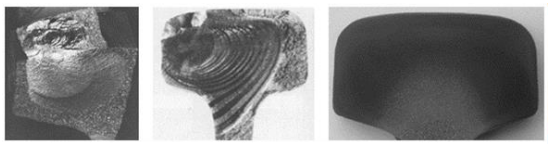
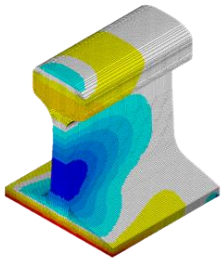
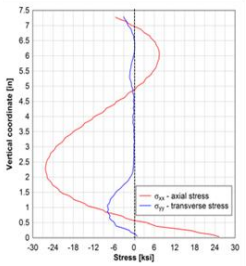
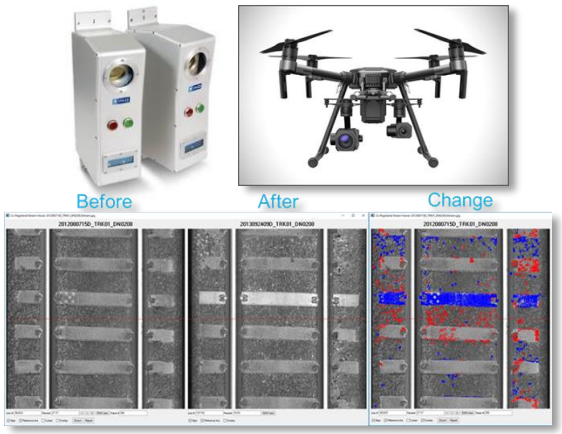
FRA RD&T Transportation Research Board Review

Track Research

Gary A. Carr

May 14, 2019

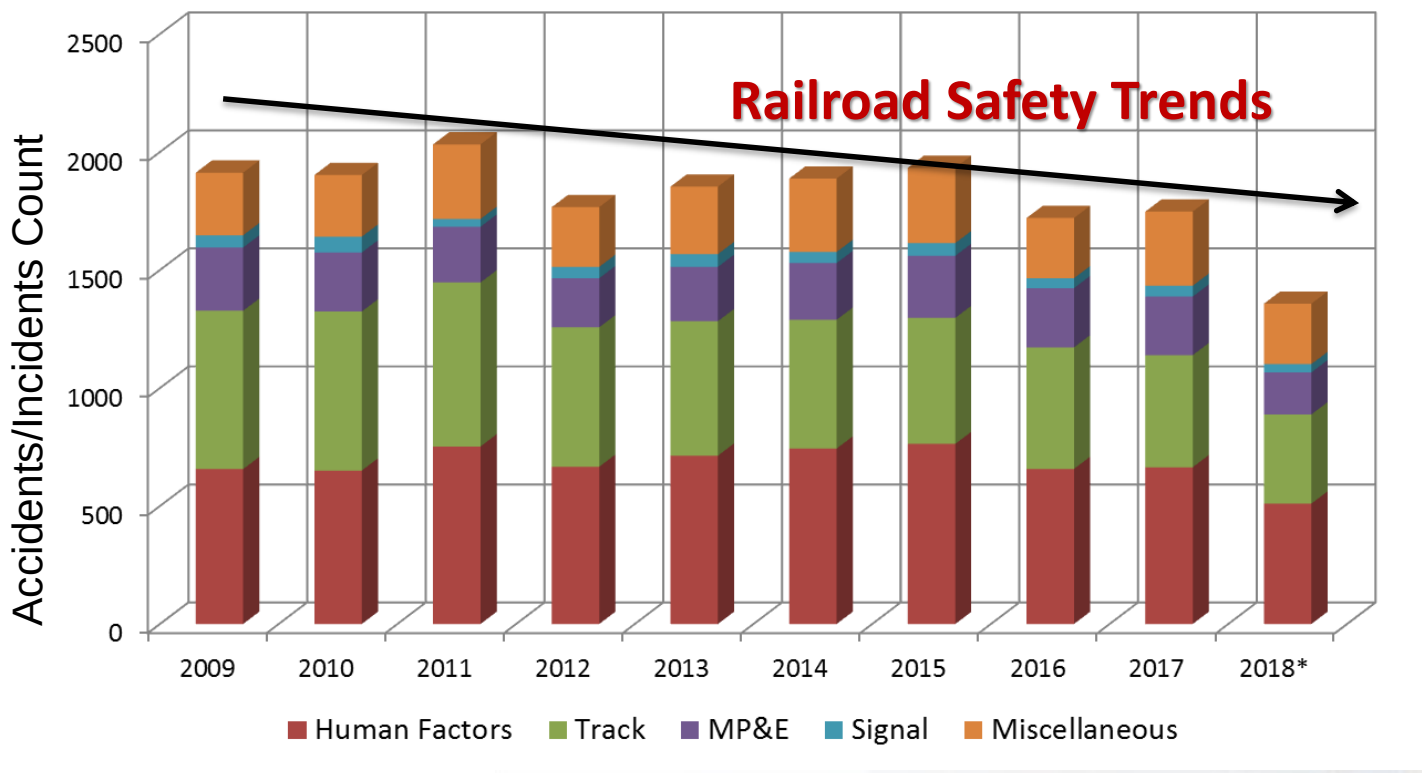
U.S. Department of Transportation
Federal Railroad Administration

Track Research Division

Agenda

- Introduction
- Track Research Division Team
- Program Structure and Strategy
- Research Topics
- Detailed Project Descriptions (Reference Only)

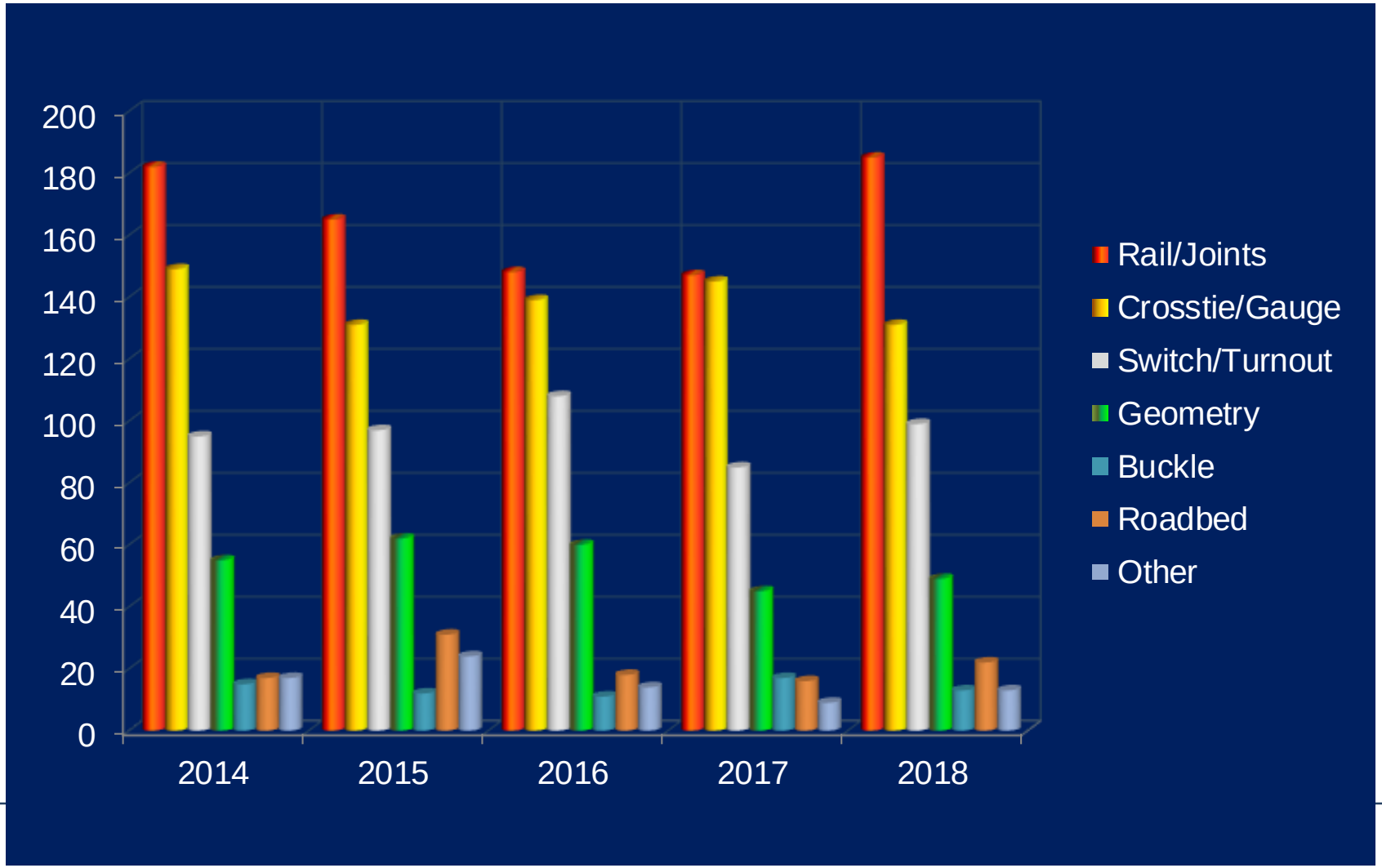
Driving Derailments to Zero!



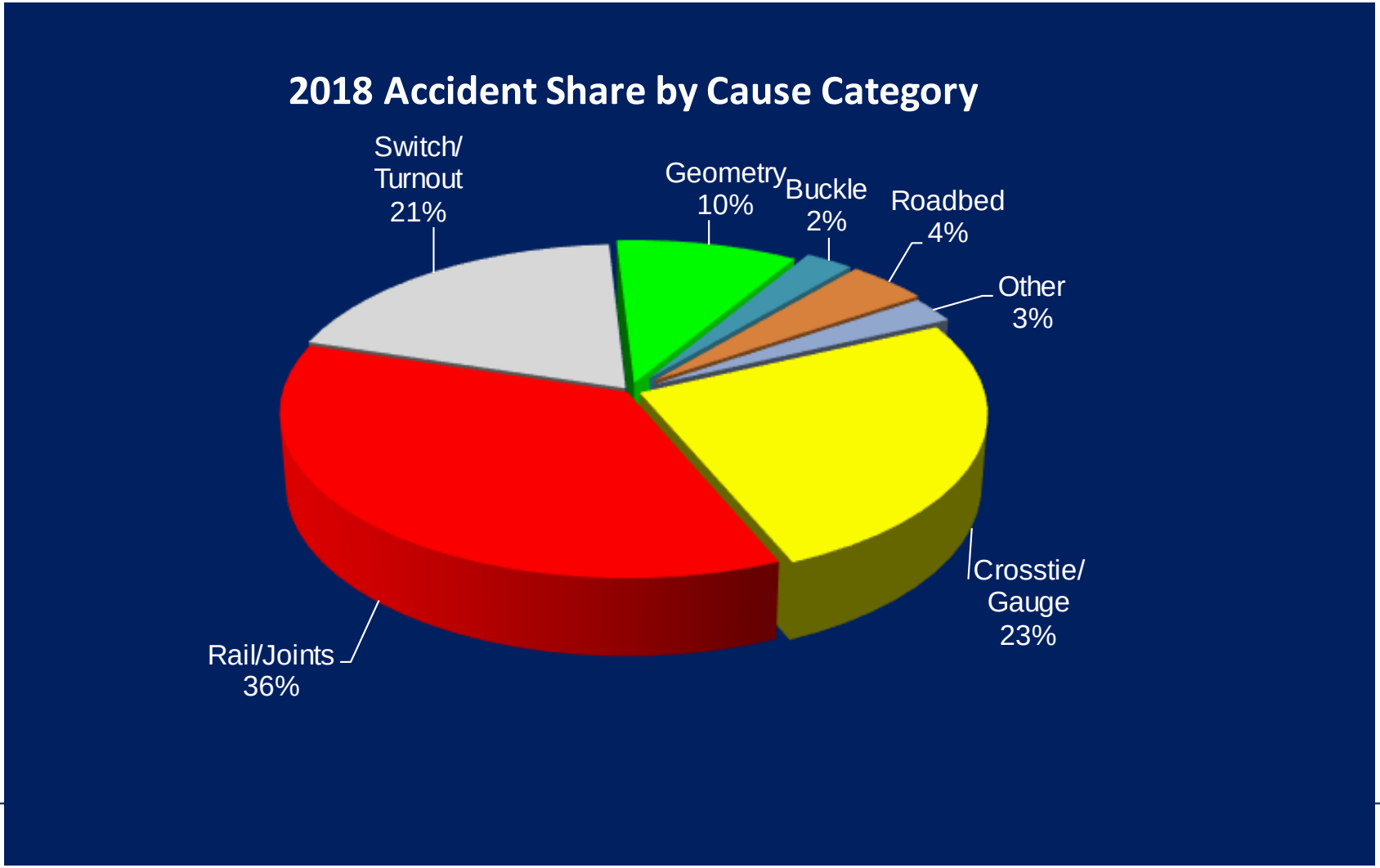
The Federal Railroad Administration's mission is to enable the safe, reliable, and efficient movement of people and goods for a strong America, now and in the future.

