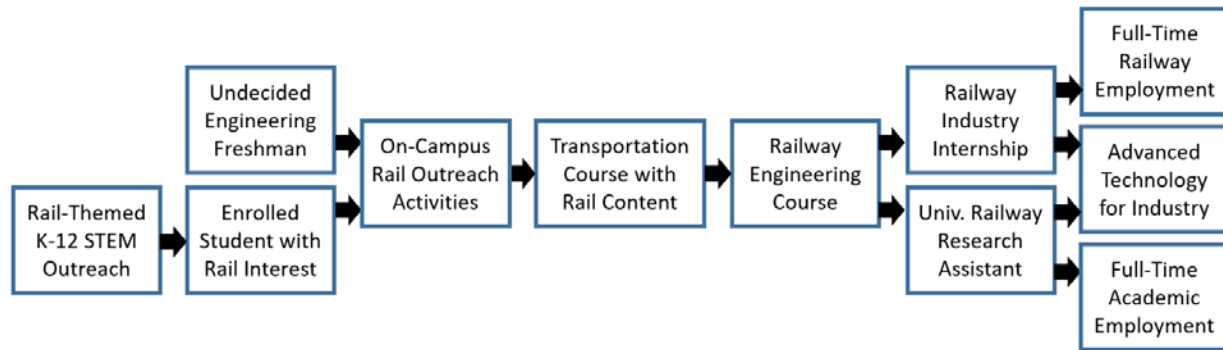
18 The railway capacity projects required to support growing freight and passenger traffic
19 created a sudden increase in demand for railway engineering professionals that academia was not
20 equipped to meet (13). For the rail industry, the general demographic trend of an aging
21 transportation workforce (14) was compounded by the decades-long lack of railway engineering
22 course content at the university level. As the senior project managers who had railroad
23 engineering in their academic programs continue to retire, the railroad industry faces the prospect
24 of all future rail design being inherited by a young generation of designers who have little, if any,
25 academic background and domain knowledge of railroads (15). Under these conditions, it was
26 recognized that reversing this trend requires the re-introduction of railway concepts to
27 transportation engineering curricula and rebuilding the relationship between the railway industry
28 and academia.

29 **A Necessary Partnership**

30 Academicians, and engineering professors in particular, play an integral role in meeting the
31 demand for railway transportation professionals by guiding students through the university
32 pathway to the rail industry (Figure 1). While railways still fascinate many young people and
33 youth continue to be involved in model railroad and other railway enthusiast hobby activities,
34 only a very small minority of students seek out specific academic programs in railway
35 engineering based on their personal interests. With little railway industry outreach to youth at
36 the K-12 level, the vast majority of incoming engineering students enter university without any
37 awareness of potential careers in the rail industry. The rail industry relies on faculty engaged in
38 railway education and research to act as ambassadors and promote student awareness of the
39 railway field. Faculty may be aided in on-campus outreach to incoming freshmen by student
40 groups, such as student chapters of the American Railway Engineering and Maintenance-of-Way
41 Association (AREMA).

42 Students most often receive their first formal exposure to railway concepts through
43 lectures in introductory transportation engineering courses. These lectures are key to sparking
44 student interest in the field and, where available, leading students to enroll in senior-level
45 elective courses specifically on railway topics. Relationships between faculty and railway
46 practitioners are also essential to arranging experiential learning opportunities for students

1 through industry internships or involvement in railway research at the undergraduate or graduate
 2 level. Railway industry support of student involvement in rail research conducted by faculty
 3 provides potential advantages at three levels: 1) new solutions to problems facing the industry
 4 through research results and 2) a well-trained university graduate prepared to implement these
 5 solutions as they embark on a career as a railway transportation professional, 3) new academic
 6 faculty with demonstrated capabilities and interest in continuing rail related research.
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8
 9 **FIGURE 1 University pathway to the rail industry**

10
 11 To further increase the pool of potential students for industry careers, faculty and
 12 AREMA Student Chapters have also engaged in outreach to K-12 students, typically through
 13 railway-themed Science, Technology, Engineering and Mathematics (STEM) activities.
 14 Examples include the Summer Youth Program in Rail and intermodal Transportation at
 15 Michigan Technological University, Engineering Open House and summer STEM Camp rail day
 16 at the University of Illinois at Urbana-Champaign, and support of the Boy Scout “Railroading”
 17 merit badge at various campuses.

18 Although this university pathway to the rail industry works well, it is only truly
 19 functioning at a handful of campuses across North America. Further academic involvement is
 20 needed but there are various barriers to overcome.

21 **Challenges to Increased Academic Involvement**

22 The resurgence of railway transportation, and in particular the purchase of BNSF Railway by
 23 Berkshire Hathaway and introduction of the Obama administration “Vision for High-Speed
 24 Rail”, both in 2009, did not go unnoticed by academia. An AREMA Education and Training
 25 Committee (“Committee 24”) survey of civil and transportation engineering professors found
 26 interest in incorporating railroad engineering material into current transportation courses and
 27 development of new courses devoted to the subject (16). However, the survey also identified
 28 barriers to an increase in railway education activity:

- 29 • lack of research funding to attract young faculty to pursue rail-related topics
- 30 • lack of teaching materials focusing on railway concepts due to railroad courses being
 31 discontinued for many years
- 32 • lack of connections between faculty and railway engineering professionals, with a
 33 particular lack of alumni due to elimination of railroad courses and programs

1 When competing for academic attention, the above barriers make railways less attractive than
2 other transportation modes where federal and state funding is more readily available, teaching
3 materials have been maintained, and professors have direct connections to decades of
4 transportation alumni. Interestingly, even in Europe, which is perceived to have a stronger
5 railway academic community than North America, varying faculty interest in rail has resulted in
6 gaps in university railway curricula (17). Thus, it became clear that a strong push from industry
7 would be required to overcome these obstacles in North America (16). The concept of an
8 innovative industry-sponsored event to provide interested faculty with railway engineering
9 course materials and connections to industry professionals was developed. The resulting
10 Railway Engineering Education Symposium (REES) would become central to rail industry
11 efforts to rebuild the railway academic community.

