Rail Work Force Development

NURail Center

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Director – National University Rail Center

FRA 2015 Conference

RAIL
Moving America Forward

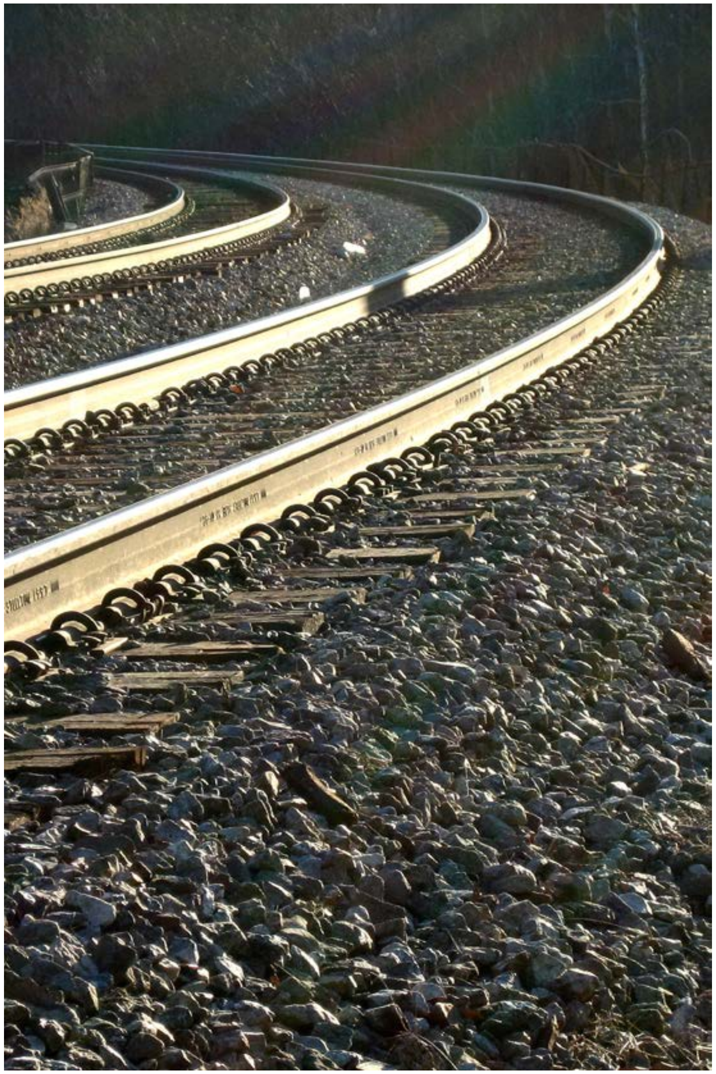
Rail Program Delivery

13-15 October 2015
Washington, DC

Michigan Tech | MIT Massachusetts Institute of Technology | UIC University of Illinois at Chicago | ILLINOIS University of Illinois at Urbana-Champaign | Rose-Hulman Institute of Technology | UK University of Kentucky | The University of Tennessee Knoxville

Outline of Presentation

- Importance of Rail Transport and Demand for New Generation of Employees
- Decline of Railway-University Relationship
- Metrics of Faculty Success, Funding and Educational Programs
- Successful Highway Research and Educational Programs
- Recent Growth in Support for Rail Academic Programs
- NURail Center and Rail Education and Workforce Development
- A New Rail Partnership
- Appendices



Resilient Railroads for a Robust Economy

- ***Safe, Economical, Energy Efficient, Environmental***
- ***Vital for sustainable economic competitiveness***
  - **Freight railroads** - Most successful in the world
    - 43% of intercity freight ton-miles
    - Vital to economic competitiveness
    - Continued traffic growth
  - **Passenger rail** - Expansion and new initiatives
    - Urban, commuter & regional rail
    - Intercity, high-speed rail projects
  - **Technology and work force challenges**…
    and opportunities!

Railways Vital to Society and Need Skilled Personnel

- **Human resources critical**
  - Skilled, motivated personnel are needed to:
  - Design, build and maintain infrastructure and equipment
  - Plan and manage all aspects of railway organizations
  - Safely, efficiently and reliably operate trains
- ***Rail community needs a new generation who understand rail transport and are committed to its present and future excellence***

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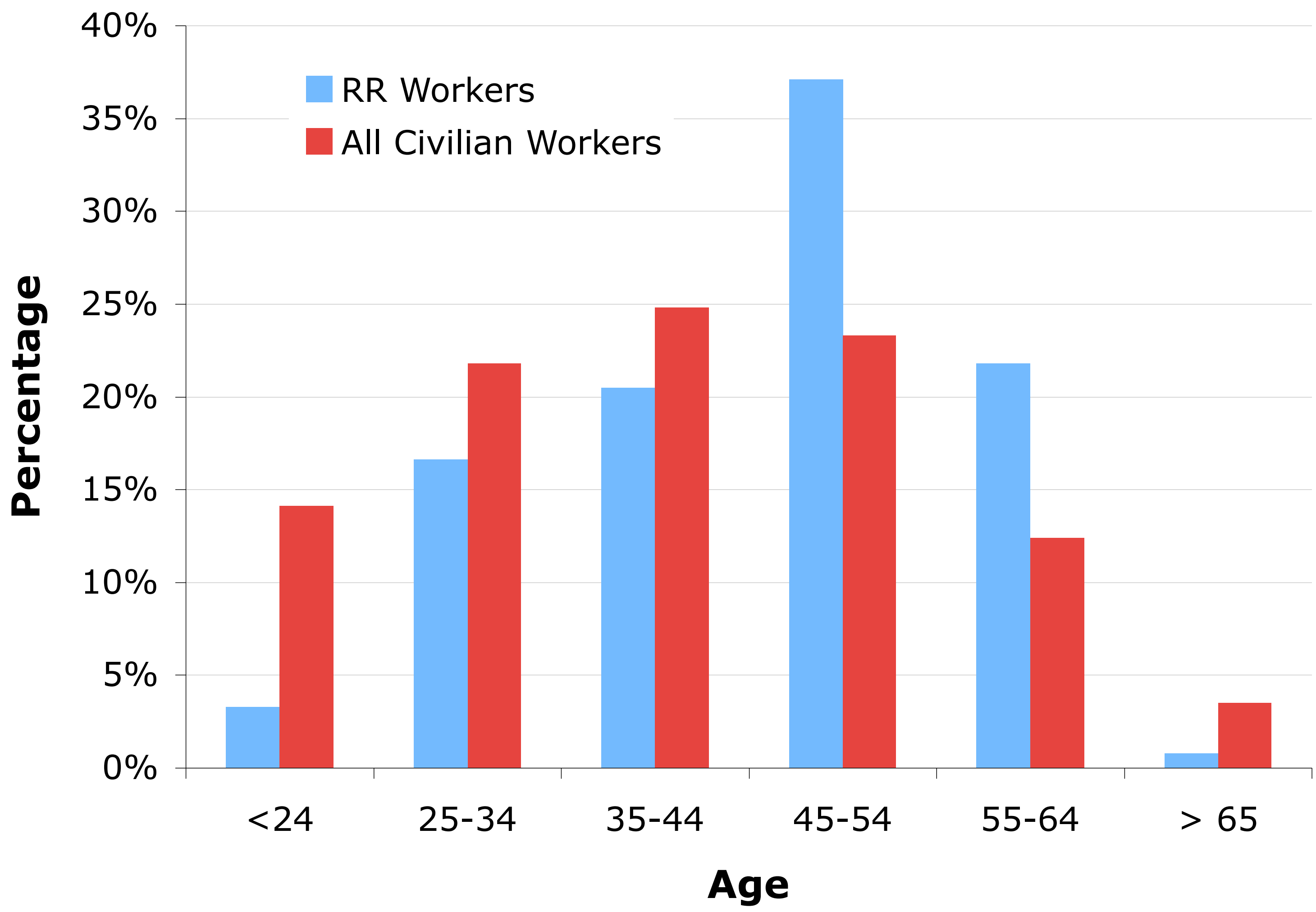
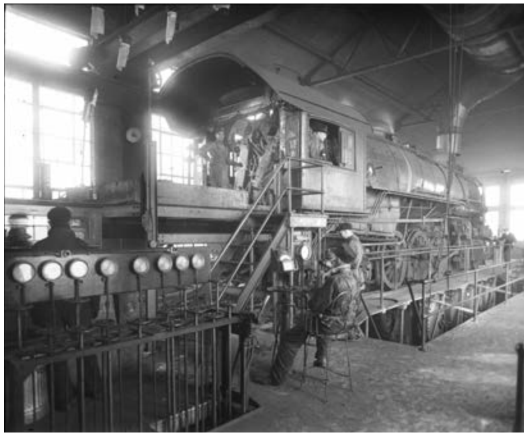
Rail workforce is older than others

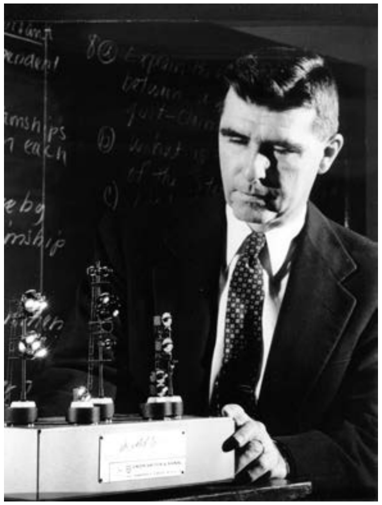


Aging demographic combined with limited number of rail education programs has led to a serious shortage in new personnel