*Accident/Incident data current through 9/30/2018
Source: FRA Office of Safety Database (12/03/2018)

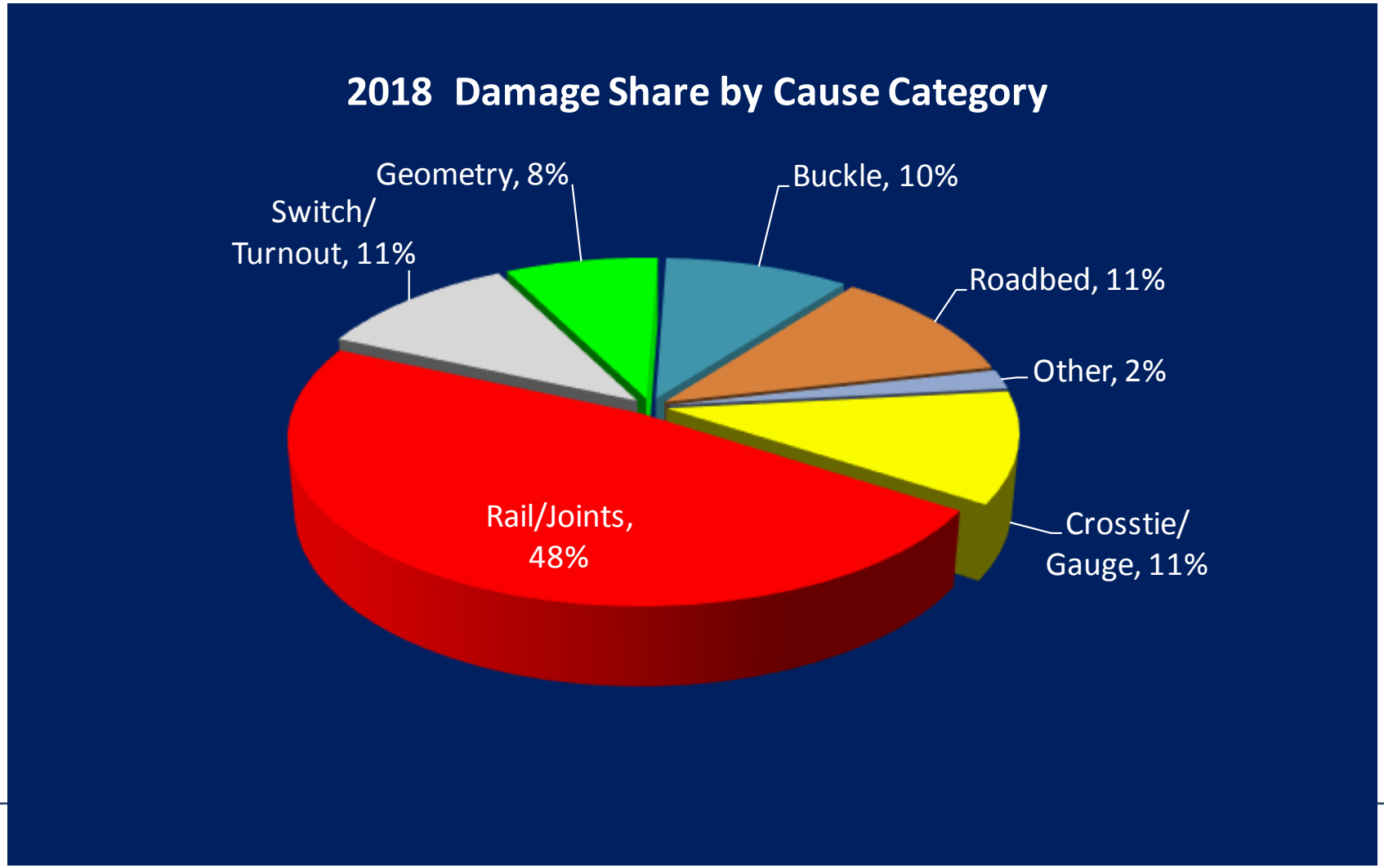
Cause Categories (all tracks)



Accident Share by Cause Categories



Cost Share ($%) by Cause Categories



Track Research Program

Track & Structures		System Performance & Analysis	R&D Facilities & Equipment
FY19 Funds	$ 5.8 M	$ 3.2 M	$2.0 M
• Track Stability – Track Support & Substructure – Track Buckling & Panel Shift – Tie & Fastener Performance • Rail Performance – Rail Integrity – Joints & Weld Integrity • Track Inspection – Inspection Technologies and Processes • University Research Program • Special Activities – Bridges & Structures – Track Design & Special Trackwork		• Vehicle/Track Performance – Vehicle Qualification – Vehicle & Track Performance – Wheel/Rail Interface – Derailment Mechanism and Prevention – Minimum Safety Requirements • Predictive Analytics – AI Technologies – Derailment Risk Assessment – Track Degradation Prediction • Small Business Innovative Research (SBIR)	• FRA Research Assets – On-Track Research & Testing – Research Equipment • Transportation Technology Center – Site Support – Site Improvements & Sustainability

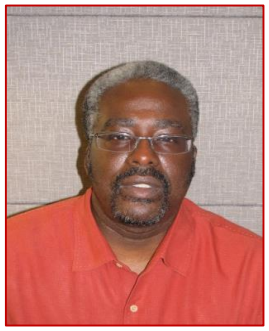
Track Research Team

Gary Carr
Track Research
Division Chief

Ali Tajaddini
Vehicle and Track
Performance

Jay Baillargeon
Predictive Analytics

Cam Stuart
Track Inspection
Systems and BAA



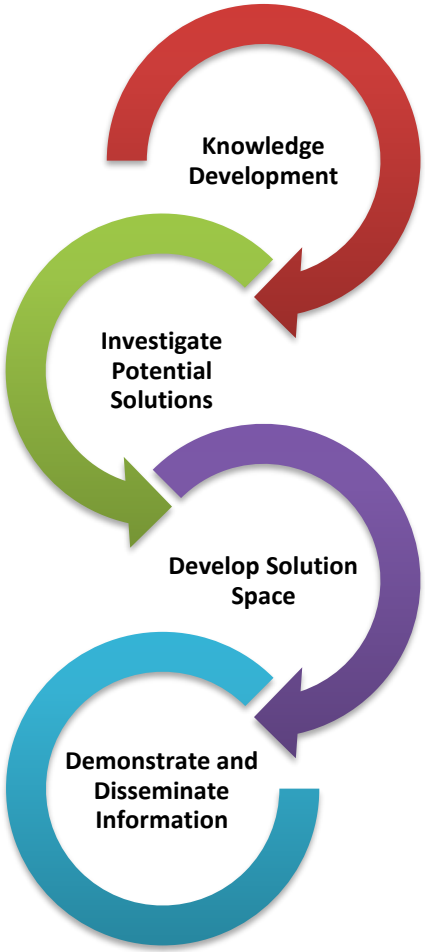
Hugh Thompson
Track Support and
Substructure

Luis Maal
Onsite Manager at
TTCI

Robert Wilson
Rail Integrity and Track
Buckling

Vacant
General Engineer

Strategy



- Evaluate problem and research areas
- Assess rules and regulations which are inadequate and/or ineffective
- Evaluate derailments with severe consequences

- Technology improvements
- Research potential rule changes (RSAC)
- Understanding of problems

- Conduct applied research
- Develop new technologies
- Work with small businesses

- Run demonstrations/proof tests
- Recommend rule changes
- Work with suppliers to commercialize technology
- Publish FRA/Industry Research and Technical Papers

Track Research Program

Focus: Develops track condition assessment technologies; vehicle and track computer modeling capabilities; expands the use of autonomous inspection methods and develops new techniques for monitoring difficult to detect safety issues.

Core Research Priorities

- Autonomous Inspection Technologies
- Artificial Intelligence-Based Risk Analysis
- Safety Assurance Performance Measures
- Rail Safety Simulations and Testing
- Advanced Defect Detection Measures
- TTC Research Facility Maintenance and Enhancement

Goals: Safety, Infrastructure, Innovation and Accountability

Rail Performance

- Automation of Detection for Ultrasonic Rail Inspection
- Development of Rail Flaw Imaging Technology based on Ultrasonic Tomography
- Laser Vibrometer Measurements for Rail Integrity Inspection
- Non-contact Rail Inspection Prototype Improvements
- TTCI Rail Integrity Research
- Advancing Rail Flaw Detection Capability
- Volpe Support IAA for Rail Performance
- Technical Support for FRA Office of Railroad Safety

Predictive Analytics

- Development of Predictive Analytics Using Automated Track Geometry Measurement Systems
- Development of Methodologies for the Evaluation of Track Inspection Technology Effectiveness
- Artificial Intelligence Technology for Track-related Defect Detection & Prediction

Track Stability

- Ballast Waiver Study
- Track Strength and Innovative Track Inspection Technologies
- Ground Penetrating Radar Research
- Investigation of Ballast Characteristics Before and After Maintenance
- Automated Machine Vision Based Ballast Scanning System

- Enhance Acoustic Birefringence Method for Measuring Rail Stress
- Image Processing and Machine Learning Algorithms to Measure Axial Stress in Rails
- Longitudinal Stress Measurements in Rail Using a Non-Contacting Reference-Free Vision-Based Approach
- Longitudinal Rail Stress Measurement using Ultrasound
- Reference-free Longitudinal Rail Stress & Neutral Temperature Measurement Utilizing Multidirectional Elastic Waves
- Rail Temperature and Buckling Risk Prediction Website
- Upgrade of CWR -Safe Software
- TTCI Management of Rail Neutral Temperature (RNT) and Longitudinal Rail
- Volpe Support IAA – Ballast and Subgrade/Track Buckling and Panel Shift