12 **RAILWAY ENGINEERING EDUCATION SYMPOSIUM**

13 REES brings engineering professors together with peers already specializing in railway
14 engineering and with railway engineering professionals who work for railroads, governments,
15 consultants and research facilities. The symposium provides the professors with lecture materials
16 for incorporation into transportation classes. Through presentations and discussions, they learn
17 basic railroad engineering concepts which enable them to use the lecture materials effectively.
18 REES also exposes the professors to various facets of the railway industry, including its
19 recruitment and research needs.

20 REES has its origins in a 2007 white paper developed by AREMA Committee 24 that
21 outlined the basic framework for the event:

- 22 • Three-day workshop for professors including classroom lectures and field visit
- 23 • Industry and experienced railway academics to provide lecture materials designed
24 for incorporation into a civil engineering curriculum
- 25 • Modular lecture materials so professors can mix and match self-contained
26 material to fit interests and available lecture slots in their transportation courses
- 27 • 10-20 invited professors with limited previous exposure to rail concepts
- 28 • Stipends to cover travel expenses of invited professors
- 29 • \$20,000 funding goal from major railroads, Federal Railroad Administration,
30 Association of American Railroads and major railway engineering consultants
- 31 • Event coordinated by AREMA Committee 24

32 The concept of the railway industry developing lecture content on railway topics for
33 distribution to universities through AREMA Committee 24 actually dates back to the late 1950s
34 (3). However, these early efforts lacked the first-person interaction and networking elements
35 that would become one key to the success of REES.

36 The first REES event, held in 2008, was highly successful. Subsequent REES events have
37 been held every two years since, with the most recent in July, 2016. While still fulfilling its
38 original mission of exposing professors new to the rail field to railway concepts, REES has also
39 evolved into a “user conference” where returning professors involved in railway engineering
40 education can share ideas and seek input from peers on developing their railway education and
41 academic research programs.

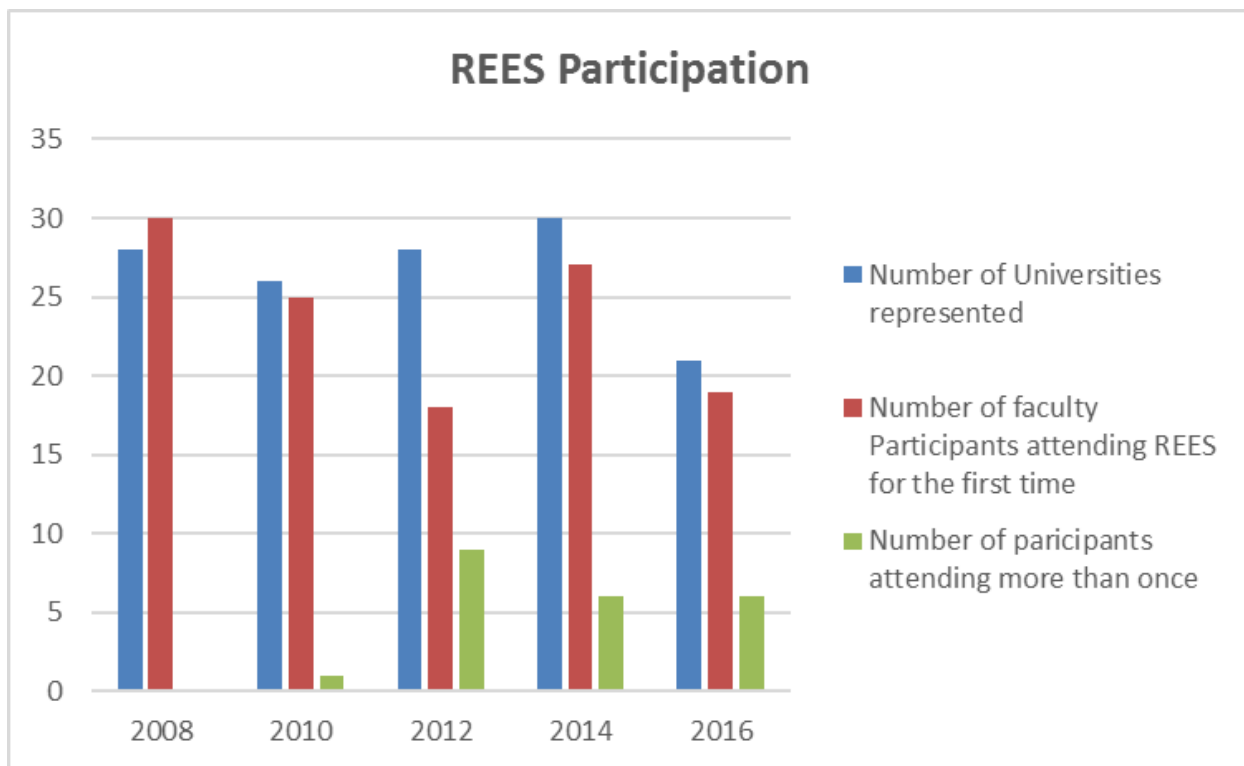
42 The planning and content development aspect of REES has also evolved over time. The
43 initial REES collaboration was between AREMA Committee 24, industry professionals and a