Legacy of university programs in railway engineering & transportation

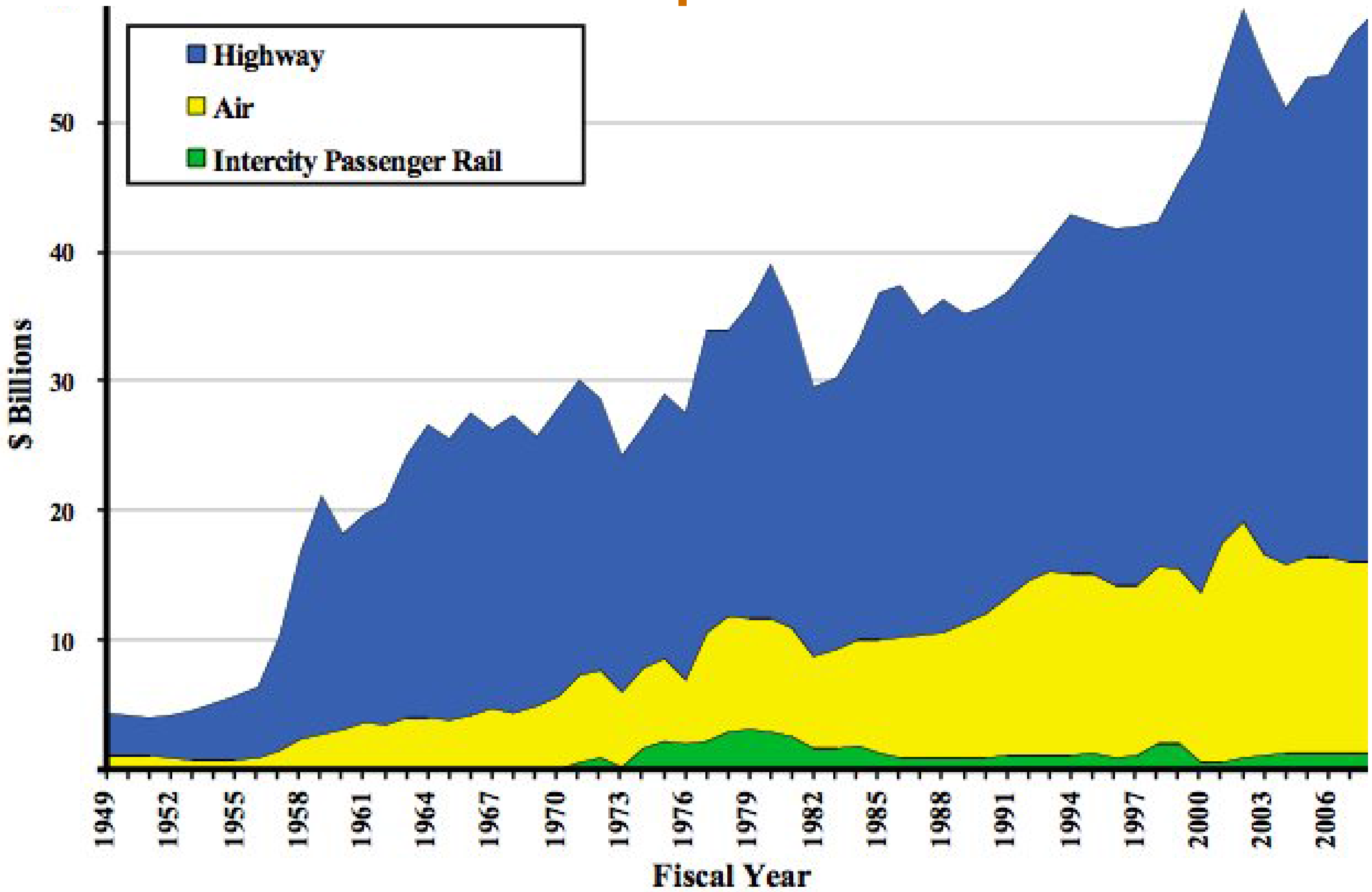
- U.S. once had substantial research and educational programs in railway transportation and engineering
- Commensurate with the importance of rail transport
  - University of Delaware
  - University of Illinois
  - MIT
  - University of Massachusetts
  - University of Michigan
  - Michigan Tech
  - Penn State
  - Purdue
  - Stanford
  - Yale, and others
  - **But this once-strong relationship between railways and academia faded**






So why did this happen?
EXIT

Government investment in highway, air and rail transport: 1949 - 2008



Railroads - The STEALTH Industry?

- For over 40 years railroads removed themselves from public view *(except the bad stuff)*
- Little public under-standing of their importance to society
- Most faculty, and consequently their students have poor knowledge of rail

Path to Estrangement

- **Railroads forgot they needed universities**
  - nearly stopped hiring people
  - nearly stopped funding research
  - communication breakdown (stopped talking to universities)
  - ***Withdrew from relationship***

- **Universities forgot the importance of railways**
  - stopped teaching about rail transport
  - stopped conducting rail research
  - communication breakdown (stopped talking to railroads)
  - ***Found someone else (highway & air transport)***

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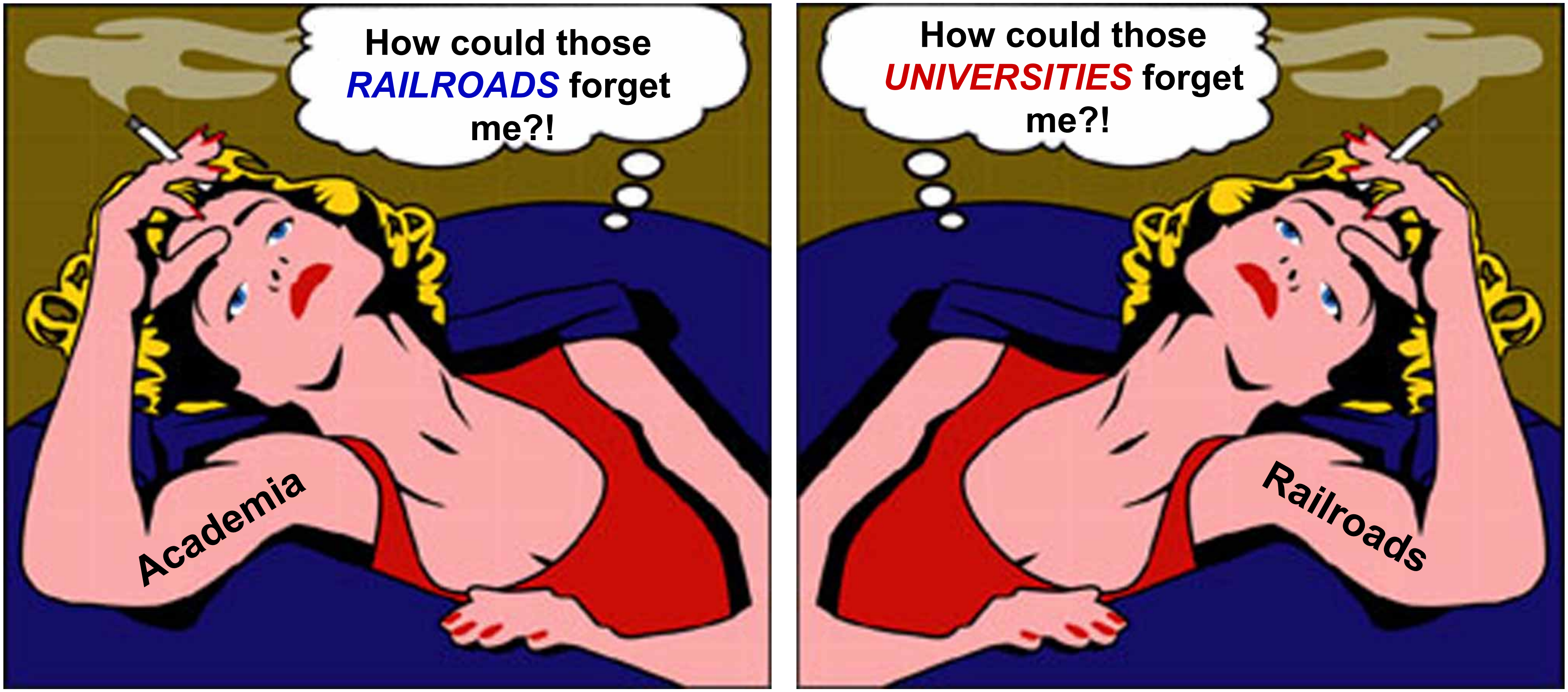
Both Felt Forsaken!



- Each may have felt wronged by the other
- Both moved on
- But the scars remain….

Meanwhile…

- Post-war demand for rapid expansion of highway infrastructure
- Major investment by federal and state agencies in R&D related to all aspects of highway transport
- Who did they turn to for for technological development and support?
- Yeah, you guessed it … ***UNIVERSITIES!***

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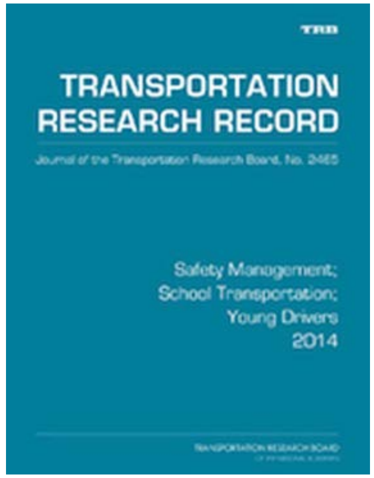
Until recently, the ratio of funding for US educational programs in highway versus rail was about

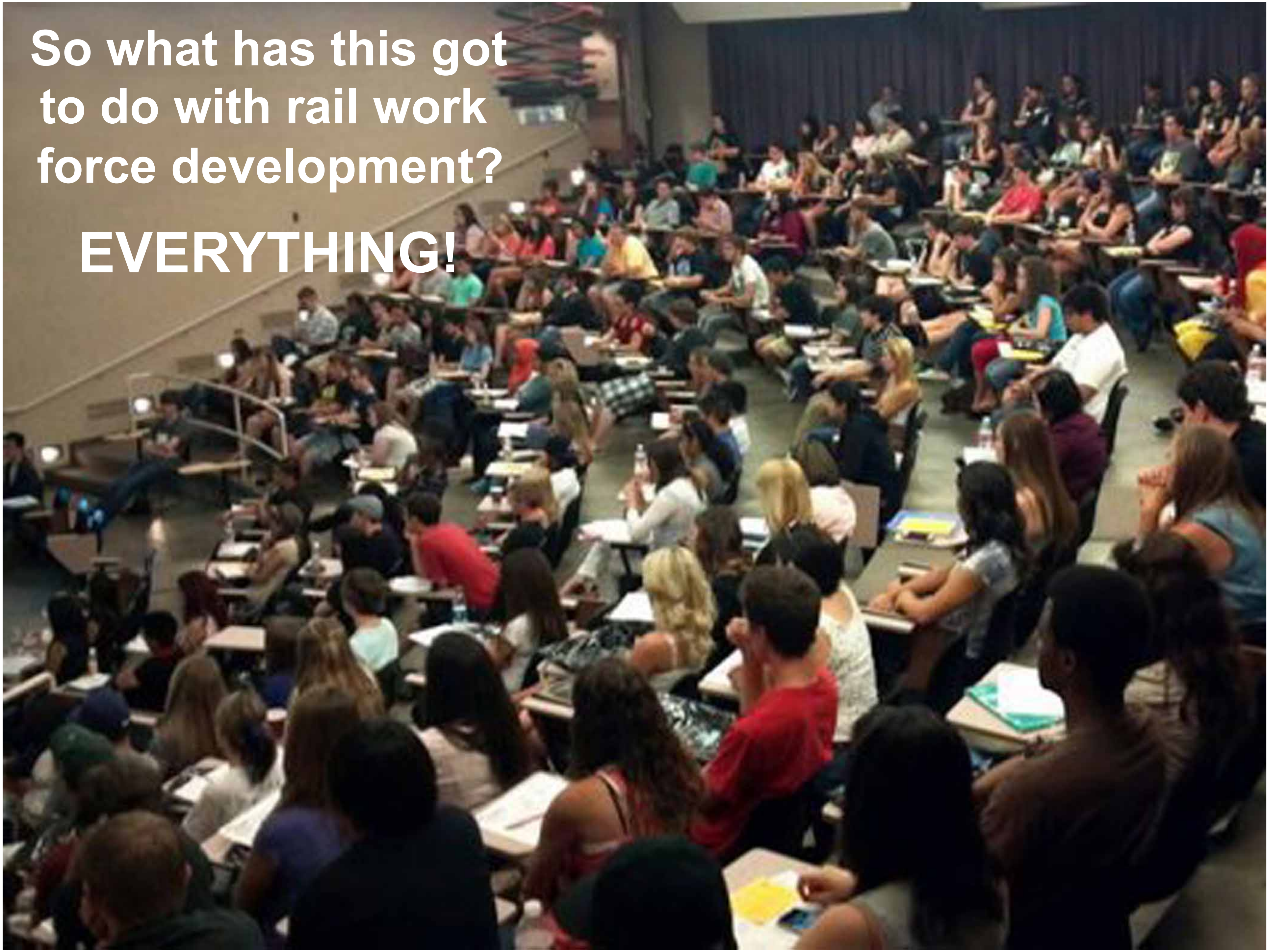
~100 : 1

So where is all this funding going?