Track Inspection

- Change Detection Technology for FRA RRS DOTX220
- Automated and Autonomous Change Detection Technology
- Drone-Based Detect of Track Safety Risks
- Intelligent Track Systems Technology
- Automated Detection of Broken Spike Fasteners in Wood-Tie Railroad Track

Vehicle and Track Performance

- Wheel/Rail Interface Research
- Influence of Track Irregularity and Surface Conditions on Vehicle Dynamics
- Development of Models and Procedures for Analysis of Railroad Vehicle/Track Dynamics
- Track Geometry Measurement System Evaluation

Special Activities

- Collision Detection for Bridges
- University Research
- Wireless Bridge Condition Monitoring
- Robotics for Bridge Inspection
- Unmanned Aerial Vehicle Technology for Rail Applications

SECTION ONE

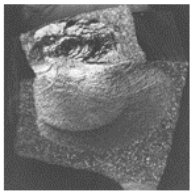
TRACK

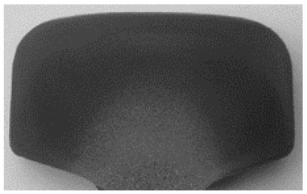
U.S. Department of Transportation
Federal Railroad Administration

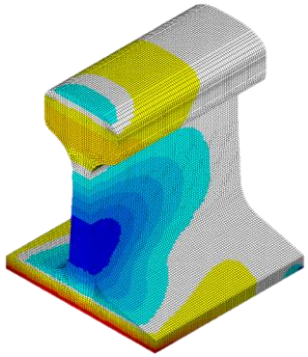
Defect Growth Characterization in Modern Rail Steel

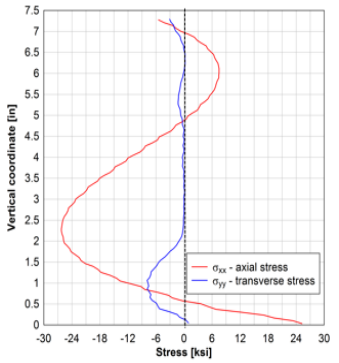
PROJECT DESCRIPTION

- Process and analyze all the data generated in Phase I in reference to existing data for legacy rails, including a comparative study.
- Perform detailed crack growth analyses, accounting for both internal (i.e., residual) and external stresses in the rails.
- Determine the safe inspection interval for modern rails based on the above analyses.









RAILROAD IMPACT

- Detailed experimental characterization of microstructural gradient and residual stress effects in head-hardened rails.
- Framework for modern rail characterization with a consistent testing protocol applicable to variety of rail grades and types.
- Modular/ building block development framework that considers previously collected data and expertise, and allows multiple extensions to account for advancements in material science and rail manufacturing technology – paradigm shift.
- Process developed could be applied to determine optimal inspection intervals or even the remaining life of the rail, given the flaw detected during routine inspection. This could aid repair scheduling as well as analysis of the delayed remedial action scenarios.

PROJECT PARTNER(S)

- Weidlinger Associates, Inc.
- Harvard University
- Lehigh University
- ArcelorMittal
- National Institute of Standards and Technology (NIST)

COST & SCHEDULE

- Funding: $697,016
- Project Duration: January 2016 – June 2019

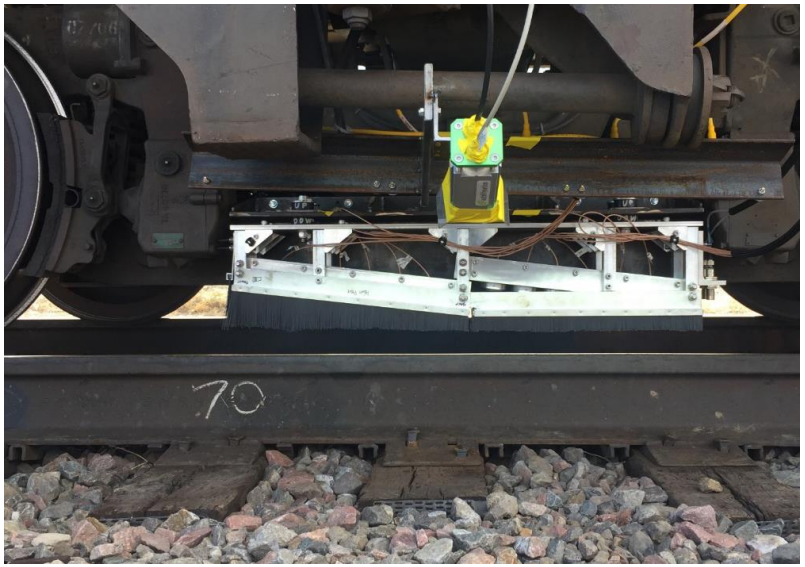
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Robert Wilson, PhD • (617) 494-2265 • robert.wilson@dot.gov

Non-Contact Rail Inspection Prototype (Passive-Only System for High-Speed Rail Inspection)

PROJECT DESCRIPTION

- Evaluate a new technique that uses non-contact acoustic sensors and special signal processing algorithms to detect internal defects in rails by exploiting the acoustic excitations naturally induced in the rail by the wheels of a running train.
- Develop new inspection concept based on the application of special signal processing algorithms aimed at extracting a "stable" acoustic Transfer Function between two points of the rail despite the "random" acoustic excitation by the rolling train wheels.
- Perform successful feasibility tests of the "passive" Transfer Function extraction were conducted in September 2016 at the Transportation Technology Center (TTC) by using a prototype designed by UCSD to speeds of 80 mph.
- Complete and test second generation prototype at the TTC High Tonnage Loop (first tests completed November 2018).



PROJECT PARTNER(S)

- University of California, San Diego (UCSD) – grantee
- ENSCO, Inc. – test support
- Transportation Technology Center, Inc. (TTCI) – test support

COST & SCHEDULE

- Funding: $561,323
- Project Duration: May 2016 – May 2019

RAILROAD IMPACT

- Passive rail inspection technology that exploits the natural train wheel excitations would enable extremely high testing speeds, well beyond the ~ 25 mph maximum speed currently allowed by conventional (e.g., RSU-based) rail inspection cars.
- Inspecting the rail at regular train speeds would simplify scheduling of rail inspections around normal traffic.
- "Smart train" approach: this technology could be used on regular trains to enable multiple redundant inspections of the same track, thereby improving the inspection reliability and, ultimately, the safety of transportation.

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Robert Wilson, PhD • (617) 494-2265 • robert.wilson@dot.gov

Robust Railway Track Crack Detection System Using Thermal Signatures

PROJECT DESCRIPTION

Develop a prototype sensor with low-power microprocessor, InfraRed (IR) camera, GPS and gyro to detect rail breaks from the back of a train.

Our Phase II objectives are:

- Construct smaller second generation sensor platform.
- Use a higher resolution IR camera for broken rail detection application.
- Employ various image processing and enhancement techniques to increase the likelihood of break detection.
- Better discriminate between true cracks and background clutters.
- Incorporate feedback from MBTA.

PROJECT PARTNER(S)

- Migma Systems, Inc.
- Massachusetts Bay Transportation Authority (MBTA)

COST & SCHEDULE

- Funding: Approx. $300,000 (cost to date)
- Project Duration: May 2017 – May 2019

RAILROAD IMPACT

- Automated railway inspection is critical for ensuring the safety of public transportation. Rails often break under trains but do not lead to immediate derailment until further damage occurs at the fracture, causing catastrophic derailment.
- Video cameras have been used to detect the rail cracks with limited success as the video image quality is highly impacted by the environment such as alignment of light source and weather conditions. The system developed under this Small Business Innovation Research (SBIR) Phase II project utilizes an IR camera for the detection of rail cracks through their unique thermal signatures. It can be mounted on the back of trains and detect cracks in real time as trains are in service.

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Robert Wilson, PhD • (617) 494-2265 • robert.wilson@dot.gov

High-Speed Broken Rail Detection

PROJECT DESCRIPTION

- Demonstrate a second generation prototype detection system.
- Automated detection of broken rails.
- Real-time imaging of rail morphology allows breaks to be differentiated from rail joints.
- Novel high-speed detector enables detection of broken rails from trains at normal operational speeds (does not require dedicated metrology/inspection).
- Field tests being conducted on Vermont Rail System.

RAILROAD IMPACT

- Broken rails or welds are a common cause of Class I mainline derailments. Rails often break under trains but do not cause immediate derailment until further damage leads to catastrophic failure.
- Current inspection methods are periodic and may miss the critical period during which initial damage progresses to complete failure.
- Detection of early-stage rail defects from normal service revenue trains enables repair before catastrophic failure and derailment.

PROJECT PARTNER(S)

- Creare, LLC
- Vermont Rail System

COST & SCHEDULE

- Funding: $299,000
- Project Duration: May 2017 – May 2019

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Robert Wilson, PhD • (617) 494-2265 • robert.wilson@dot.gov

Quantification and Evaluation of Rail Flaw Inspection Practices and Technologies

PROJECT DESCRIPTION

Rail Flaw Library of Associated Defects (RF-LOAD)

- Collect naturally occurring flaws from revenue service operations. These rail flaw samples will be used for training of inspectors using hand-held Non-Destructive Evaluation (NDE) instruments, Probability of Detection (POD) method development, and initial development of advanced inspection technologies.

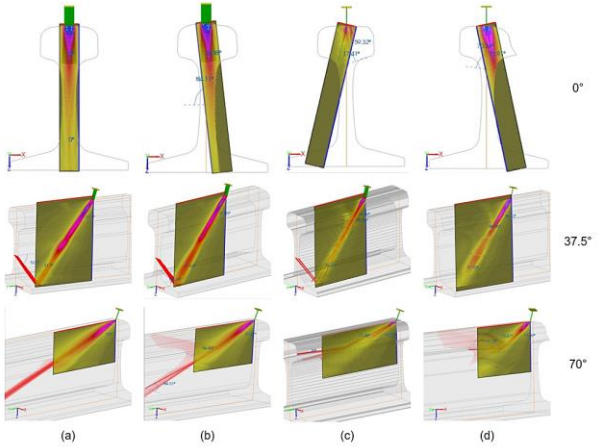
Ultrasonic Beam Modeling & Inspection Simulations

- Conduct Ultrasonic Testing (UT) simulations to better understand ultrasonic beam and probe responses for commonly missed flaws (shape, size, orientations) in revenue service under different inspection scenarios.

Flash Infrared Thermography (IRT)

- Assess the feasibility of using this technology at track speed for non-contact in motion rail base inspection

Rail Flaw Library



Ultrasonic beam field computation (transmission) of ultrasonic transducers for different 136 RE rail head profiles. (a) Virgin rail profile; (b) Normal used profile; (c) Surface damaged profile; (d) Gage wear profile.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: $449,000
- Project Duration: July 2016 – May 2019

RAILROAD IMPACT

- Support future research directed towards evaluating and improving the performance of current and future rail inspection technologies for use in detecting rail flaws as well as the methods for quantifying them.
- Rail flaw library will serve other researchers to allow them direct access to the realistic rail flaw samples for validating their work on rail inspection technologies.
- Achieve higher reliability of Ultrasonic NDE inspection for rail flaw detection and characterization.
- Optimized ultrasonic parameters and inspection angles for improved detection of missed flaws in revenue service.