1 handful of professors actively teaching railway engineering courses. As more faculty have
 2 become engaged in railway education activities, the lecture content is now almost exclusively
 3 developed by railway academicians. With the formation of the National University Rail Center
 4 (NURail), a US DOT University Transportation Center, in 2012, professors affiliated with
 5 NURail have taken on a larger role in organizing the logistics of more recent REES events.
 6 While funds raised through the AREMA Educational Foundation continue to financially support
 7 the attendance of professors new to the rail domain, travel costs for many presenting professors
 8 and return attendees are supported in part by NURail funds from US DOT.

9 **EVOLUTION OF REES**

10 **REES Participation**

11 Overall, the 2008-2016 REES events have had a total of 113 new and 22 returning professors
 12 from 70 different universities (Figure 2). As discussed earlier, REES was initially developed to
 13 introduce railway engineering to professors with no prior exposure. This can be seen in Figure 2
 14 as the first two REES events were dominated by the “new” professors participating for the first
 15 time. However, from 2012 forward, the event was modified to include complementary content
 16 for professors interested in returning to expand their learning and exposure. Thus, the
 17 participation in later events has shifted toward a closer balance between new and returning
 18 professors.
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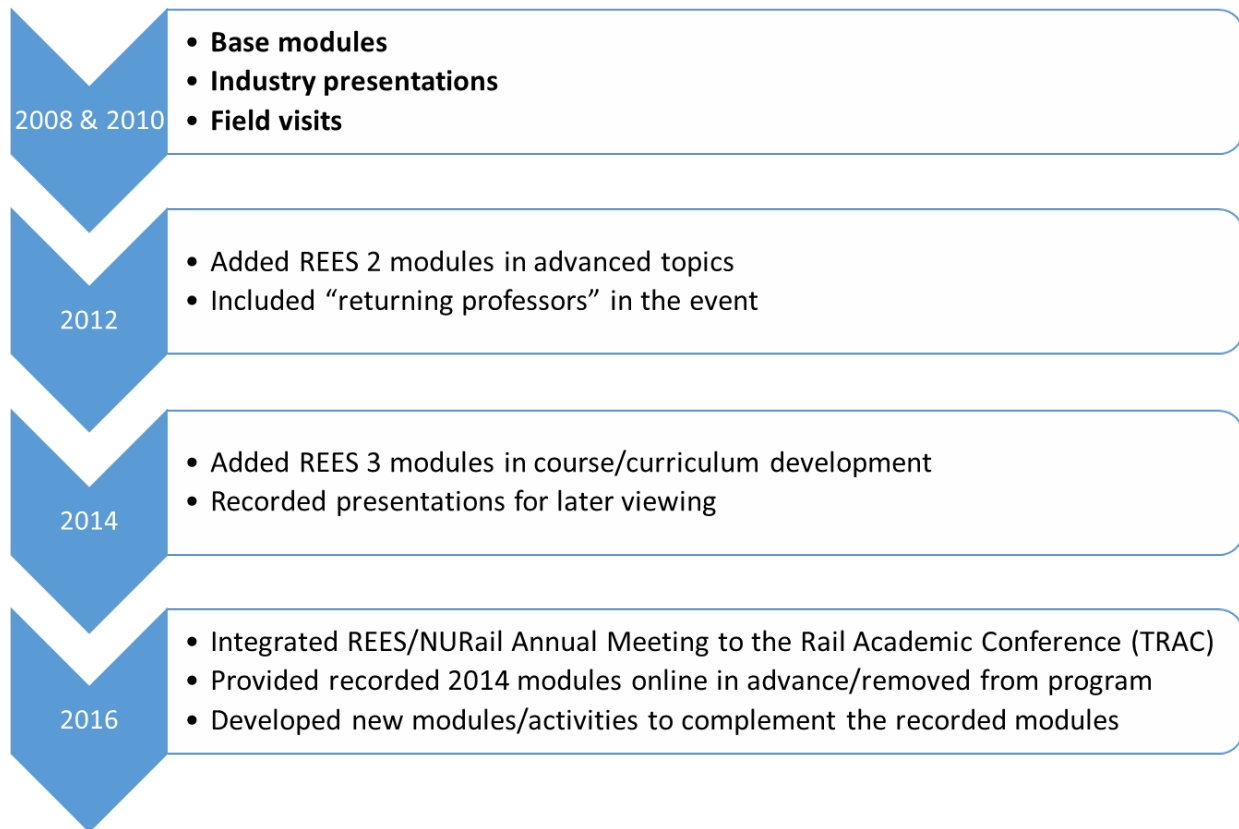
21 **FIGURE 2 REES participation by event (2008-2016)**

22

1 REES Content and Materials

2 While the overall structure and organization of REES has remained stable the event needs to
 3 evolve to remain relevant as the railway academic community grows and matures. The first two
 4 REES events concentrated on the content originally envisioned in the 2007 AREMA Committee
 5 24 white paper (Figure 3). However, modifications were made for each of the consecutive
 6 events. These changes were based on the outcomes of previous REES events, but were also
 7 affected by the feedback obtained in a 2013 comprehensive survey of 2008-2012 REES
 8 participants that yielded 17 responses (20 percent of total past participants).