TRB TRR 2014 Volumes



- Geomaterials
- Trucks and Bus Safety: Roundabouts
- Environment and Sustainability
- Operational Effects of Geometrics and Access Management
- Travel Survey Methods
- Structures, Vol. 1
- Structures, Vol. 2
- Construction
- Marine Transportation, Terminal Operations, and International Trade
- Freight Systems, Vol. 1
- Freight Systems, Vol. 2: Urban Freight, Hazardous Materials and Trucking
- Travel Behavior, Vol. 1
- Travel Behavior, Vol. 2
- Research and Education
- Transit, Vol. 1
- Transit, Vol. 2: Carsharing, Taxis, and Automated Transport
- Transit, Vol. 3
- Transit, Vol. 4
- Transit, Vol. 5
- Performance Measurement and Strategic Management
- Traffic Flow Theory and Characterizations, Vol. 1
- Traffic Flow Theory and Characterizations, Vol. 2
- Intelligent Transportation Systems, Vol. 1
- Intelligent Transportation Systems, Vol. 2
- Traffic Law Enforcement; Occupant Protection; Alcohol
- Marine Environment, Marine Safety, and Human Factors
- Air Quality, Vol. 1
- Air Quality, Vol. 2
- Travel Demand Forecasting. Vol. 1
- Travel Demand Forecasting, Vol. 2
- Maintenance and Preservation
- Safety Data, Analysis and Evaluation
- Geology and Properties of Earth Materials
- Human Performance, User Information, and Simulation
- Highway Safety Performance
- Highway Design, Vol. 1
- Highway Design, Vol. 2
- Traffic Signal Systems, Vol. 1
- Traffic Signal Systems, Vol. 2.
- Maintenance Services, Transportation Weather, and Winter Maintenance
- Concrete Materials
- Urban and Traffic Data Systems, Vol. 1
- Urban and Traffic Data Systems, Vol. 2
- Asphalt Materials and Mixtures, Vol. 1
- Asphalt Materials and Mixtures, Vol. 2
- Asphalt Materials and Mixtures, Vol. 3
- Asphalt Materials and Mixtures, Vol. 4
- Railroads
- Aviation
- Revenue, Finance, Pricing, and Economics
- Developing Countries
- Socioeconomic, Health, and Human Factors
- Planning
- Energy, Climate Change, and Alternative Fuels
- Pavement Management, Vol. 1
- Pavement Management, Vol. 2
- Pavement Management, Vol. 3
- Visibility; Work Zone Traffic Controls; Highway-Rail Grade Crossings
- Critical Infrastructure, Emergency Evacuation, and Logistics of Disaster Recovery
- Data Systems and Asset Management
- Highway Capacity and Quality of Service
- Soil Mechanics
- Traffic Control Devices
- Pedestrians
- Safety Management; School Transportation; Young Drivers
- Network Modeling, Vol. 1
- Network Modeling, Vol. 2
- Bicycles and Motorcycles
- Demand Management, Parking, Taxis, and Accessible Transportation and Mobility


So what has this got to do with rail work force development?
EVERYTHING!

Faculty metrics of success

- Three principal metrics for faculty success
  - ***Publications*** in peer-reviewed, scholarly journals *("publish or perish")*
  - Funding for ***graduate students'*** research as part of their education *(for whom there is competition)*
  - ***Teaching*** quality courses in their area of expertise
- Rail community ***needs*** faculty interested in rail engineering:
  - First to get hired
  - Then to get tenure
- Faculty cannot achieve this by themselves
- **Requires both institutional and financial support**
- ***Rail community must understand this if rail education and work force development is to increase***

University of Illinois at Urbana-Champaign

- **Transportation Engineering Courses (excluding railroad courses)**
  - 310 Transportation Engineering
  - 406 Pavement Design, I
  - 407 Airport Design
  - 415 Geometric Design of Roads
  - 416 Traffic Capacity Analysis
  - 417 Urban Transportation Planning
  - 418 Public Transportation Systems
  - 506 Pavement Design, II
  - 508 Pavement Evaluation and Rehabilitation
  - 509 Transportation Soils
  - 512 Logistics Systems Analysis
  - 515 Traffic Flow Theory
  - 517 Traffic Signal Systems

University of California, Berkeley

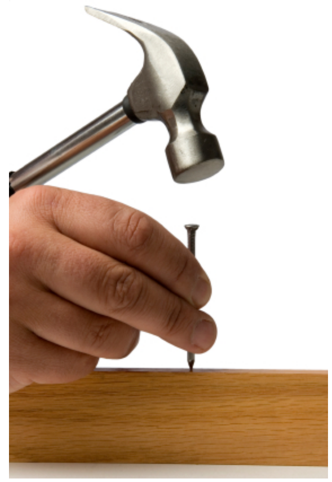
- **Transportation Engineering Courses**
  - CE 153 Design and Construction of Transportation Facilities
  - CE C154 Transportation Planning
  - CE 155 Transportation Systems Engineering
  - CE 156 Infrastructure Planning and Management
  - CE 250 Transportation Policy, Planning and Development
  - CE 251 Transportation Operations
  - CE 252 Transportation Systems Analysis
  - CE 253 Intelligent Transportation Systems
  - CE 255 Highway Traffic Operations
  - CE 256 Transportation Sustainability
  - CE 259 Public Transportation Systems
  - CE 260 Air Transportation
  - CE 263 Operations of Transportation Terminals
  - CE 265 Traffic Safety and Injury Prevention
  - CE 290U Transportation and Land Use Planning
  - CE 290V Transportation Finance
  - CE 290Z Selected Topics in Air Transportation

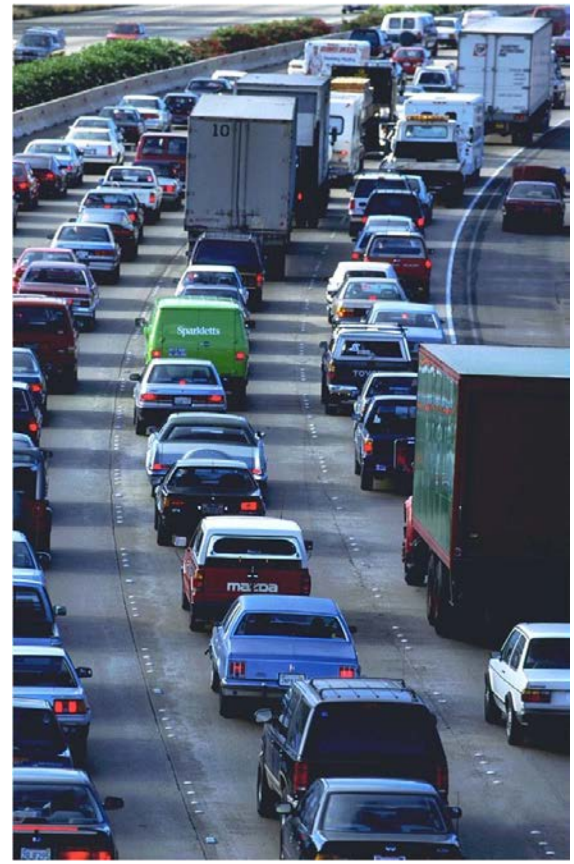
University of Texas, Austin

- **Transportation Engineering Courses**
  - CE 367T Traffic Engineering
  - CE 367P Pavement Design & Performance
  - CE 367G Design & Evaluation of Ground Based Transportation Systems
  - CE 391C Analysis and Design of Transportation Systems I
  - CE 391D Analysis and Design of Transportation Systems II
  - CE 391E Advances in Transportation Demand Analysis
  - CE 391F Advanced Theory of Traffic Flow
  - CE 391H Urban Transportation Planning
  - CE 391J Transportation Planning: Methodology and Techniques
  - CE 391L Advanced Traffic Engineering
  - CE 391M Advanced Geometric Design
  - CE 391N Engineering Systems Evaluation and Decision Making
  - CE 391P Highway and Airport Pavement Systems
  - CE 391P (1) Theory and Behavior of Pavements
  - CE 391P (2) Design and Performance of Pavements
  - CE 391P (3) Pavement Management Systems
  - CE 391Q Bituminous Materials
  - CE 391R Airport Design and Operation
  - CE 391T Contemporary Transportation Issues
  - CE 391W Transportation Systems Operations and Control
  - CE 392C Transportation Network Analysis
  - CE 392D Dynamic Traffic Assignment
  - CE 392E Acquisition and Analysis of Transportation Data
  - CE 392M Public Transportation Engineering
  - CE 392N Topics in Infrastructure Systems
  - CE 392N (1) Infrastructure Systems Management
  - CE 392N (2) Reliability and Maintainability of Infrastructure Systems
  - CE 392N (3) Intelligent Infrastructure Systems
  - CE 392P Sustainable Pavement Engineering
  - CE 392R Discrete Choice theory and Modeling
  - CE 392S Intermodal Transportation Systems
  - CE 392T Transport Economics
  - CE 392U Transportation Systems Management
  - CE 392V Methods to Characterize Bituminous Materials

"If the only tool you have is a hammer, you tend to see every problem as a nail."

Abraham Maslow





- **For at least two generations, transportation-engineering students in the U.S. have been taught to solve transportation problems using *highway transport "tools"***

North America Needs a Balanced Transportation System

… and we need a balanced transportation education and research program to achieve and sustain it

Leveraging!