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Robert Wilson, PhD • (617) 494-2265 • robert.wilson@dot.gov

Rail Neutral Temperature (RNT) and Longitudinal Force Management

PROJECT DESCRIPTION

- **RNT Data Mining and Analysis**
- **Monitoring RNT and Curve Movement under Heavy Axle Loads**
- **Evaluation of Potential Curve Monitoring Technologies**
- **RNT Workshop**
  - Develop a workshop to document the best RNT management practices from industry and FRA.
- **RNT Test Bed Design**
  - This task will develop an RNT and Track Buckling Test Bed design concept and performance requirements. The potential exists for installation of a track segment that can have independent rail force loading capability while still being part of an operating track, such as the High Tonnage Loop at the Transportation Technology Center.
- **Track Maintenance Effects on RNT**

RAILROAD IMPACT

- Characterization of RNT changes in revenue service track.
- Characterization of rail force at the time of weld and rail failure under “real world” conditions.
- Evaluation of new methods to monitor curve movement.
- Understand how curves breathe with and without train traffic.
- Measure rail movement and RNT changes simultaneously in curves at the FAST Facility.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: Approx. $524,000
- Project Duration: July 2016 – December 2019

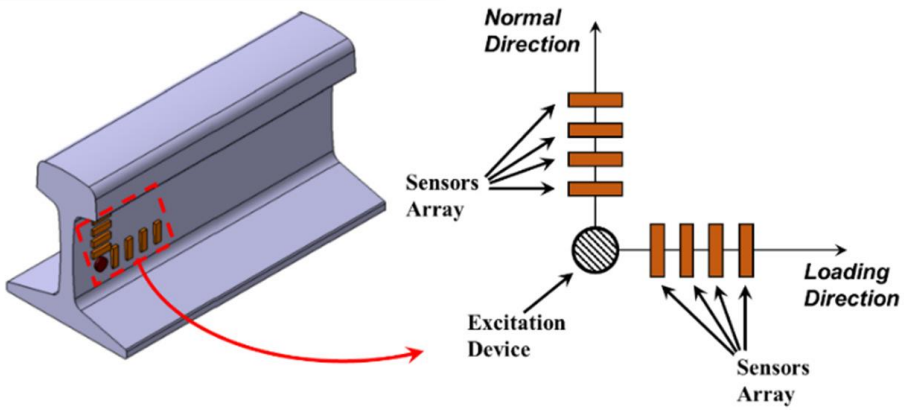
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Robert Wilson, PhD • (617) 494-2265 • robert.wilson@dot.gov

Rail Neutral Temperature (RNT) Measurement by Virginia Tech

PROJECT DESCRIPTION

- The primary goal of this research effort is to develop, validate, and implement a novel acoustoelastic-based approach for longitudinal rail stress and neutral temperature measurement.
- The proposed approach has two fundamentally distinctive features compared to current ultrasonic practices, these are:
    1. The utilization of *low-frequency* flexural waves to calculate the state-of-stress, which offers enhanced sensitivity and robustness.
    2. The utilization of the vertical (normal-to-loading) direction as a reference, which further enhances the robustness of the technique and allows compensating for uncertainties in rail characteristics.



RAILROAD IMPACT

- Potential to provide reliable, *reference-free* measurements of longitudinal rail stress and neutral temperature.
- Better understanding and management of RNT through regular measurements.
- Ability to spot-check RNT on any given rail.
- Potential to reduce track buckles and pull-a-parts.

PROJECT PARTNER(S)

- Virginia Tech
- Norfolk Southern

COST & SCHEDULE

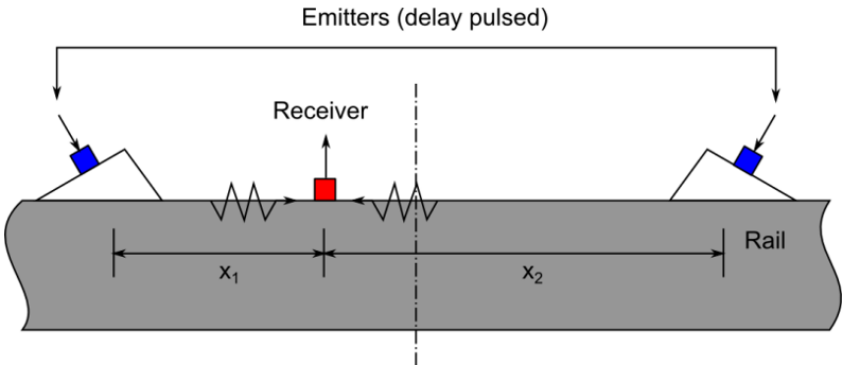
- Funding: $141,000
- Project Duration: July 2018 – July 2020

FRA PROJECT MANAGER: Robert Wilson, PhD • (617) 494-2265 • robert.wilson@dot.gov

ail Neutral Temperature (RNT) Measurement (University of Sheffield)

PROJECT DESCRIPTION

- Apply an ultrasonic interferometry approach to the problem of longitudinal rail stress, and develop and demonstrate a prototype measurement device which overcomes current measurement limitations. The system will be tested on track with the assistance of FRA staff who will ensure safe and suitable trials are performed.
- The proposed ultrasonic measurement system will consist of data acquisition hardware, processing software mounting clamp and sensors. It will offer a way of measuring the stress state of the rail non-destructively and in-situ without the need to unpin or modify the rail. Fast measurements (<5 min), of high resolution could be carried out by a single person. Neutral temperature (NT) predictions with a confidence band of ±5°F or better are targeted.



RAILROAD IMPACT

- Potential to provide reliable, *reference-free* measurements of longitudinal rail stress and neutral temperature.
- Better understanding and management of RNT through regular measurements.
- Ability to spot-check RNT on any given rail.
- Potential to reduce track buckles and pull-a-parts.

PROJECT PARTNER(S)

- The University of Sheffield
- Transportation Technology Center, Inc. (TTCI) – test support

COST & SCHEDULE

- Funding: $150,000
- Project Duration: November 2018 – November 2019

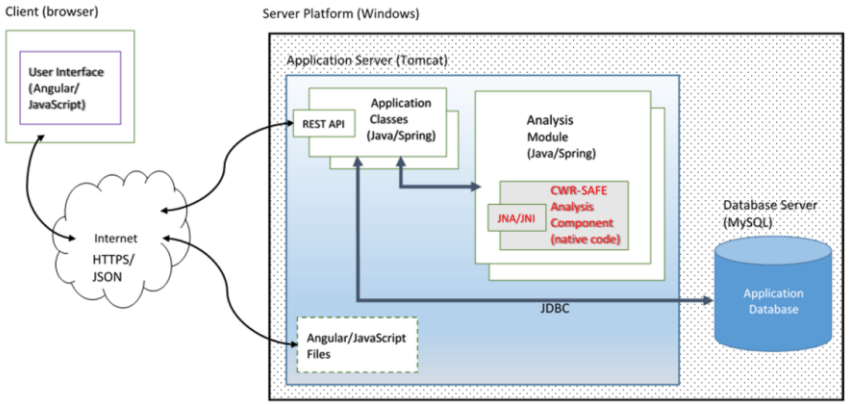
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Robert Wilson, PhD • (617) 494-2265 • robert.wilson@dot.gov

Upgrade of CWR-SAFE Software

PROJECT DESCRIPTION

- Upgrade CWR-SAFE, a computational model for track buckling safety analyses, to run on modern computer operating systems and mobile platforms.
- Promote FRA and industry use of the CWR-SAFE application through provision of the utility via secure website.



RAILROAD IMPACT

- Provide industry with a tool for a deterministic evaluation of buckling strength and safety.
- Prevent or minimize consequences of track buckling related derailments.
- Establish better awareness of buckling danger for track personnel.

PROJECT PARTNER(S)

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $150,000
- Project Duration: September 2018 – September 2019

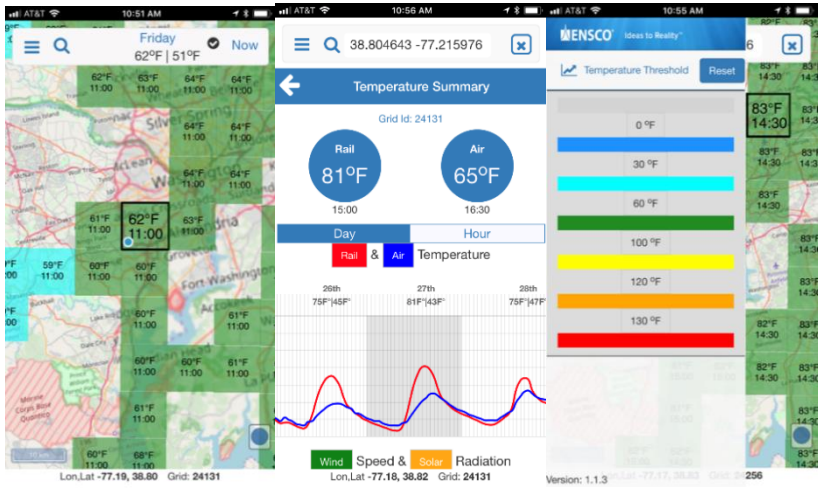
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Robert Wilson, PhD • (617) 494-2265 • robert.wilson@dot.gov

Rail Temperature and Buckling Risk Prediction

PROJECT DESCRIPTION

- Expand the functionality of FRA's existing Rail Temperature and Buckling Risk Prediction web-mobile application.
- Support training for use of the application including user documentation and training webinars.



RAILROAD IMPACT

- Provide industry with a tool to issue heat slow orders in a more effective and targeted way.
- Prevent or minimize consequences of track buckling related derailments by improved heat slow order management process.
- Establish better awareness of rail temperature for track personnel through use of a utility that provides information in near real time.

PROJECT PARTNER(S)

- ENSCO, Inc.
- Amtrak
- Norfolk Southern

COST & SCHEDULE

- Funding: $39,942
- Project Duration: September 2018 – December 2019

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Robert Wilson, PhD • (617) 494-2265 • robert.wilson@dot.gov

Ballast Waiver Support

PROJECT DESCRIPTION

- Better define the performance, degradation, variability, and safety of “reduced performance” ballast through a better understanding of its long-term behavior.
- Collect and analyze pertinent information using track inspection vehicles, long-term track instrumentation, Ground Penetrating Radar and other available data.
- Continue stakeholder support for the operations under the fouled ballast waiver and the activities related to concurrent joint Association of American Railroads-FRA research effort.

RAILROAD IMPACT

- Better understanding of “reduced performance” or “fouled” ballast under a range of weather conditions, and its affect on track performance and safety critical conditions.
- Development of objective criteria for both railroads and FRA inspectors to use for identifying and managing “fouled” ballast conditions.
- Production of information for potential data driven recommendations related to enforcement of §213.103 of the Track Safety Standards.
- Improved railroad safety and maintenance operations.

PROJECT PARTNER(S)

- ENSCO, Inc.
- Association of American Railroads (AAR)
- BNSF
- University of Illinois, Urbana-Champaign
- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $404,455
- Project Duration: August 2018 – July 2019

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Hugh Thompson • (202) 493-6383 • hugh.thompson@dot.gov

Quantification of Track Instabilities Due to Ballast Movement at Special Locations Using Integrated Sensor Networks

PROJECT DESCRIPTION

- Develop a platform of hardware and software to: (1) quantify in the field ballast failure mechanism and criteria; and (2) offer a platform for the future "real-time ballast stability evaluation and monitoring program."
- Develop advanced sensors with: (a) onboard programmable ballast failure mechanism and criteria algorithm; and, (b) advanced communication protocols such as "iBeacon."
- Install field instrumentation of the advanced sensor networks at different locations under different traffic and maintenance conditions.
- Initiate the "real-time ballast stability evaluation and monitoring program" based on validated ballast failure mechanism and criteria.