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12 **FIGURE 3 Evolution of major REES components (2008-2016)**

13

14 The basic modules were presented at every REES event until the 2016 event (Table 1).
 15 However, as detailed in the table, the 2012, 2014 and 2016 events each saw development of new
 16 modules, either to increase the depth or the breadth of the railway topics covered in the lecture
 17 modules. Nearly two-thirds of the 2013 comprehensive survey respondents saw this as the most
 18 effective way to improve the next REES event, also highlighting the interest from past REES
 19 participants to return for more learning and materials.

20

21 The 2016 event presented a major shift in the development of REES for two reasons.
 22 First, we moved away from the presentation of basic and advanced modules as at previous REES
 23 events. The recorded videos of 2014 modules and accompanying lecture slides were made
 24 available to the REES participants, but instead of dedicating event time for this purpose, it was
 25 done through an online system that is available 24/7 (18). There is no cost to use the materials,
 but they are meant for non-commercial uses only and access requires user registration. The

TABLE 1 REES Content and material (2008-2016)

Year Event	2008 REES	2010 REES	2012 REES 1	2012 REES 2	2014 REES 1	2014 REES 2	2014 REES 3	2016 TRAC/REES*	
Location	University of Illinois at Urbana-Champaign - Urbana, IL	Johnson County Community College - Overland Park, KS	Johnson County Community College - Overland Park, KS	Johnson County Community College - Overland Park, KS	Johnson County Community College - Overland Park, KS	Johnson County Community College - Overland Park, KS	Johnson County Community College - Overland Park, KS	University of Illinois at Urbana-Champaign - Urbana, IL	
Course Modules	Intro Railroad Engineering Intro Railroad Infrastructure Railroad Power, Acceleration & Traffic Control Railroad Intermodal Transportation	Intro Railroad Engineering Intro Railroad Infrastructure Train Energy, Power & Traffic Control Railroad Intermodal Transportation	Intro Railroad Engineering Intro Railroad Infrastructure Train Energy, Power & Traffic Control Railroad Intermodal Transportation	Vehicle Train Dynamics Train Performance Advanced Train Control Intro Railroad Capacity	Intro Railroad Engineering Intro Railroad Infrastructure Train Energy, Power & Traffic Control Railroad Intermodal Transportation	Intro Railroad Engineering Intro Railroad Infrastructure Train Energy, Power & Traffic Control Railroad Intermodal Transportation	Dynamic Models of Railway Systems Train Performance Intro to Railroad Capacity Advanced Train Operations	Railway Course/Program Development and Coordination Raising Student Interest and Recruiting through Student Chapters Railroad Engineering Design Case Studies Intro to Rail Software 1	Track Structure Design Tutorial** Track Geometry Tutorial** Interactive Classroom Activities Rail Bridge Design
Keynote and Industry Speakers	Sergi Pecori - Hanson Professional Services AMTRAK Canadian National FRA AAR/TTCI	Robert Boileau - BNSF Kansas City Terminal RR FRA AAR/TTCI	William Van Trump - Union Pacific Railroad BNSF FRA AAR	William Van Trump - Union Pacific Railroad BNSF FRA AAR	James Carter - Norfolk Southern BNSF J.L. Patterson Associates Hanson Professional Svcs	James Carter - Norfolk Southern BNSF J.L. Patterson Associates Hanson Professional Svcs	James Carter - Norfolk Southern BNSF J.L. Patterson Associates Hanson Professional Svcs	Cuck Gullaks on - CSX Brian Lindamood - Alaska Railroad & AREMA President Canadian National Railway Union Pacific Railroad CH2M Hanson Professional Services	
Field Trip	NS Decatur Yard - Decatur, IL	BNSF Argentine Yard - Kansas City, KS	BNSF Argentine Yard - Kansas City, KS	BNSF Argentine Yard - Kansas City, KS	BNSF Argentine Yard - Kansas City, KS	BNSF Argentine Yard - Kansas City, KS	BNSF Argentine Yard - Kansas City, KS	Norfolk Southern Decatur Yard - Decatur, IL & UIUC RailTEC RAIL Lab - Champaign, IL	

* Table includes modules presented during REES portion of the TRAC Conference

** Modules that built upon earlier REES

1 majority of the modules developed for the 2016 REES event built upon the basic and advanced
2 modules presented at earlier editions of REES and recordings and slides for these modules will
3 also be made available through the online system. The remaining modules newly-developed for
4 REES 2016 concentrated on providing tutorials and hands-on examples for professors so they
5 can more effectively teach the REES materials in a more interactive format.

6 The second major shift in 2016 was integration of REES and the NURail annual meeting
7 to form The Railway Academic Conference (TRAC). It was recognized that the goals of REES
8 and NURail are closely aligned and integration with another railway event was considered as the
9 preferred delivery method for future REES events by more than half of the 2013 survey
10 respondents. The REES portion of the event still concentrated on providing and discussing new
11 materials and curriculum development, while the NURail portion concentrated on discussions
12 related to K-12 outreach, workforce attraction and development, and future needs for research.
13 The formation of TRAC allowed academics coming to the REES event to also participate in the
14 NURail discussions, an opportunity often missed due to lack of funding and time to participate in
15 multiple conferences.