- Each professor engaged in rail teaching and research will influence dozens or hundreds of students per year
  – Future rail sector employees
  – Future public officials
  – Public in general

University of Illinois at Urbana-Champaign

- ***Rail*** **Transportation Engineering Courses**
  - 408 - Railroad Transportation Engineering
  - 409 - Railroad Track Engineering
  - 410 - Railway Signaling & Control
  - 411 - Railroad Project Design and Construction
  - 412 - High-Speed Rail Engineering
  - 498 HRP - High-Speed Rail Planning
  - 498 HRM - High-Speed Rail Construction Management
  - 498 TSR - Transportation Safety and Risk
  - 598 ATE - Advanced Track Engineering
  - 598 SRC - Shared Rail Corridor Engineering & Operation
  - 598 RTD - Railway Terminal Design & Operation
- **Joint with KTH, Swedish Royal Institute of Technology**
  - 498 RVT - Rail Vehicle Technology
  - 598 RVD - Rail Vehicle Dynamics
  - 598 ET - Electric Traction
- **Rail course enrollment has increased more than five-fold in last five years**

Thanks to FRA and US DOT OST funding for rail academic programs has at least doubled in the past five years

National University Rail (NURail) Center

- University Transportation Centers UTCs are consortia of colleges and universities conducting research, education and technology transfer with a specific transportation-related focus
- Funded by the US Department of Transportation (DOT) – Office of the Assistant Secretary for Research and Technology
- US DOT reorganized UTC program in 2011, stressing a new, multi-modal focus
- University of Illinois led a successful consortium for the first ever rail-focused UTC: the ***National University Rail (NURail) Center***
- Proposal received broad industry and government support
- Re-competed in 2013 and selected again
- Theme:
  Shared Rail Corridors and
  Economic Competitiveness

NURail Center Partners

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UK
UNIVERSITY OF KENTUCKY

ILLINOIS
1867
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

UIC
UNIVERSITY OF ILLINOIS AT CHICAGO

MIT
Massachusetts Institute of Technology

THE UNIVERSITY of TENNESSEE UT

MichiganTech

ROSE-HULMAN
INSTITUTE OF TECHNOLOGY

NURail Center Goals

NURail Center

Focused on advancement of rail transportation through education, research, workforce development and technology transfer

Education

Research

ACADEMIA

Workforce Development

Technology Transfer

INDUSTRY & GOVERNMENT

ILLINOIS – University of Illinois at Urbana-Champaign

UIC – University of Illinois at Chicago

The University of Tennessee Knoxville

MIT – Massachusetts Institute of Technology

Rose-Hulman Institute of Technology

Michigan Tech

UK – University of Kentucky

Rail Education Pathway

K-12 Rail Engagement

Undecided Engineering Freshman

Enrolled Student with Rail Interest

AREMA Student Chapter Booth

AREMA Student Chapter Activities

Railway Engineering Course

Undergraduate & Graduate Railway Research

Railway Co-op or Internship

Advancements in Rail Technology

New Railway Professors

Full-time Career Railway Employee

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NURail Education & Workforce Development

- Developing & teaching rail engineering courses and curricula
- Assisting students gain railroad internships and coops
- Teaching railroad short courses
- Conferences and workshops on broad range of rail topics
- Railway Engineering Education Symposia (AREMA & APTA)
- NURail Affiliate Program
- Outreach to K-12 age groups
- Minority engagement and education

NURail Affiliate Members

UMASS AMHERST

VILLANOVA UNIVERSITY

PENNSTATE Altoona

UNIVERSITY OF MARYLAND 1856

UNIVERSITY OF SOUTH CAROLINA

VT

UNIVERSITY of DAYTON

WISCONSIN UNIVERSITY OF WISCONSIN–MADISON

NDSU NORTH DAKOTA STATE UNIVERSITY

KU THE UNIVERSITY OF KANSAS

Colorado State University Pueblo

UNLV UNIVERSITY OF NEVADA LAS VEGAS

Oregon State UNIVERSITY

UNIVERSITY OF MANITOBA

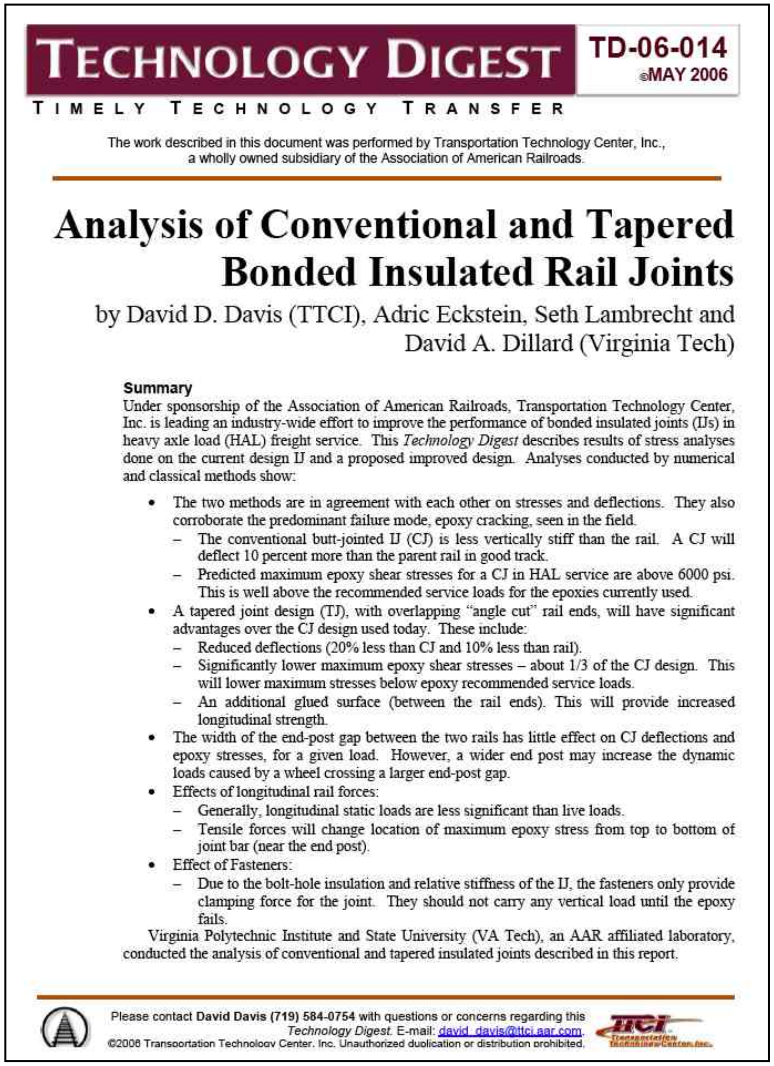
UBC THE UNIVERSITY OF BRITISH COLUMBIA

UNIVERSITY TRANSPORTATION CENTER FOR RAILWAY SAFETY

In 2013 US DOT OST Funded a Second Rail-Focused UTC

- **University Transportation Center for Railway Safety**
  - University of Texas Rio Grande Valley
  - University of Nebraska
  - Texas A&M University
- In addition to their rail safety theme, they too have a strong commitment to railroad work force development

Funding university research provides two "DELIVERABLES"



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TIMELY TECHNOLOGY TRANSFER

The work described in this document was performed by Transportation Technology Center, Inc., a wholly owned subsidiary of the Association of American Railroads.

Analysis of Conventional and Tapered Bonded Insulated Rail Joints

by David D. Davis (TTCI), Adric Eckstein, Seth Lambrecht and David A. Dillard (Virginia Tech)

Summary

Under sponsorship of the Association of American Railroads, Transportation Technology Center, Inc. is leading an industry-wide effort to improve the performance of bonded insulated joints (IJs) in heavy axle load (HAL) freight service. This *Technology Digest* describes results of stress analyses done on the current design IJ and a proposed improved design. Analyses conducted by numerical and classical methods show:

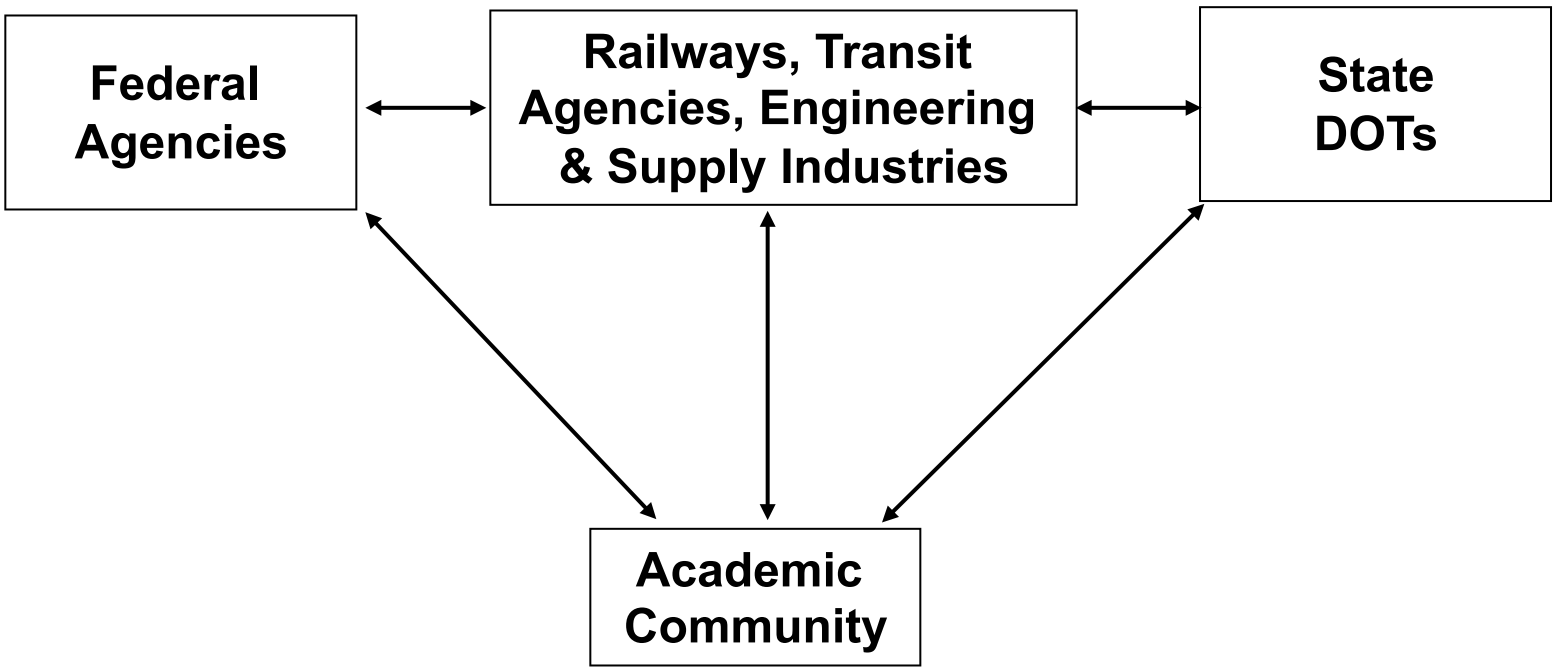
- The two methods are in agreement with each other on stresses and deflections. They also corroborate the predominant failure mode, epoxy cracking, seen in the field.
  - The conventional butt-jointed IJ (CJ) is less vertically stiff than the rail. A CJ will deflect 10 percent more than the parent rail in good track.
  - Predicted maximum epoxy shear stresses for a CJ in HAL service are above 6000 psi. This is well above the recommended service loads for the epoxies currently used.
- A tapered joint design (TJ), with overlapping "angle cut" rail ends, will have significant advantages over the CJ design used today. These include:
  - Reduced deflections (20% less than CJ and 10% less than rail).
  - Significantly lower maximum epoxy shear stresses – about 1/3 of the CJ design. This will lower maximum stresses below epoxy recommended service loads.
  - An additional glued surface (between the rail ends). This will provide increased longitudinal strength.
- The width of the end-post gap between the two rails has little effect on CJ deflections and epoxy stresses, for a given load. However, a wider end post may increase the dynamic loads caused by a wheel crossing a larger end-post gap.
- Effects of longitudinal rail forces:
  - Generally, longitudinal static loads are less significant than live loads.
  - Tensile forces will change location of maximum epoxy stress from top to bottom of joint bar (near the end post).
- Effect of Fasteners:
  - Due to the bolt-hole insulation and relative stiffness of the IJ, the fasteners only provide clamping force for the joint. They should not carry any vertical load until the epoxy fails.