RAILROAD IMPACT

- Real-time data collection and integrated analysis system allows railroad companies to more accurately identify the instantaneous condition of their ballast and track-bed and proactively assign maintenance windows to ensure safe and efficient train operation with the least amount of train delay due to maintenance outages.
- Allow railroads to identify an objective threshold by which they can establish a window or opportunity for ideal track maintenance.
- Technology is "moving platform ready" with "iBeacon" technology because sensor data can not only be sent to the engineers in real time but can also be stored and "picked up" by geometry cars passing by, with which track engineers will have significant higher resolution and real-time images of their track in terms of safety and serviceability.

PROJECT PARTNER(S)

- Penn. State
- HyGround
- Amtrak
- Railroad Technology & Services (RTS)

COST & SCHEDULE

- FRA BAA Funding: $322,842 – Scheduled for 24 months (two phases)
- Granted In-kind Support from:
  - RTS – 50 "SmartRocks" free of charge and other technical support (equivalent to a cash value of $48,600)
  - Amtrak – site access and protection, technical support, etc.
- Project Duration: September 2018– August 2020

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Hugh Thompson • (202) 493-6383 • hugh.thompson@dot.gov

Innovative Track Inspection Technologies

PROJECT DESCRIPTION

- Support for the introduction of new track inspection approaches and advancement of existing track inspection technologies with focus on data interpretation and analysis.
- Research into assessment of FRA's Vertical Track Deflection Measurement System (VTDMS) and alternative approaches to directly measure vertical defection under given loads.
- Provide engineering and data analysis support for Gage Restraint Measurement System (GRMS), Ground Penetrating Radar (GPR), VTDMS, and similar track evaluation technologies.
- Support field activities for FRA track research.

RAILROAD IMPACT

- Broaden the application of innovative technologies to detect degraded track conditions.
- Improve the understanding of track behavior through characterization of various track components and parameters.
- Provide practical uses of technology to improve railroad safety and maintenance practices.

PROJECT PARTNER(S)

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $112,486
- Project Duration: August 2018 – April 2019

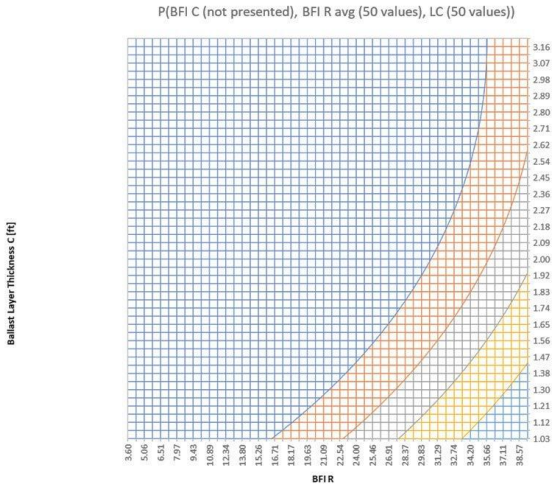
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Hugh Thompson • (202) 493-6383 • hugh.thompson@dot.gov

Relationship Between Track Geometry Defects and Measured Track Subsurface Conditions

PROJECT DESCRIPTION

- Develop engineering and/or statistical relationships between track substructure inspection parameters and track geometry defects.
- Specific focus on the relationship between ballast condition as defined by Ground Penetrating Radar (GPR) and development of track geometry defects.
- Provide identification of track locations with potential for development of track geometry defects that will grow to unsafe levels.
- Develop analysis algorithm(s) to correlate key GPR inspection parameters, with track geometry defects



RAILROAD IMPACT

- GPR is being used on an increasing basis by railroads to identify ballast condition.
  - Key GPR parameters include Ballast Fouling index and Ballast Layer Thickness.
- The ability to use GPR inspection to identify potential track geometry initiation/development sites would be a valuable tool for railroads.
  - Provides information on where high-risk track geometry could develop.

PROJECT PARTNER(S)

- University of Delaware (Railroad Engineering and Safety Program)
- GREX

COST & SCHEDULE

- Funding: $289,842 overall cost
- Project Duration: August 2016 – December 2018
  - Report to be issued in 2018
  - 24-month schedule included data collection and preparation, development of engineering relationships, statistical analysis, development of analysis algorithms
  - Partner participation for data collection and analysis (labor).

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Hugh Thompson • (202) 493-6383 • hugh.thompson@dot.gov

Near Real-Time Processing of Targeted Ground Penetrating Radar (GPR) Data for Ballast Condition

PROJECT DESCRIPTION

- Support introduction of new track inspection approaches and advancement of existing track inspection technologies with focus on data interpretation and analysis.
- Research into assessment of FRA's Vertical Track Deflection Measurement System (VTDMS) and alternative approaches to directly measure vertical defection under given loads.
- Provide engineering and data analysis support for Gage Restraint Measurement System (GRMS), Ground Penetrating Radar (GPR), VTDMS, and similar track evaluation technologies.
- Support field activities for FRA track research.

RAILROAD IMPACT

- Broaden the application of innovative technologies to detect degraded track conditions.
- Improve the understanding of track behavior through characterization of various track components and parameters.
- Provide practical uses of technology to improve railroad safety and maintenance practices.

PROJECT PARTNER(S)

- Balfour Beatty
- Zetica Rail

COST & SCHEDULE

- Funding: $378,782
- Project Duration: September 2018 – August 2019

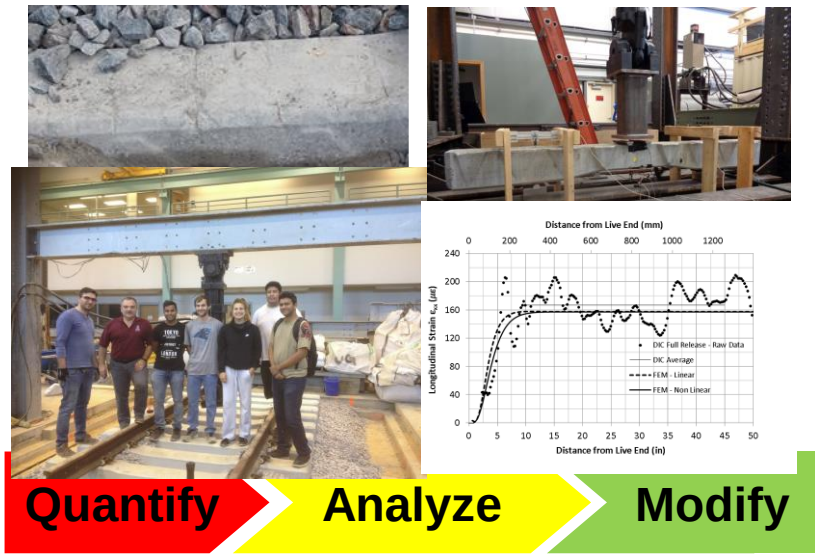
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGERS: Hugh Thompson • (202) 493-6383 • hugh.thompson@dot.gov
James Payne • (202) 493-6005 • james.payne@dot.gov

Concrete Tie Design and Performance Research

PROJECT DESCRIPTION

- Basic research to quantify the stress state of the track superstructure.
- Review and revise FRA regulations pertaining to concrete ties.
- Advanced computer modeling of ties and track systems.
- Research new materials for improved concrete tie performance.
- Improve testing standards for concrete ties.
- Study the operating environment of concrete ties, especially areas that foster tie abrasion and poor support conditions.
- Create new technologies to assess the internal stress state of concrete ties.



RAILROAD IMPACT

- Basic and applied research to establish sound design, construction, and testing practices for concrete crossties.
- Advance the state of science in the area of concrete ties for high-speed rail and freight applications.
- Develop industry recommended practices and testing standards for design and production of concrete ties.
- Create useful tools and techniques for improving concrete tie quality and performance.
- Study the operating environment and understand the effects of this environment on the performance of concrete ties.

PROJECT PARTNER(S)

- Universities
  - University of Illinois, Kansas State, University of South Carolina, Western New England University, University of Florida
- Class I Railroads (all)
  - Rocla, CXT, GIC and other suppliers

COST & SCHEDULE

- Funding: Total program – Approx. $1,000,000/year
- Project Duration: June 2011 – June 2019

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Automated Frog Repair Technology

PROJECT DESCRIPTION

- Phase 2 project includes field testing of repaired frogs on Class I railroads.
- Development of metal cored electrode to reduce weld slag and eliminate inter-pass cleaning.
- Develop conceptual framework for field-deployable automated repair system.

RAILROAD IMPACT

- Automated, improved repair process for Austenitic Manganese Steel (AMS) frogs.
- Eliminates errors and inconsistencies in field repairs.
- Controlled process ensure high quality and extend life for repaired frogs.
- Automated process allows for off track rehabilitation, thus reducing time on track.

PROJECT PARTNER(S)

- Edison Welding Institute
- CSX
- Norfolk Southern

COST & SCHEDULE

- Funding: $300,000
- Project Duration: March 2016 – September 2019

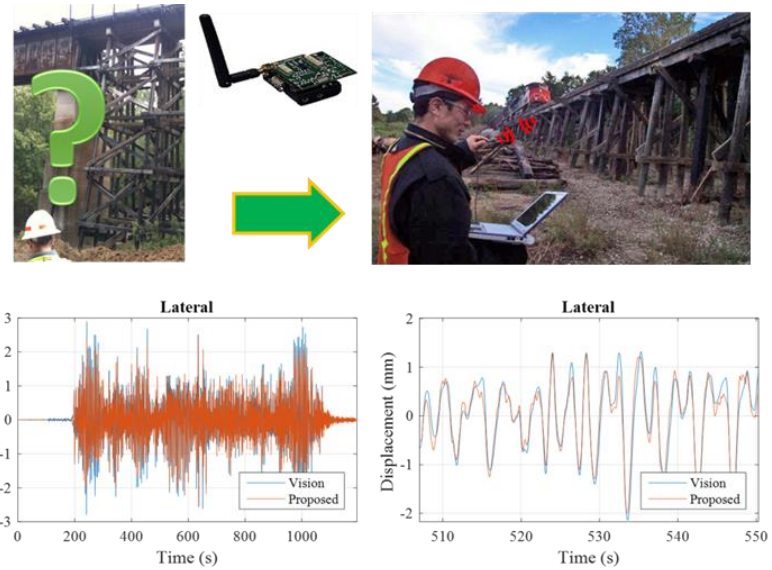
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Bridge Condition Assessment Using Smart Sensors

PROJECT DESCRIPTION

- Phase 2 development effort.
- Field trials of equipment on multiple bridges in the Midwest of the US.
- Establish service limit thresholds based on measured data.
- Test the reference-free displacement estimation algorithms and user interface.



RAILROAD IMPACT

- Accurate, reference-free bridge displacement estimations under revenue traffic.
- Dynamic bridge safety limit thresholds.
- Wireless technology – no fixed installation required.
- Quantitative data for railroad use in prioritization of bridge maintenance and replacement.

PROJECT PARTNER(S)

- University of Illinois at Urbana-Champaign (UIUC)
- FRA Office of Railroad Safety
- Class I - CN, multiple short line railroads

COST & SCHEDULE

- Funding: $350,000
- Project Duration: January 2017 – June 2019

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Investigation of Timber Crosstie Spike Fastener Failures

PROJECT DESCRIPTION

- Identify and quantify the extent of spike failures in the field.
- Collect data on operating conditions, environmental characteristics, track construction, maintenance, and age.
- Develop and test failure cause hypotheses.
- Make recommendations to eliminate failures.