16 REES OUTCOMES

17 The organization of every REES event requires a significant financial and time commitment,
18 both from the industry and academics involved in the event. Therefore, each two-year cycle
19 begins with an analysis to determine whether continuation of the program is justified. This
20 justification relies on input from AREMA constituents on the industry demands and the feedback
21 from the past participants to evaluate the outcomes and benefits of the event. In addition to the
22 survey of all past participants in 2013, a separate survey has been conducted after each individual
23 event. Just like REES, the surveys have evolved over time, so only some of the responses are
24 directly comparable across all events. A paper by Lautala et al. (19) provided a more detailed
25 comparison of the 2010 and 2012 survey results, but this paper incorporates comparable
26 parameters from the 2008, 2014, and 2016 surveys, as well as selected information from the
27 2013 comprehensive survey.

28 The following figures and paragraphs summarizes some of the key findings from the
29 event-specific surveys from 2008-2016 and the 2013 survey that covered all past participants.

30 Overall Success and Helpfulness

31 One of the core questions in the follow-up surveys that were started after 2010 event has been
32 the perceived overall success and helpfulness, based on a 5-step Likert scale (Figure 4). It can be
33 seen that 2010-2016 events have been rated high in their overall success and helpfulness. This is
34 one of the primary reasons why the overall structure of REES has remained fairly stable
35 throughout its history. The figure also shows that participants have expressed a high level of
36 interest toward possibilities to obtain grants for the development of educational materials in the
37 field. As presented in the 2013 paper (19), some REES follow-up surveys have included ratings
38 on the transferability of the educational modules. While there has been greater variation between
39 the individual module ratings than the overall success and helpfulness scores, most modules have
40 been rated as highly transferable.

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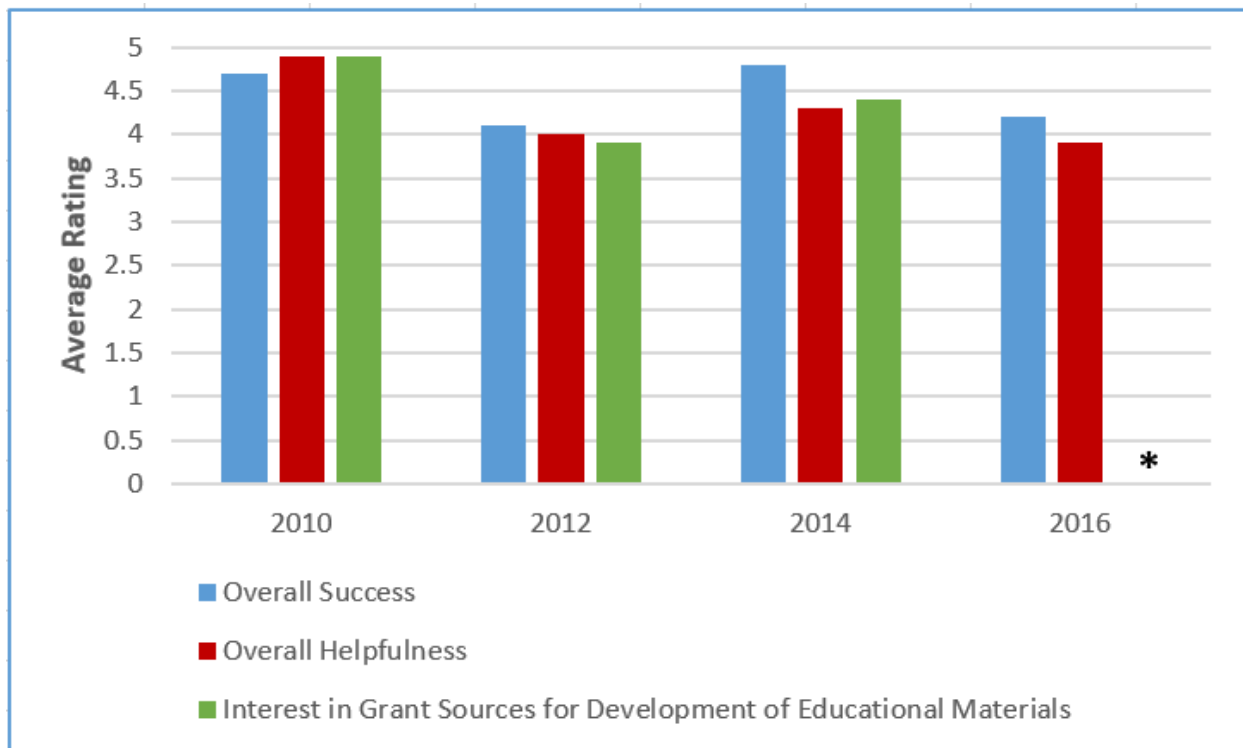
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FIGURE 4 Overall participant ratings of 2010-2016 REES events and interest in grants to develop educational materials (1 = not successful/helpful/interested, 5 = extremely successful/helpful/interested), * = question not included in the survey