Virginia Polytechnic Institute and State University (VA Tech), an AAR affiliated laboratory, conducted the analysis of conventional and tapered insulated joints described in this report.

Please contact **David Davis (719) 584-0754** with questions or concerns regarding this *Technology Digest*. E-mail: david_davis@ttci.aar.com.

- **New Results**
- **New Intellects**

A New Rail Partnership
US DOT – State DOTs – Rail Sector – Academia



Working together to support academic research and education we can advance rail transport and, develop the next generation of rail transportation professionals

Questions and Discussion

FRA 2015 Conference

Rail Program Delivery

RAIL
Moving America Forward

NURail Center

THANK YOU!

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This project was supported by the National University Rail (NURail) Center
A US DOT OST-R
Tier-1 University Transportation Center

U.S. Department of Transportation
Office of the Secretary of Transportation

Michigan Tech | MIT Massachusetts Institute of Technology | UIC University of Illinois at Chicago | Illinois University of Illinois at Urbana-Champaign | Rose-Hulman Institute of Technology | UK University of Kentucky | The University of Tennessee Knoxville

Appendix 1:
US DOT Rail University Transportation Center Contact Info

National University Rail (NURail) Center

http://www.nurailcenter.org/index.php

Director – Christopher P.L. Barkan

Professor – University of Illinois at Urbana-Champaign

cbarkan@illinois.edu

University Transportation Center for Railway Safety (UTCRS)

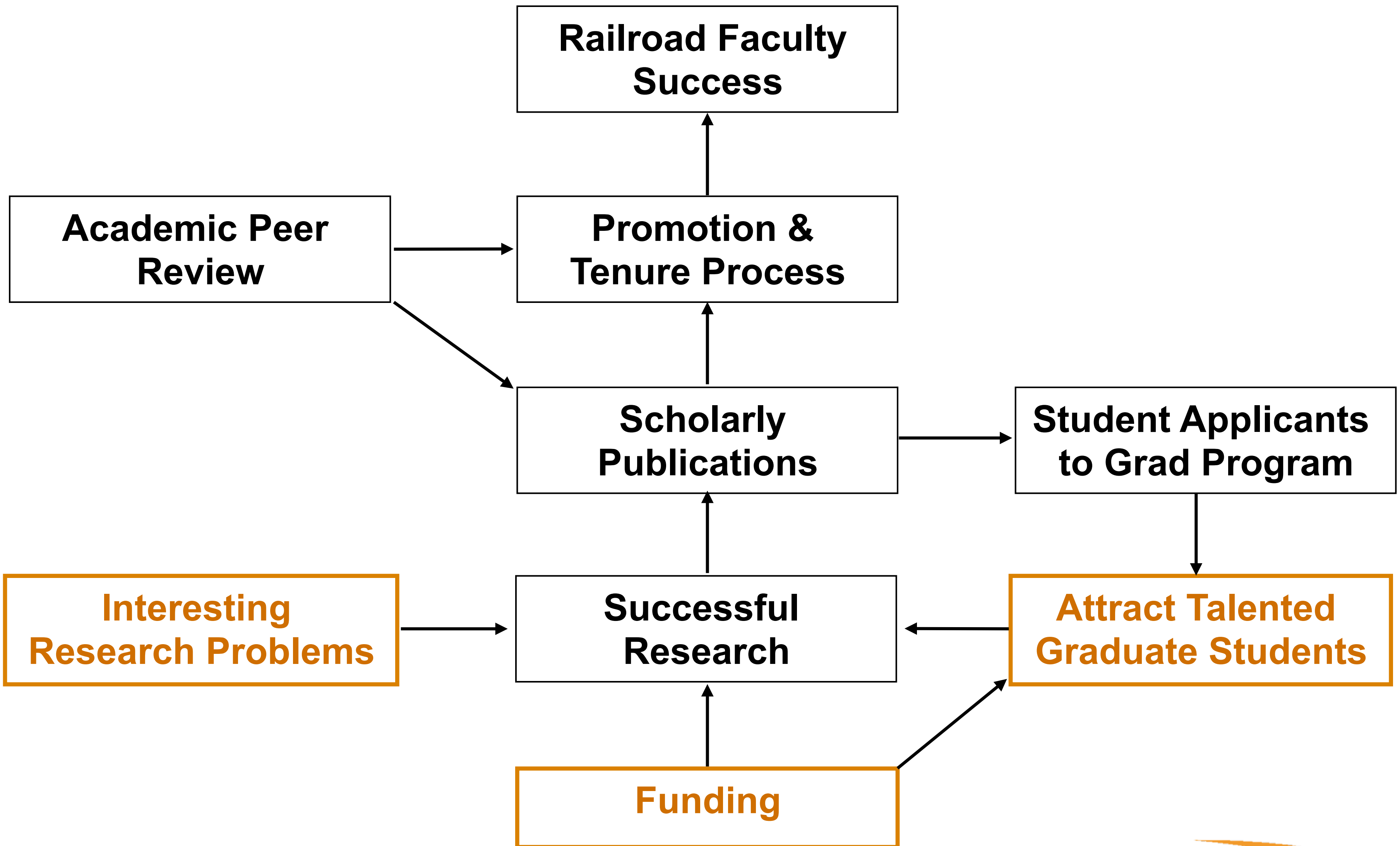
http://portal.utpa.edu/railwaysafety

Director – Constatine M. Tarawneh

Professor – University of Texas Rio Grande Valley

tarawneh@utpa.edu

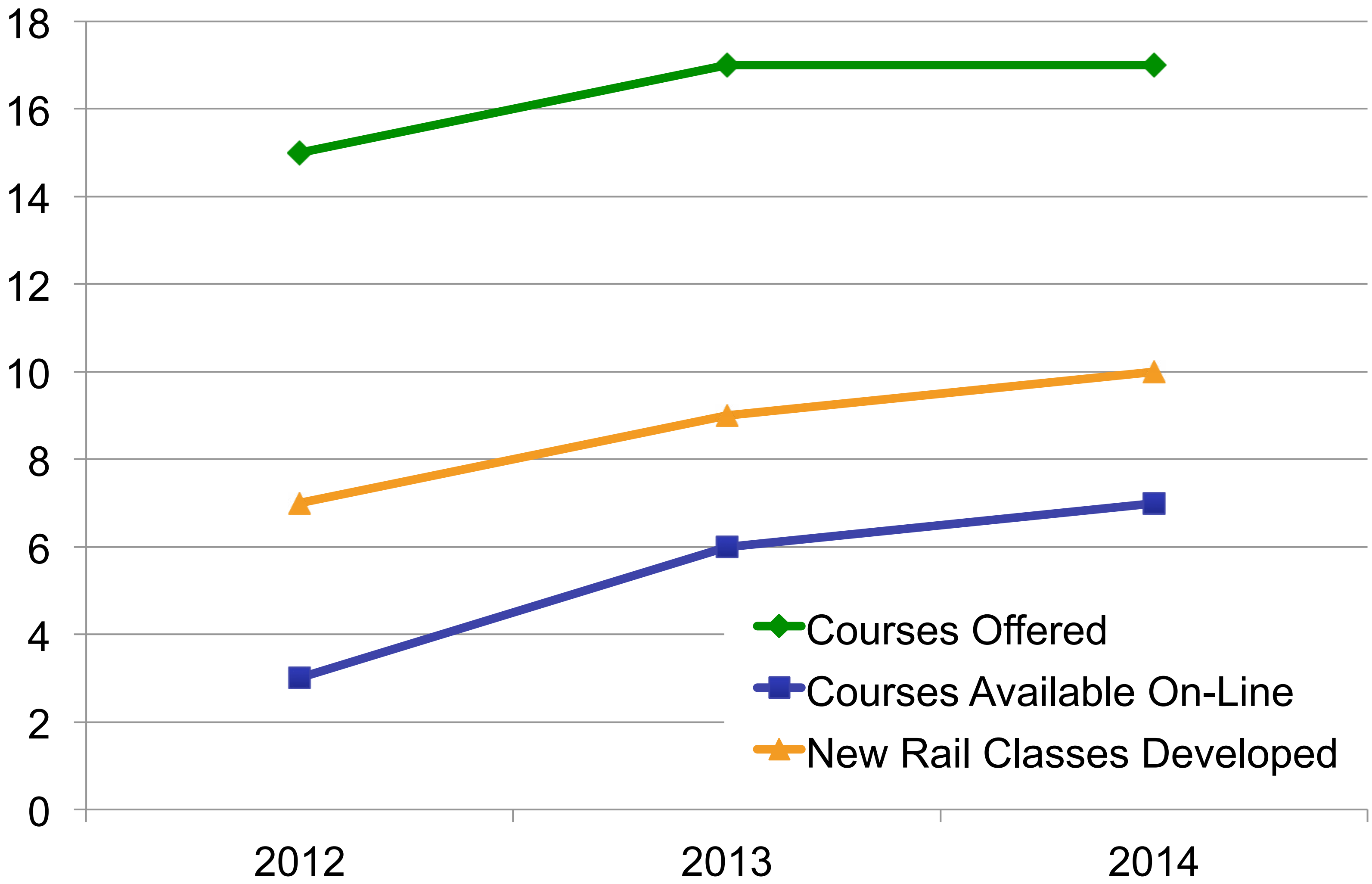
Appendix 2: Flowchart of Academic Success