RAILROAD IMPACT

- Improve system safety and reliability, and reduce life cycle infrastructure costs.
- Improve spike design and system arrangements.
- Reduce risk of derailments due to fastener failures.

PROJECT PARTNER(S)

- University of Illinois at Urbana-Champaign (UIUC)
- Class I railroads: Norfolk Southern, BNSF, CSX, UP, CN
- Suppliers: Pandrol

COST & SCHEDULE

- Funding: FY18 – FY19 Approx. $300,000
- Project Duration: April 2018 – April 2019

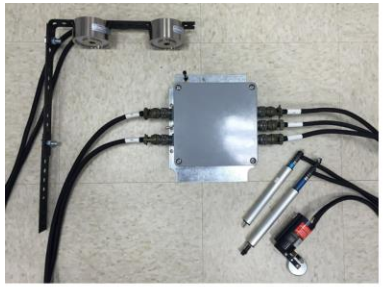
U.S. Department of Transportation
Federal Railroad Administration

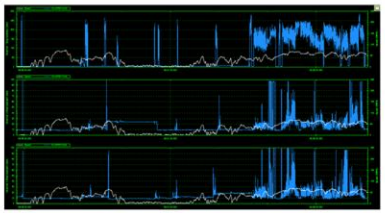
FRA PROJECT MANAGER: Cameron Stuart • (202) 493-6384 • cameron.stuart@dot.gov

Portable Rail Suspension Displacement Monitoring System

PROJECT DESCRIPTION

- System will have the capability to measure the displacement of any two points on the vehicle suspension, including, axle box to truck frame, truck frame to car body, and truck rotation.
- System will incorporate detachable mounting mechanisms and wireless sensors to facilitate displacement measurements on any rail vehicle at any time.
- System will integrate with existing portable acceleration monitoring systems to determine correlations between vehicle/track interaction data and displacement data.





RAILROAD IMPACT

- Current rail suspension displacement monitoring systems are costly and unwieldy to install, configure, and operate.
- The portable rail suspension displacement monitoring system addresses these detriments to allow railroad companies to easily monitor rail suspension displacement with advanced wireless sensors.
- The displacement data will be beneficial in determining vehicle suspension problems and for model validation and qualification testing.

PROJECT PARTNER(S)

- dFuzion, Inc.

COST & SCHEDULE

- Funding: $300,000, cost to date
- Project Duration: December 2016 – December 2018

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Track Geometry Measurement System (TGMS) Evaluations

PROJECT DESCRIPTION

- Develop procedures for testing and evaluating Track Geometry Measurement Systems (TGMS) under controlled conditions to verify accuracy and repeatability.
- Known vertical and lateral track perturbations on TTC's High-Speed Adjustable Perturbation Slab (HS-APS) track including "blind tests."
- Tests of DOTX 216 at speeds 15 to 105 mph in 2015 and 2016
  - Combinations of perturbation vertical and lateral wavelengths and amplitudes.
- FRA and Volpe Center: develop procedures and analyze test data.
- TTCI: assist with developing/reviewing procedures, install, measure perturbations, provide wayside measurements, operations support and improvements to HS-APS based on testing experience.
- ENSCO: test planning, operate DOTX 216 and collect TGMS data.

RAILROAD IMPACT

- Consistent method for evaluating and benchmarking TGMS cars.
- Reduce TGMS measurement error.
- Verify accuracy and repeatability, including effects of measurement speed and repeated/multiple deviations.
- Identify potential issues for measurement/analysis of certain types of track geometry (TG) perturbations.
- Increased confidence in TG data and exception reports.
- Improved TG data for input to vehicle-track dynamic interaction computer simulation models.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Volpe National Transportation Systems Center
- ENSCO, Inc.

COST & SCHEDULE

- Funding: $1,225,151
- Project Duration: May 2015 – December 2018
- Phase 1 and 2 testing completed in 2016, with test report delivered to FRA September 2017
- Report on improvements to HS-APS December 2018 including:
  - Track stiffness & damping characterization tests.
  - Additional wayside strain gages & instrumentation shed.
  - Improved lateral alignment and permanent benchmarks.
  - Cost estimate for design and construction of Curved HS-APS in 50 minute high speed curve at the Transportation Technology Center (TTC).

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Steering Traction on Wheel and Rail Damage – Full Scale Testing with Rolling Contact Fatigue Simulator (RCFS)

PROJECT DESCRIPTION

- The RCFS was developed and installed in the Rail Dynamics Laboratory at FRA's Transportation Technology Center (TTC) in Pueblo, Colorado.
- RCFS is capable of testing full scale, freight and passenger wheelsets and rails under current and anticipated future load conditions with precisely controlled variables.
- Testing at various traction forces under 36-ton axle load shows plastic flow dominant, combination of plastic flow and wear, and wear dominant damage modes.
- RCF and wear performance of different class wheels and rails are investigated: wheel/rail contact forces, creep force, creepage characteristic measurement, lubrication and rail grinding effect on RCF, tribology study

RAILROAD IMPACT

- Reduction of RCF through optimization of wheel and rail materials, profiles, and maintenance procedures.
  - Rails with RCF may lead to derailment.
  - RCF may contribute to shattered and vertical split rims of wheels; it may also mask deeper seated cracks in rail from ultrasonic detection.
- Lowered stresses and lowered crack growth in rail.
- Measured wheel/rail contact creep characteristics provide valuable information for developing maintenance strategy and safety limits.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)
- Jointly funded by FRA and Association of American Railroads

COST & SCHEDULE

- FRA Funding: $2,176,253
- Project Duration: September 2013 – October 2019
- The RCFS was commissioned in March 2015
- Low traction ratio RCF tests completed in 2017
- Second Phase testing and measurement improvement continued in 2018

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Evaluation of Wheel/Rail Contact Mechanics and Dynamics

PROJECT DESCRIPTION

- Complete the commissioning of the state-of-the-art Virginia Tech-FRA roller rig intended for more advanced evaluation of the wheel-rail interface (WRI).
- Conduct a series of experiments for scientifically determining the effect of third body layers on traction coefficients simulating conditions during field operations.
- Evaluate the effect of wheel load and creepage force on conditions that can lead to wheel-rail accelerated wear.
- Evaluate the effect of wheel-rail angle of attack (AoA) on wheel wear and potentially offer recommendations for reducing such wear.

RAILROAD IMPACT

- Understanding the complex mechanics and dynamics that occur at the WRI is critical for improving railway operational safety and efficiency.
- Introducing a new level of accuracy for measuring a multitude of contact parameters that are critical in WRI modeling and technology advancement for both passenger and freight trains, far beyond the means currently available to FRA and rail industry.
- Scientifically evaluating parameters and conditions that affect wheel-rail wear, but cannot be evaluated accurately in the field due to the naturally-varied conditions.

PROJECT PARTNER(S)

- Virginia Tech
- Norfolk Southern
- Standard Steel

COST & SCHEDULE

- Funding: $300,000
- Project Duration: September 2017 – February 2019 (Phase II)

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Ground Truth Measurement of Track Geometry on FRA Test Track

PROJECT DESCRIPTION

- FRA's adjustable test track at the Transportation Technology Center (TTC) can be configured with known geometry deviations for vehicle testing as well as measurement system assessment.
- The objective of this task is to design, build, and demonstrate a measurement device that accurately and quickly establishes the ground truth track geometry following modification of the test track.

RAILROAD IMPACT

- FRA's adjustable test track is an important tool for research related to vehicle-track interactions, validation of dynamic simulations, vehicle safety testing, and the assessment of track measurement technology.
- The results of this effort will be vital to these activities by allowing researchers and test engineers to accurately determine the configuration of the test track.

PROJECT PARTNER(S)

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $480,000
- Project Duration: September 2018 – September 2019

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

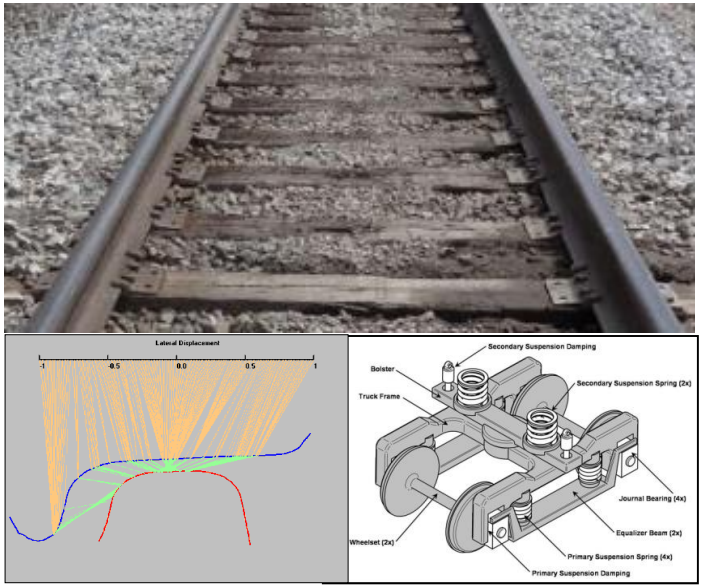
Vehicle-Track Interaction Testing, Modeling and Analyses

PROJECT DESCRIPTION

- Modeling, simulation, testing, data collection and analyses of vehicle-track interaction related issues.
- Efforts include evaluating current track geometry standards and exploring influence of track geometry characteristics and speeds on vehicle dynamic forces.

RAILROAD IMPACT

- Studies in this area can reduce derailment risk, track degradation, vehicle wear or damage, lading damage, and passenger discomfort.
- Research considers performance-based track geometry tolerances and vehicle design parameters that ensure safety, and maximize effective and efficient use of maintenance resources.



PROJECT PARTNER(S)

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $231,000
- Project Duration: September 2018 – September 2019

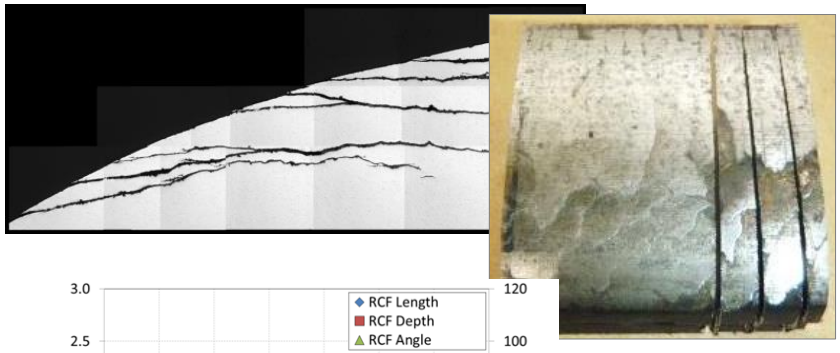
U.S. Department of Transportation
Federal Railroad Administration

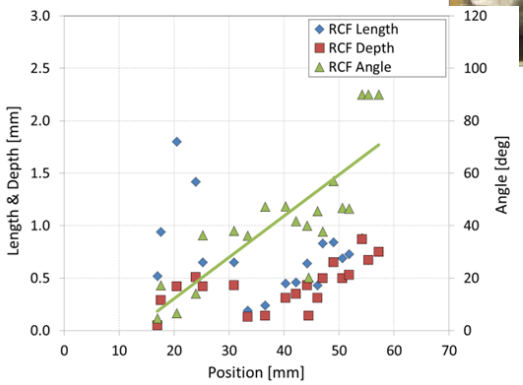
FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Rolling Contact Fatigue (RCF) Qualification

PROJECT DESCRIPTION

- Measuring RCF severity on rail to improve railroad safety and reliability. s RCF impacts railroad safety and reliability, having information on RCF's severity on a given rail is crucial.
- Over the last year, 15 rail samples were analyzed metallurgically to determine the extent of RCF and its correlation with visible surface damage.
- Relationships are being developed between surface damage appearance and subsurface crack propagation angles and depths using Eddy Current (EC) measurement techniques.
- These same relationships can be applied to surface photographs being collected by imaging systems.
- All inspection results are being placed in an 'RCF Matrix' for public use, while many different combinations of steel type, curvature, and tonnage remain to be analyzed.