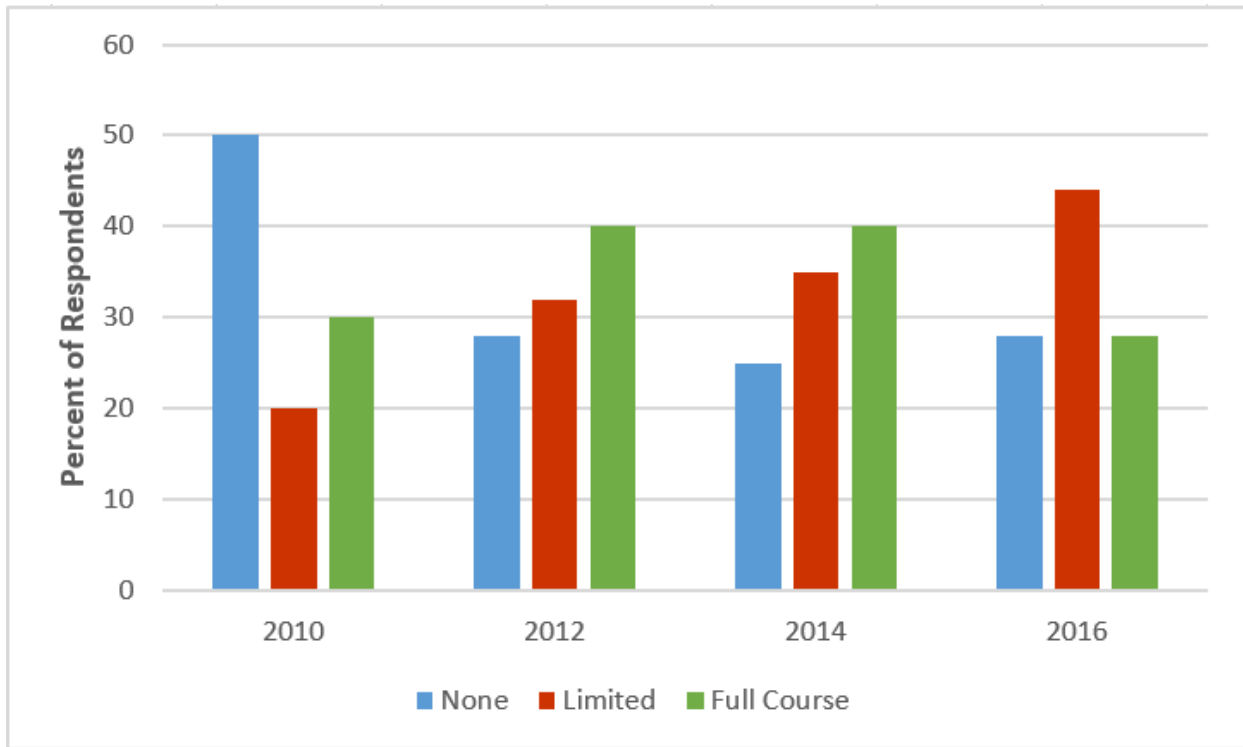
7 Curriculum Development

8 The second key category covered in the surveys has been inquiries on the railway content
9 included in the curriculum of participating universities before the event, and their plans for future
10 incorporation of materials obtained through REES. More recent REES events have seen less
11 universities with no railroad content prior to the event, dropping from half of the participants to
12 less than one third (Figure 5). From 2012 forward, this can be partially explained by the
13 inclusion of specific modules for returning professors in the event program (Table 1).

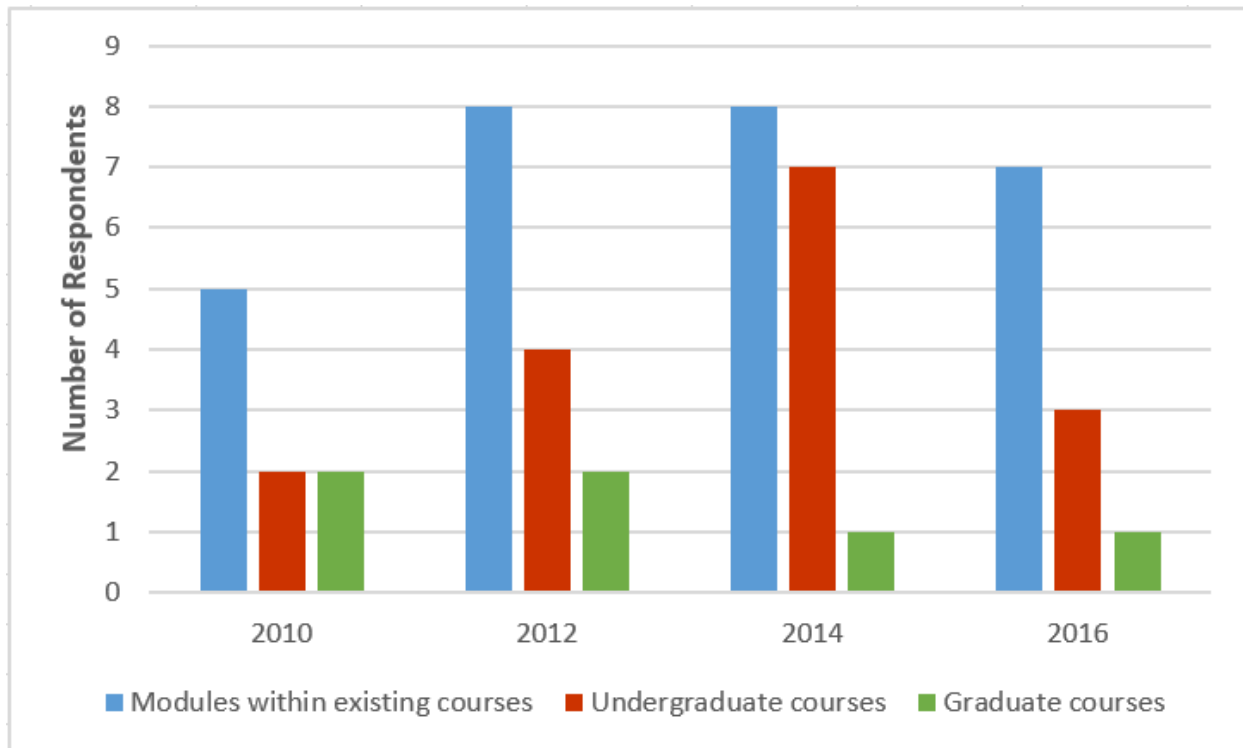
14 A great majority of participants plan to use the materials as either modules within
15 existing courses or as part of new undergraduate courses in railways and/or transportation
16 (Figure 6). This is understandable when we consider the extent and type of the modules. Even
17 with the addition of REES 2 and 3, the modules by themselves are insufficient to cover a full
18 semester-long courses. In addition, majority of topics are introductory of nature and as such more
19 applicable to existing/undergraduate courses.