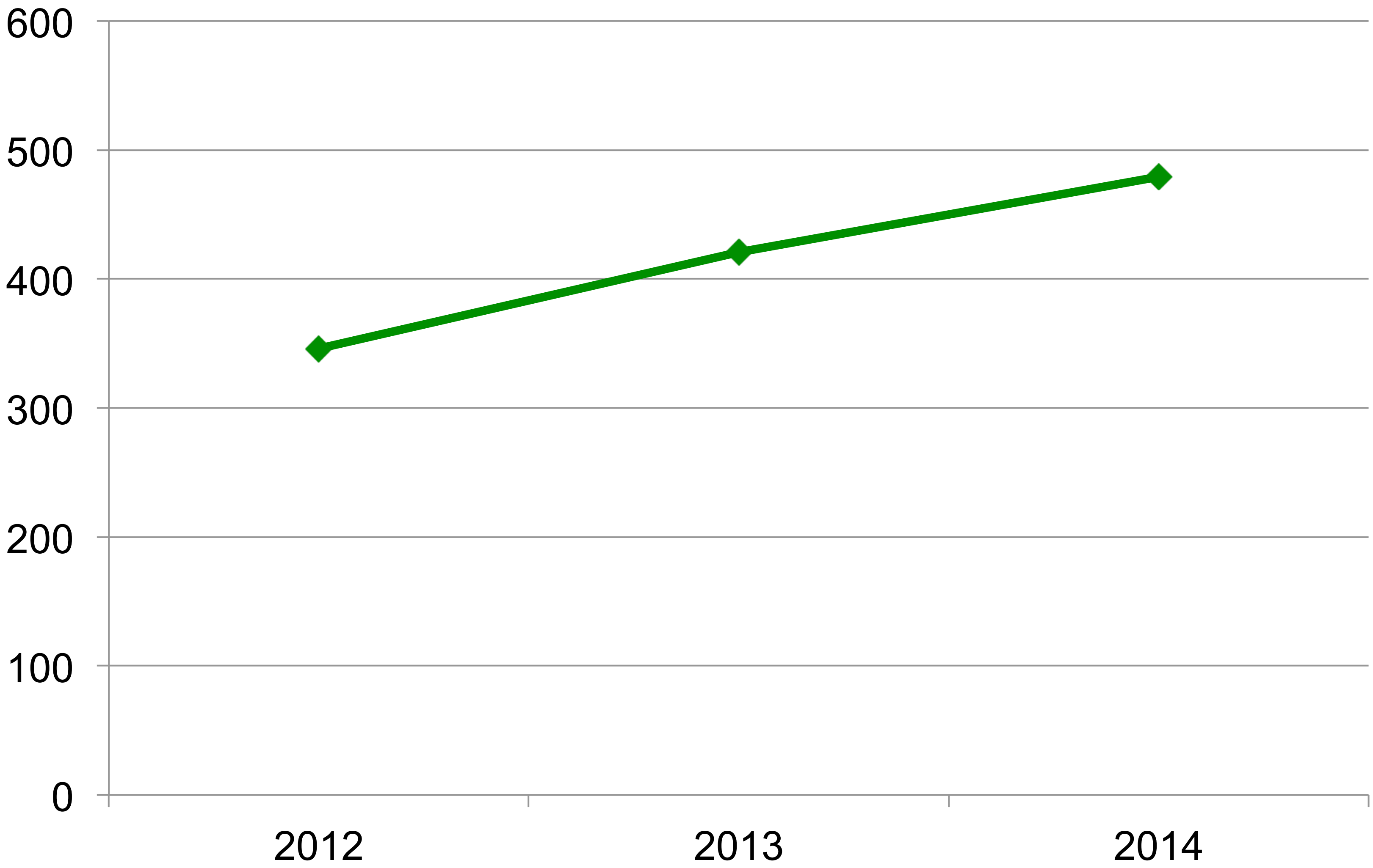
Appendix 3: NURail by the Numbers

- Formation of NURail Center has stimulated growth in a variety of rail educational, research and technology transfer activities
- NURail Center tracks various performance metrics
  - Rail courses taught
  - Enrollment in rail classes
  - Student participation in rail research
  - Graduate students supported
  - Degrees awarded
  - Publications
  - Attendance at rail conferences
  - Technology transfer activities
  - Collaborative activities