RAILROAD IMPACT

- **Safety:** Understanding rail subsurface RCF damage as a function of track curvature and million gross ton (MGT) accumulation will allow railroads to more safely manage RCF.
- **Economic competitiveness:** Accurate mapping of RCF is useful to railways for making grinding and rail replacement decisions, and to RCF modelling experts for predicting rail life under variable conditions.

PROJECT PARTNER(S)

- National Research Council (NRC) of the Government of Canada

COST & SCHEDULE

- Funding: $90,000 annually
- Project Duration: 2017 –2020

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Track Geometry Measurement System (TGMS) Evaluation Procedures

PROJECT DESCRIPTION

- Plan and coordinate testing on FRA adjustable test track at the Transportation Technology Center (TTC) with FRA's High-Speed Geometry Car DOTX 216.
- Support analysis and documentation efforts comparing DOTX 216-collected geometry data with ground truth measurements.
- Analyze and document data collected with DOTX 216's Instrumented Wheel Sets.
- Write a procedure for testing and measuring ground truth and testing Track Geometry Measurement Systems.

RAILROAD IMPACT

- Current TGMS verification methods rely on a statistical measure of precision and periodic verifications of accuracy by comparing static and dynamic measurements.
- FRA can introduce precise geometry into a test track at the Transportation Technology Center (TTC) to provide controlled comparison to measured track geometry data.
- This project is first of several steps in establishing a procedure by which track assessment technology can be objectively evaluated.

PROJECT PARTNER(S)

- ENSCO, Inc.
- Transportation Technology Center, Inc. (TTCI)
- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $800,000
- Project Duration: April 2015 – March 2019
  - DOTX 216 TTC Testing – 2015, 2016

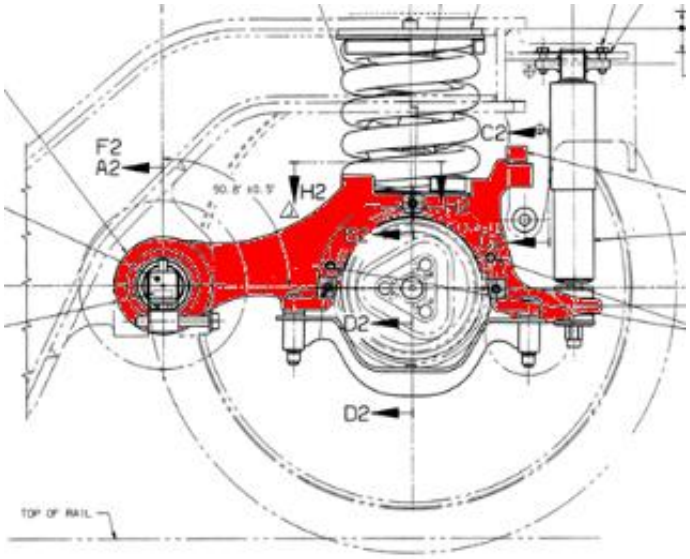
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Coil Spring Characterization and Modeling

PROJECT DESCRIPTION

- Procure a multiaxial test machine to test suspension springs under various loading conditions.
- First phase is to procure the test machine.
- Measure the axial, shear, and torsional stiffness of the spring.
- Study the best practice for modeling suspension springs in the trucks.
- Investigate the need for modifications in the methods that the springs are modeled in multibody simulation programs.



RAILROAD IMPACT

- Provide guidelines how to measure spring properties.
- Provide information on how to model springs in multibody simulation program.

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center
- Zwick

COST & SCHEDULE

- Funding:
  - Phase I – Procure the test machine: $500,000
  - Phase II – Perform testing to characterize springs: $200,000
- Project Duration: 2014 – 2019

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Influence of Track Irregularities on Derailment Safety

PROJECT DESCRIPTION

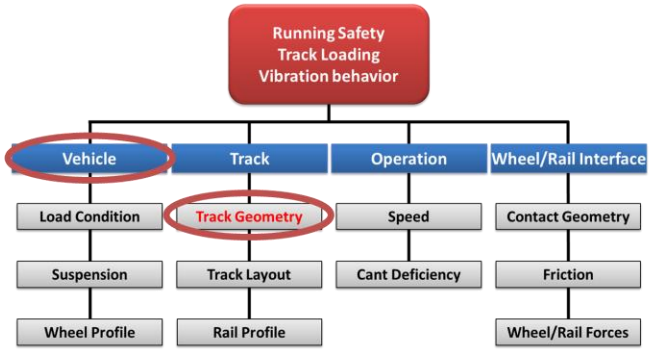
- Develop validated computer models of freight and passenger rail vehicles to study dynamic response for speeds up to 220 mph.
- Currently working on developing validated tank car computer model including the effects of liquid slosh on vehicle dynamics on Track Classes 1 through 5.
- Perform parametric studies using computer modeling to study the relationship between vehicle performance, track geometry, and derailment safety.
- Use model results to identify safe operating speeds, maximum allowable track geometry deviations, and other operating conditions needed to minimize the risk of derailment.

RAILROAD IMPACT

- Help provide an infrastructure that supports a variety of vehicles for speeds up to 220 mph.
- Address derailment safety concerns and support industry's needs in terms of identifying safe track geometry limits and procedures used for assessing the performance of new rail vehicles from a derailment safety standpoint.
- Working with industry to develop a tank car model suitable for examining the response of tank cars to track geometry deviations with the inclusion of sloshing effects to examine effects of combined track geometry deviation on vehicle performance.

VTI Safety – Track Geometry

- Safety limits - maximum allowable track geometry variations
- Identify conditions that require immediate attention
- Help provide an infrastructure that supports a variety of vehicles



PROJECT PARTNER(S)

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $400,000
- Project Duration: June 2018 – May 2020

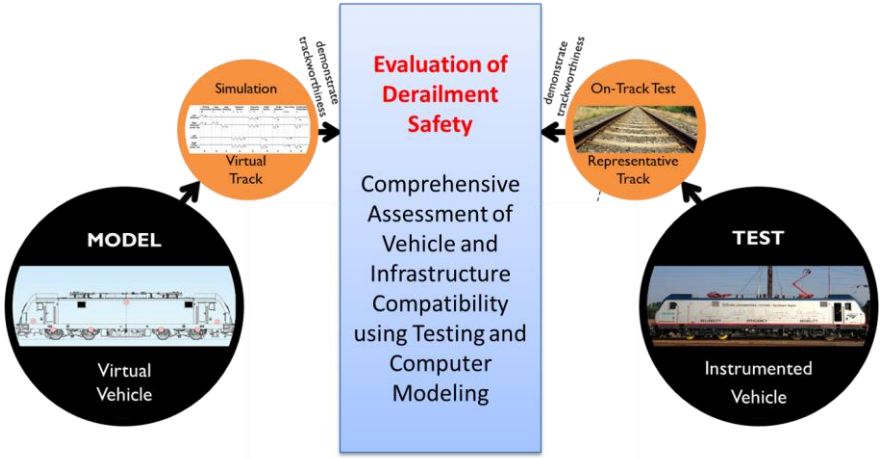
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Support of FRA Office of Railroad Safety

PROJECT DESCRIPTION

- Review test plans submitted for qualification testing and pre-revenue service acceptance testing.
- Develop and update new procedures for assessing safety of rail vehicles, including existing designs imported to North America, prior to usage in revenue service and taking advantage of state-of-the-art computer modeling and testing.
- Analyze data collected during physical testing as well as data from simulations from vehicle qualification process.
- Assist in derailment investigations.



RAILROAD IMPACT

- Review of qualification testing results identifies potential safety concerns which can be addressed before revenue service.
- Simulations included in qualification process provide a standardized procedure for vehicle manufacturers to examine the dynamics of a new design intended for the North American railroad operating environment.
- Derailment investigation can identify root causes of accident and potentially prevent future accidents.

PROJECT PARTNER(S)

- Volpe National Transportation Systems Center

COST & SCHEDULE

- Funding: $400,000
- Project Duration: June 2018 – May 2020

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Modeling of Wheel/Rail Friction Modifier

PROJECT DESCRIPTION

- To develop a wheel/rail creep force model that incorporates the effects of the third body layer or top of the rail (TOR).
- Develop a wheel/rail creep force model that incorporates effects of the third body layer or top of the rail (TOR) friction modifier
  - Collect data on TOR products, operating practices, contact and surface conditions.
  - Conduct tribological tests to determine creep stress relationships for a range friction modifiers and contact and surface conditions for inputting to model.
  - Develop the model and its parameters.

RAILROAD IMPACT

- With integration of model into Vehicle-Track Interaction simulations, a tool that can help define TOR product choice and application protocols.
- Provide more accurate force prediction that will improve vehicle dynamics, wear and rolling contact fatigue (RCF) assessments.
- Experimental tests for benchmarking TOR products performance.

PROJECT PARTNER(S)

- University of Sheffield
- L.B. Foster Rail Technologies, Corp. (LBF)
- Virtual Vehicle Research Center (ViF)

COST & SCHEDULE

- Funding: Phase I (12 months) – Approx. $300,000
- Project Duration: September 2017 – December 2018

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

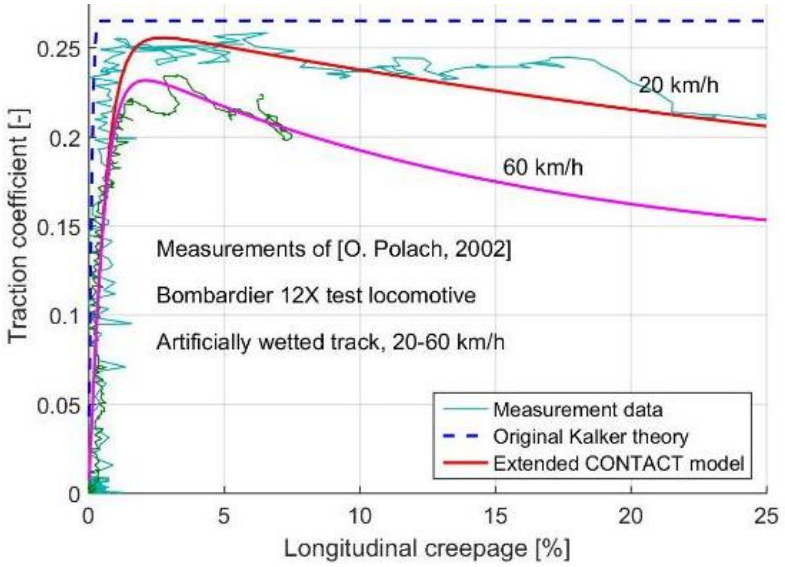
Advanced Modeling of Wheel/Rail Friction Phenomena

PROJECT DESCRIPTION

- Improve the friction modelling approach in the Extended CONTACT model.
- Validate the model against available measurements.
- Improve physics-based modelling.
- Integrate the model in the main Vehicle-Track Interaction (VTI) simulation packages.