20 The 2013 comprehensive survey provided information on the actual implementation of
21 courses in the participating universities (Figure 7). While the respondent group is smaller, the
22 figure shows the actual increase in the inclusion of the provided rail content within courses by
23 the respondents, demonstrating the actual effects of REES. When asked about the main reason
24 for “not” including REES materials in their curriculum, the most common response was the lack
25 of complementary materials to support the REES modules, such as class examples, lecture notes
26 and homework assignments. This finding was the primary motivation for evolving the 2016

1 REES program to include tutorial sessions dedicated to demonstrating in-class examples and
2 homework problems to build on previous REES modules.
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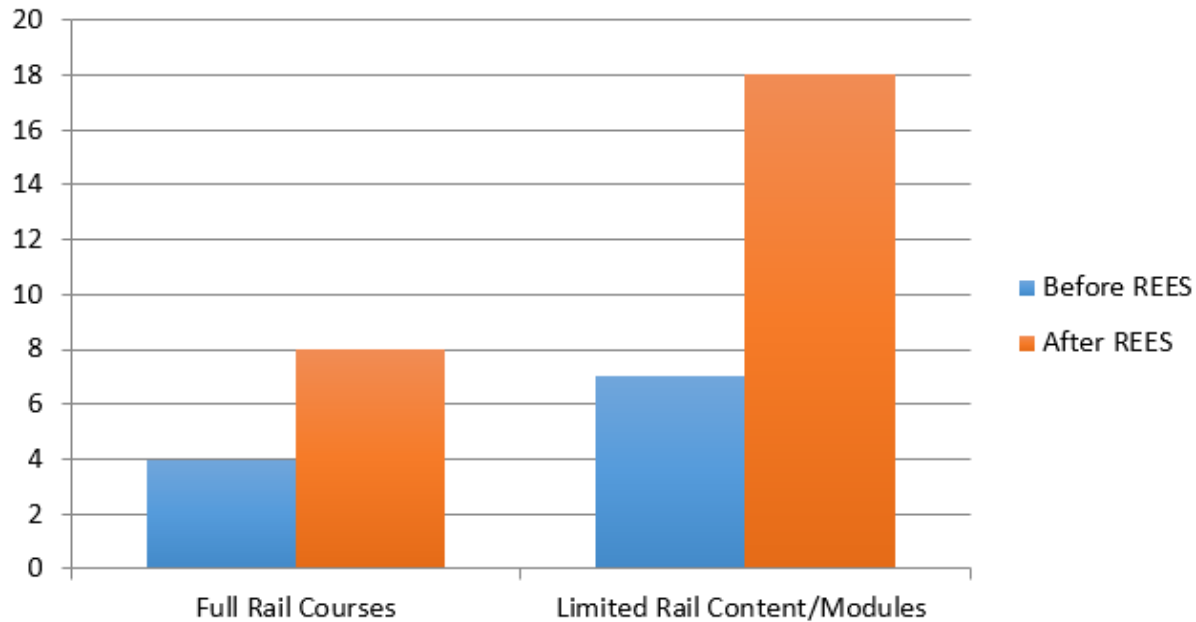


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5 **FIGURE 5 Railroad content included prior to REES event (2010-2016)**



6
7 **FIGURE 6 University plans for REES lecture materials following the event (2010-2016)**

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2

3 **FIGURE 7 Actual number of respondents reporting incorporation of 2008-2012 REES materials in university**
 4 **curriculum (from the 2013 comprehensive survey of previous REES attendees)**

5

6 **Other REES Outcomes**

7 In addition to the direct outcomes measured in the surveys, REES has also led to other tangible
 8 results that have affected the development of railway engineering education and academic
 9 participation in the field.