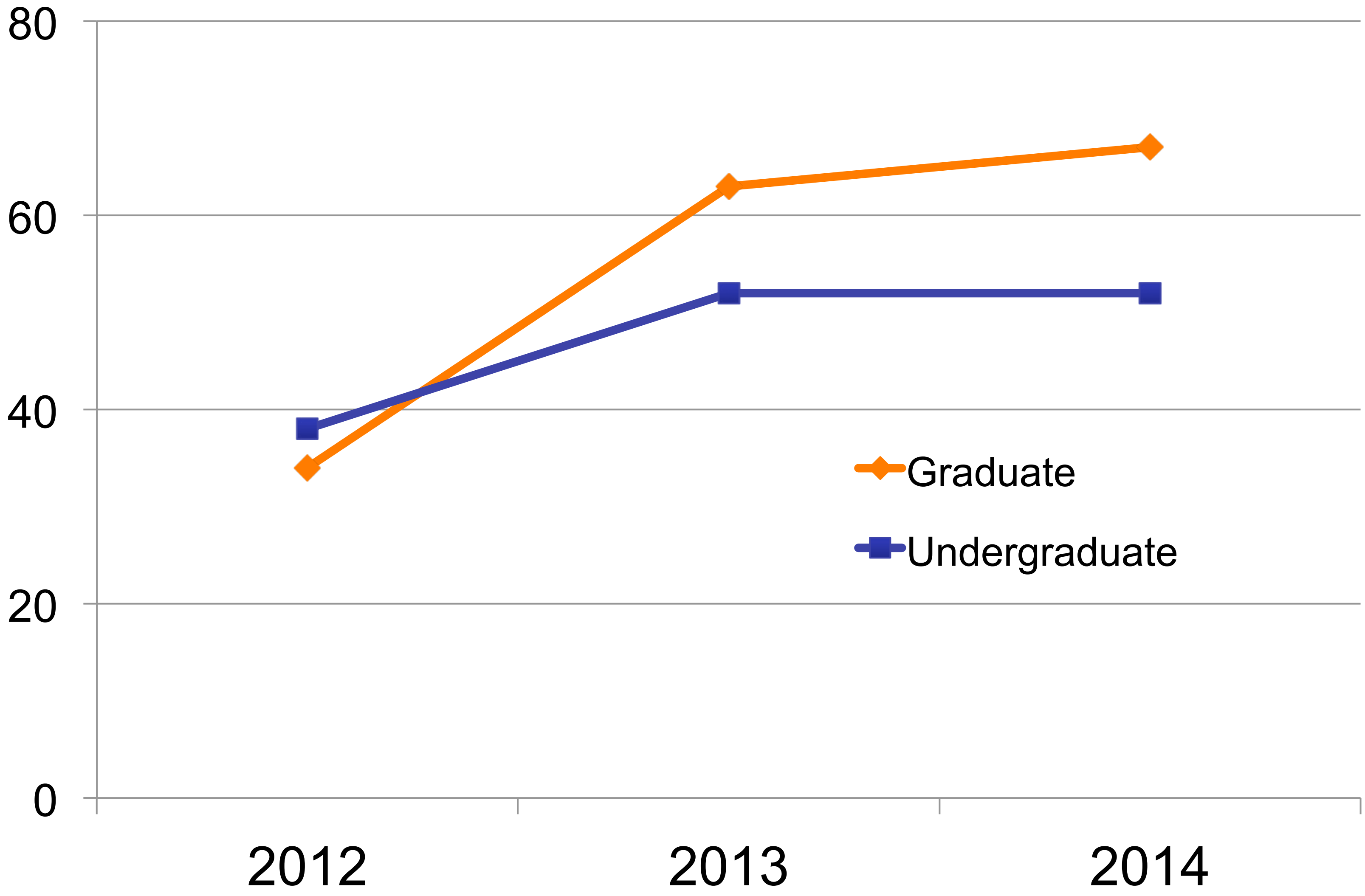
NURail Courses 2012 - 2014



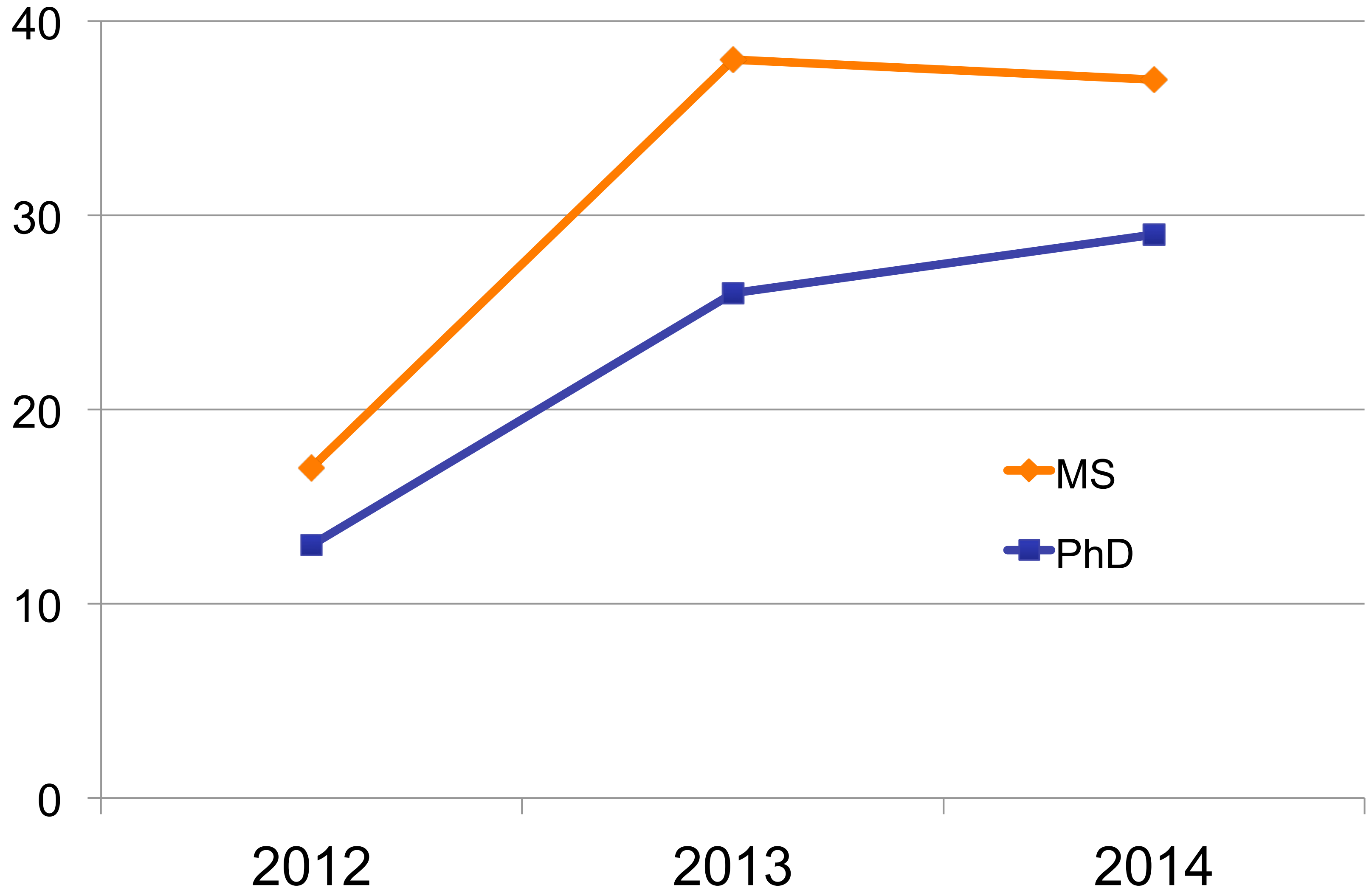
NURail Course Enrollment 2012 - 2014



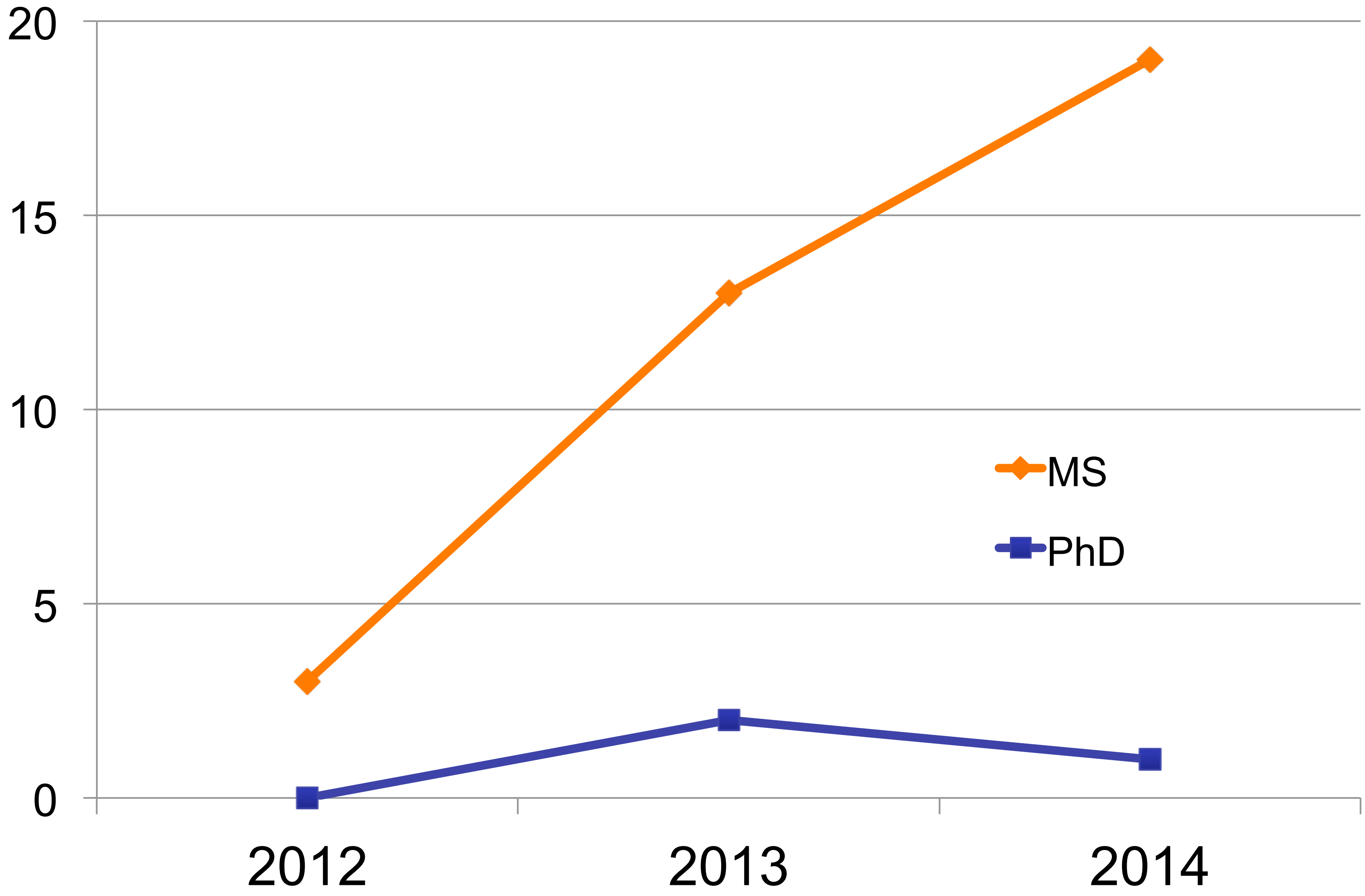
Students Participating in NURail-Supported Research Projects: 2012 - 2014



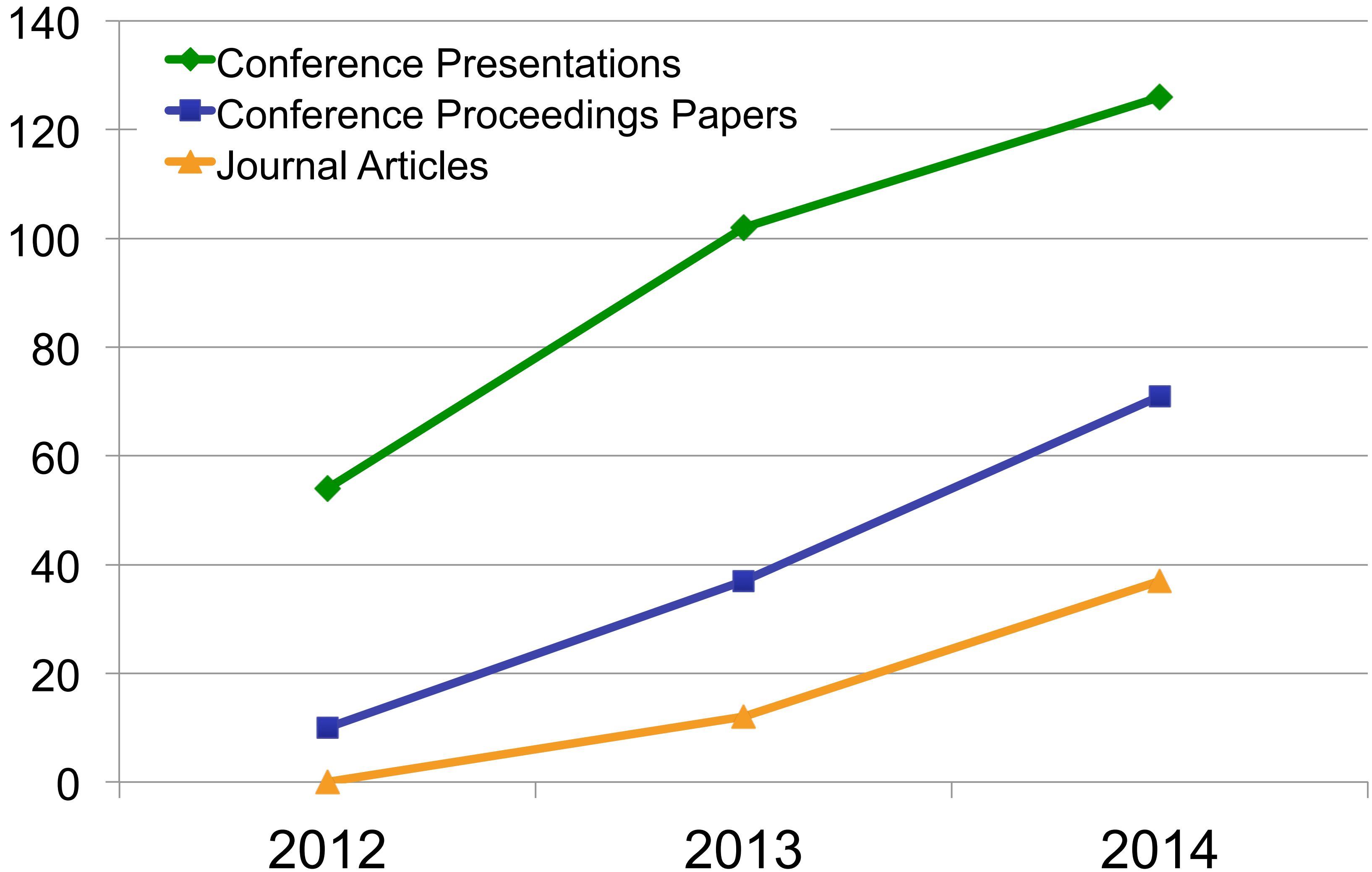
Graduate Students Supported by NURail: 2012 - 2014



NURail Graduate Student Degrees Awarded: 2012 - 2014



NURail Publications 2012 - 2014



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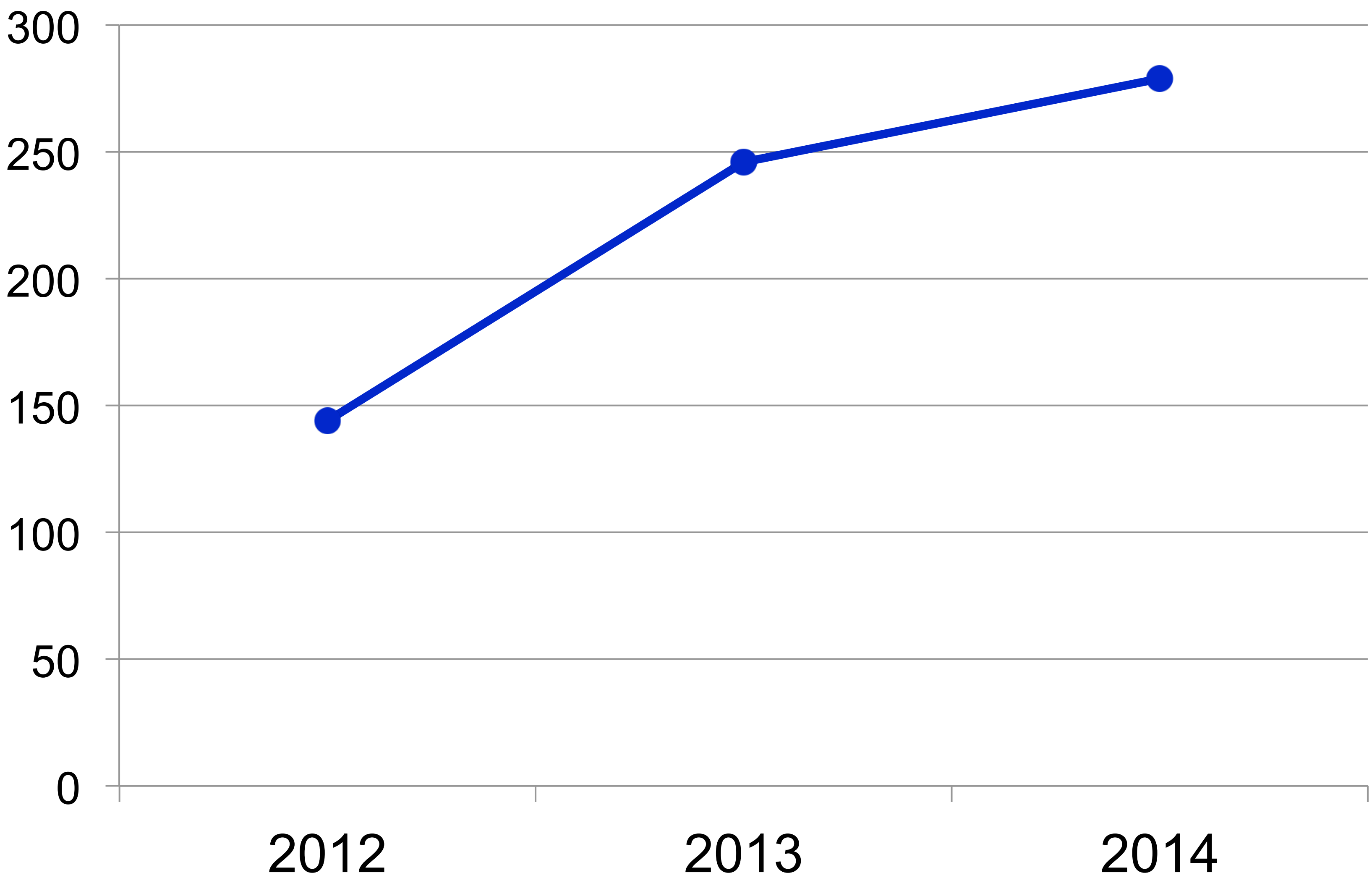
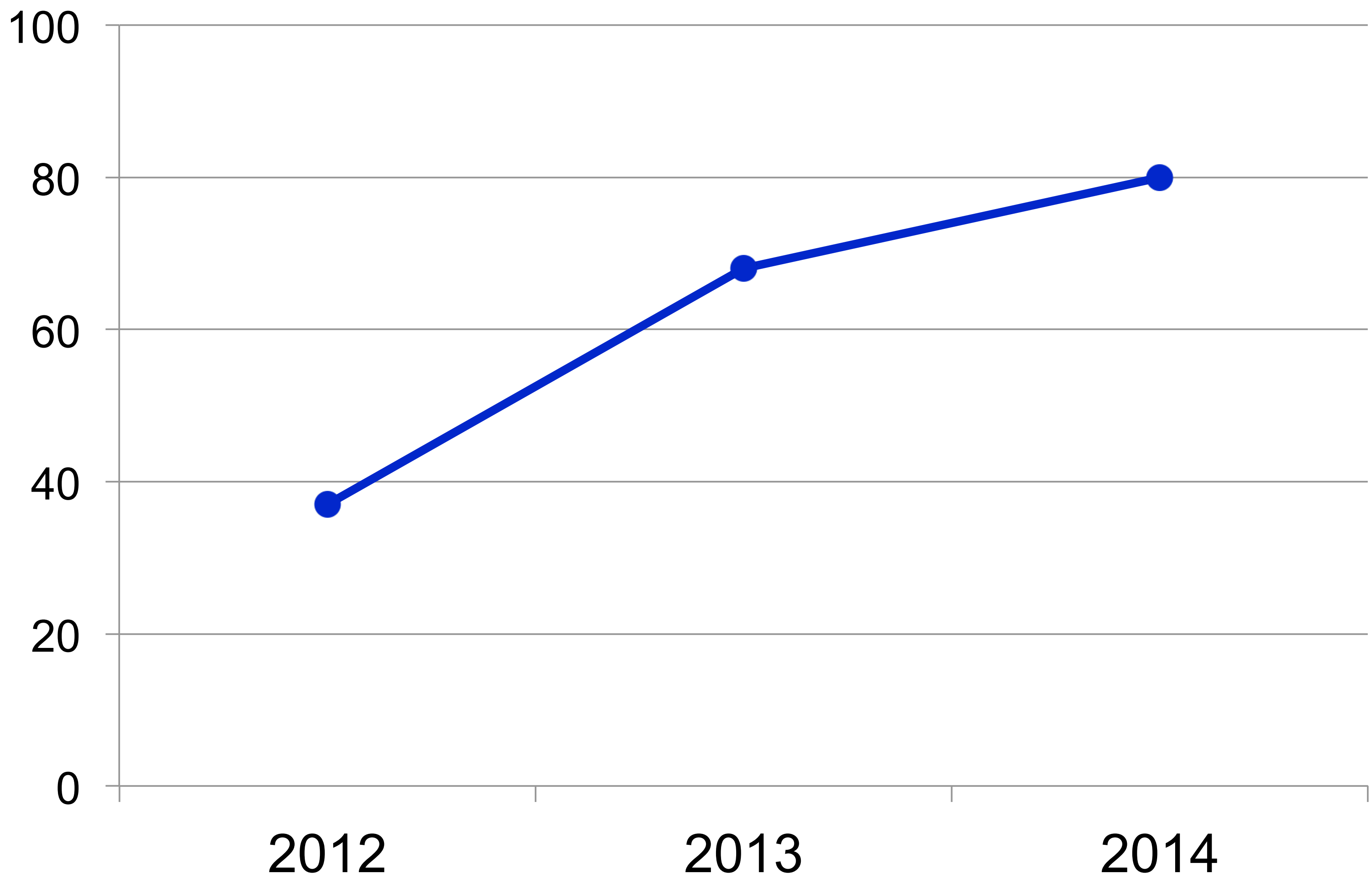
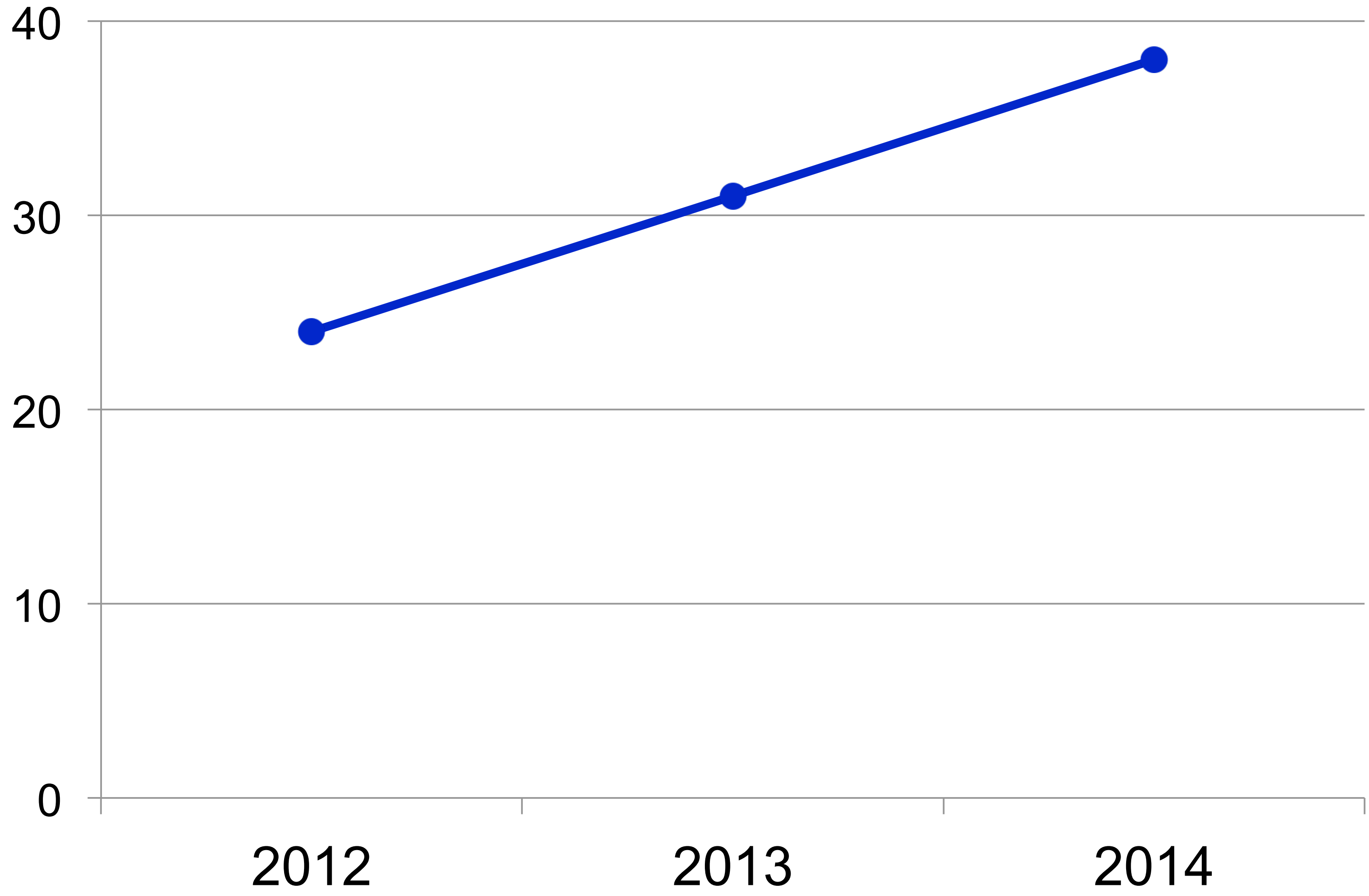
NURail Student Attendance at Rail Conferences: 2012 - 2014



NURail Technology Transfer Activities 2012 - 2014



NURail Collaborations With Other Organizations: 2012 - 2014



Appendix 4: US DOT OST UTC 2013 Map