10 One of the indirect impacts of REES has been the increase of universities participating in
 11 AREMA. According to scan of AREMA records, 25 REES participants from 2008-2014 events
 12 (22 percent) are now AREMA members, significantly increasing the overall number of academic
 13 AREMA members. In addition, in 2008 there were only two AREMA Student Chapters. Today
 14 that number has increased to twenty official student chapters and 16 of those (80 percent) are
 15 located at universities that have participated in at least one REES event (20). The 2014 REES
 16 event even included a session on the benefits of AREMA Student Chapters for rail industry
 17 recruitment. As described previously, through meetings with invited rail industry speakers, field
 18 trips and other outreach and social activities, these AREMA Student Chapters play an important
 19 role in increasing awareness of career opportunities in railway engineering amongst all students
 20 on campus. Joint activities between student chapters and the annual Quiz Bowl competition at
 21 the AREMA Annual Meeting further strengthen bonds within the growing railway academic
 22 community.

23 In addition to AREMA, REES has encouraged other organizations to become involved in
 24 similar activities to facilitate academic participation in other aspects of the railway engineering
 25 domain. In 2015, the American Public Transportation Association (APTA) collaborated with
 26 AREMA and NURail in conducting the first ever Passenger Railway Engineering Education
 27 Symposium (p-REES) that attracted 33 professors from the United States and Canada (21). The
 28 p-REES modules included a mix of original content specific to transit, commuter and intercity
 29 passenger rail and existing REES modules modified to highlight learning points of particular

1 interests to students interested in passenger rail planning, design and operations. APTA is
2 planning to continue organizing p-REES biannually during the off-years of the REES event.

3 Finally, REES has led to or assisted an increasing number universities in expanding their
4 rail related activities beyond simple incorporation of educational materials within their
5 transportation engineering curriculum. The development of railway educational and research
6 activities at four of these universities, Rose-Hulman Institute of Technology, University of
7 Nevada Las Vegas, University of South Carolina, and Villanova University, were highlighted in
8 the 2013 paper by Lautala et al. (19). Since that time, these universities have continued their
9 expansion in the field and the list of such universities has grown. It is this long-term result that
10 suggests REES is succeeding in the larger vision of rebuilding the railway academic community
11 and relationship with the rail industry that was nearly lost.

12 **REES and Industry Employment**

13 From an industry perspective, one of the core metrics to measure the success of REES is the
14 placement of students into permanent positions and internships within the rail industry. In
15 addition to direct employment with railroads, students also secure employment with rail-focused
16 consultants, manufacturers and government agencies. Students in courses prompted by REES
17 have also gone on to careers in academia with a focus on rail.

18 However, employment numbers should not be the sole measure of success. Due to wide
19 array of potential employers and number of institutions involved, it can be difficult to track the
20 eventual job placement of all students enrolled in courses that were created or modified as a
21 result of REES. Not all students report their job placement to teaching faculty and some may
22 enter the rail industry after exploring other opportunities. The success of student placement from
23 schools participating in REES is also affected by the campuses selected for railroad recruitment
24 efforts and the availability of positions in the industry in the specific year.

25 Based on limited data, students participating in rail courses at the seven NURail partner
26 campuses go on to fill an average of 25 full-time and 35 intern positions in the rail industry each
27 year. In addition, some of the REES universities that have later become NURail Affiliate
28 Universities have reported placements ranging from single digits to more than ten (1).
29 Anecdotally, reports from REES attendees, such as Rose-Hulman Institute of Technology
30 suggest that after starting a rail course, two or three students per year will find employment with
31 the rail industry where there was no interest before.

32 **CONCLUSIONS**

33 It is clear that REES has been a tremendous short-term success in increasing awareness of the
34 railway engineering field amongst civil engineering faculty and increasing the amount and
35 quality of railway engineering content included in the engineering programs at many institutions.
36 By continuing to evolve from a sole focus on professors with no rail exposure to also serving as a
37 user conference for those engaged in railway education, REES has also taken the first steps
38 toward the long-term objectives of rebuilding the railway academic community. REES has also
39 had other unanticipated benefits, such as the rapid expansion of the AREMA Student Chapter
40 program that will benefit the railway industry for years to come.

41 However, despite its successes, REES is not without its limitations and challenges.
42 Funding and presenting faculty time commitments limit REES to an event held every second
43 summer. Even with travel stipends sponsored by the rail industry, the biannual frequency of the
44 event, and specific timing during the summer when there aren't many competing events targeted
45 towards faculty greatly limit participation by interested faculty. Making recorded REES

1 modules and REES material available online “on demand” is one part of the solution, but a
2 simple download does not provide professors with the full benefits of REES attendance, such as
3 networking and detailed individual discussion of potential railway engineering research topics.

4 The two-year interval between events also limits the ability of professors to interact and
5 share their experiences with the REES materials after each academic year. Additional REES
6 webinars or other methods of online communication may facilitate the ongoing refinement of
7 railway course lecture material, class examples and assignments, and their expansion to
8 disciplines beyond civil engineering.

9 Finally, as the railway academic community continues to grow and mature, REES must
10 further evolve to strike the proper balance between content designed to fulfill the original
11 objective of exposing new professors to the railway field and content covering advanced topics
12 of professors already engaged in railway education activities, or those who are highly specialized
13 in only one particular aspect of railway engineering. Keeping the full spectrum of attendees
14 interested and engaged while still maintaining a critical mass of professors in each session is a
15 challenge for REES 2018 and beyond. If one looks back at the state of railway engineering
16 education as little as 10 to 15 years ago, many within the rail industry would conclude that this
17 challenge is a sign of a successful REES program and “a good problem to have”.

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