RAILROAD IMPACT

- Our simulation technology will improve computer simulation of:
  - The influence of humidity on vehicle stability.
  - The influence of falling friction on flange climb derailment.
  - The influence of friction modifiers on curving behavior, traction control and energy efficiency.
  - The loads exerted on the track, in a wide range of circumstances.



PROJECT PARTNER(S)

- VORtech BV

COST & SCHEDULE

- Funding: $225,000
- Project Duration: March 2017 – March 2019

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Track Geometry and Vehicle Performance

PROJECT DESCRIPTION

- To improve tank car model, FRA purchased tank car DOT-117A100W1 for performing vehicle characterization and on-track tests.
- Conduct full-scale tank car tests on the Transportation Technology Center's (TTC's) test tracks, including High Tonnage Loop (HTL), Precision Test Track (PTT) and Wheel/Rail Mechanism (WRM) loop and Railroad Test Track (RTT). For the loaded condition, crude oil is to be used as lading choice. Data acquired from the various tests will be utilized for tank car model improvement.

RAILROAD IMPACT

- On-track testing for empty and loaded conditions of a DOT-117 tank car to better understand its dynamic behavior and to provide critical data for improving the NUCARS® tank car model developed under Phase I of the project.
- Use of crude oil as the lading choice for the loaded condition testing helps determine the sloshing effects of crude oil.
- The improved tank car model can be reliably deployed to enhance applicable track geometry limits for safer tank car performance.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: $962,862
- Project Duration: September 2016 – March 2019

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

Adjustable Precision Curved Track Anomaly Test Section

PROJECT DESCRIPTION

- Track geometry measurement validation and vehicle-track interaction testing are critical functions for safety and operations of railroads, especially for high-speed passenger trains.
- This project will design a curved test track section on the high-speed test track at the Transportation Technology Center (TTC) where geometric track anomalies can be installed and adjusted.
- Curved test track section will supplement the existing tangent test track section previously built at TTC.

RAILROAD IMPACT

- Track geometry testing is a critical function for safety and operations of railroads, especially for high-speed passenger trains.
- For high-speed passenger rail, the track anomaly test section will provide a unique testing platform where vehicle-track interaction modeling simulations can be validated, and existing and new technologies can be tested.
- This track section can be used to validate a track geometry measurement system.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: FY19 $441,000
- Project Duration: October 2018 – January 2020
  - Conceptual design and 30% design plans
  - 60% and 90% design and final construction bid document preparation

U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Ali Tajaddini • (202) 493-6483 • ali.tajaddini@dot.gov

US – China Railway Technology Exchange

PROJECT DESCRIPTION

- Facilitate communication with Chinese counterparts in organizing and participating in the annual Transportation Forum held in the US and China.
- Facilitate technical exchanges with China in the areas of track inspection and maintenance standards, track structure for high-speed rail (HSR), use of risk analysis for safety assurance, transportation capacity simulation for HSR networks, and vehicle qualification.
- Organize rail technology and standards exchange meetings and technical visits.

RAILROAD IMPACT

- Enable technical exchanges especially on high-speed rail infrastructure and equipment inspection and maintenance.
- Enhance FRA's presence at the US – China Forum.

PROJECT PARTNER(S)

- Transportation Technology Center, Inc. (TTCI)

COST & SCHEDULE

- Funding: FY18 $30,000
- Project Duration: 2012 – 2019

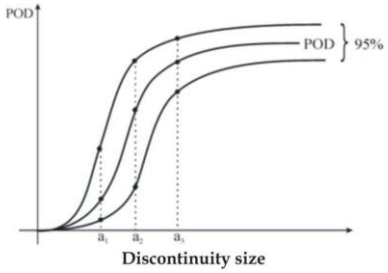
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Luis Maal • (719) 584-0551 • luis.maal@dot.gov

Evaluation of Track Inspection Technology Effectiveness

PROJECT DESCRIPTION

- Focus on the development of a general approach to quantify the effectiveness of track inspection technology.
- Conduct a comprehensive literature survey to identify available performance measures or evaluation methods employed in other fields and applicable to existing and emerging inspection technologies.
- Formulate the requirements for evaluation methods to address the gathered data, ground truth, sample sizes and acceptance criteria.
- Characterize effectiveness of Track Geometry Measurement Systems (TGMS) to illustrate the selected evaluation procedure.



Actual Class \ Predicted class	P	N
P	True Positives (TP)	False Negatives (FN)
N	False Positives (FP)	True Negatives (TN)

RAILROAD IMPACT

- Establish confidence in the effectiveness of new inspection technologies, thereby facilitating its adoption for regular use in safety assurance.
- Lay the groundwork to standardize the evaluation of effectiveness of existing and emerging track inspection technologies.

PROJECT PARTNER(S)

- ENSCO, Inc.

COST & SCHEDULE

- Funding: $124,000
- Project Duration: July 2018 – May 2019

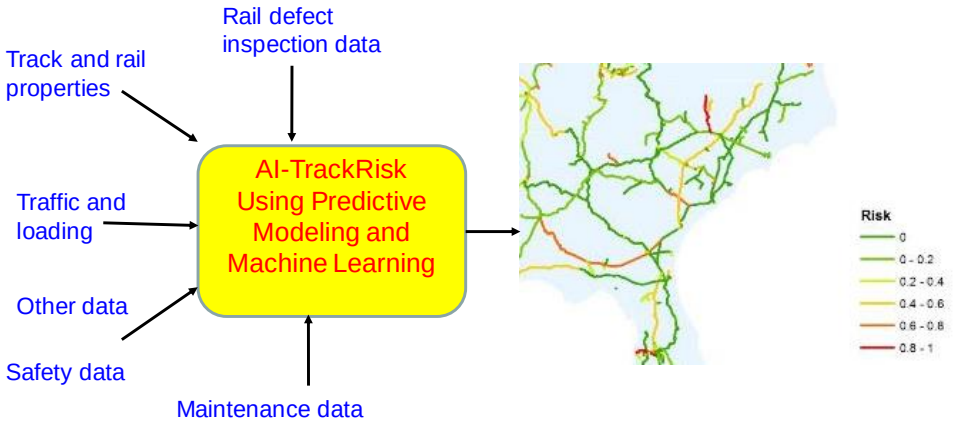
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Jay Baillargeon • (719) 584-7155 • jay.baillargeon@dot.gov

Artificial Intelligence Aided Track Risk Analysis (AI-TrackRisk)

PROJECT DESCRIPTION

- Develop an Artificial Intelligence (AI) Aided Track Risk Analysis (AI-TrackRisk) tool, focusing on rail failures at this stage.
- AI-TrackRisk is an intelligent computer system that can automate track data modeling, predictive analytics, and risk analysis, ultimately supporting optimal track inspection and maintenance decisions.
- AI-TrackRisk can be a "brain" of a "virtual risk analyst" to automatically turn volumes of track-related data directly into risk predictions and decision-making.



RAILROAD IMPACT

- Provide the industry with an innovative map-based decision-making tool to perform track data integration, statistical modeling, and risk prediction automatically, enabled by machine learning techniques.
- Acquire new knowledge and tools pertaining to how AI can be used to support track data analysis and risk management.

PROJECT PARTNER(S)

- Rutgers, The State University of New Jersey
  - Civil & Environmental Engineering Department
  - Computer Science Department
- CSX

COST & SCHEDULE

- Funding: $345,651
- Project Duration: August 2018 – August 2020

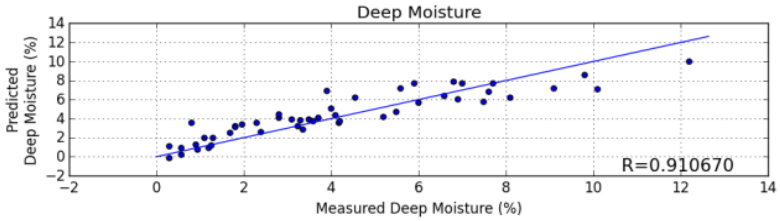
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Jay Baillargeon • (719) 584-7155 • jay.baillargeon@dot.gov

Moisture-Sensitive Ballast Fouling Measurement Tool

PROJECT DESCRIPTION

- Develop a man-portable, automated instrument to non-invasively determine fouling condition (i.e., "RABIT", or **RA**dar **B**allast **I**nspection **T**ool).
- Collect field data on outdoor test track and revenue service track.
- Compare ground-penetrating radar (GPR) results with geotechnical laboratory analysis results to show validity of the technique.
- Investigate relationship between ballast condition and ballast performance (i.e., strength).



RAILROAD IMPACT

- Provide real-time fouling measurement; no post-processing required, which eliminates the need for highly trained personnel to interpret the results.
- Plan maintenance based on fouling measurement and relationship between ballast condition and ballast performance (i.e., strength).
- Provide railroad personnel with an automated solution that allows for track to be inspected on their schedule and to spot-check problem areas.

PROJECT PARTNER(S)

- Earth Science Systems, LLC
- BNSF
- University of Massachusetts at Amherst
- Volpe National Transportation Systems Center
- FRA Office of Railroad Safety (Region 7)

COST & SCHEDULE

- Funding: $468,625
- Project Duration: July 2016 – January 2019
  - ASTM Ballast Testing Symposium: January 2018
  - Live-Track Testing with BNSF: January – March 2018
  - Additional Field Testing at the Transportation Technology Center (TTC): September 2018
  - Field Evaluation with FRA Track Inspector: December 2018
  - Final Report: 2019

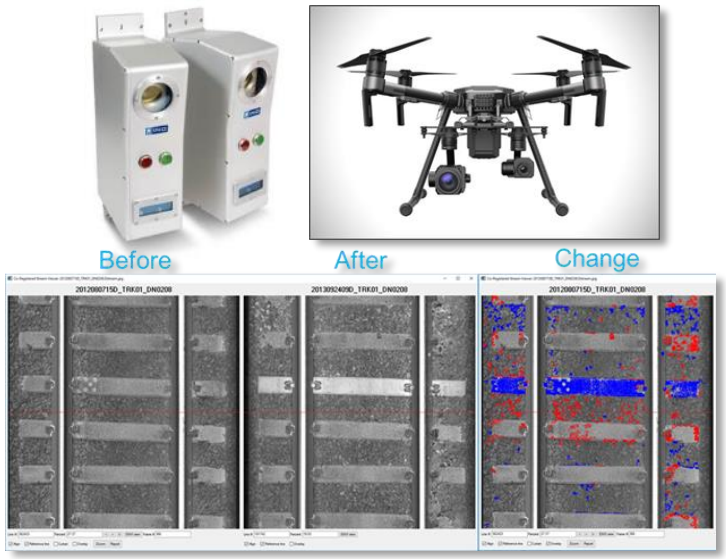
U.S. Department of Transportation
Federal Railroad Administration

FRA PROJECT MANAGER: Jay Baillargeon • (719) 584-7155 • jay.baillargeon@dot.gov

Automated Change Detection Technology for Track Inspection

PROJECT DESCRIPTION

- Leverage commercial hardware and software to create an automated change detection system applicable to the railroad track environment, capable of evaluating images against a baseline for relevant changes in the track structure automatically.
- Develop the technological framework for advancing change detection technology to a practical application for track safety assurance inspections.
- Explore alternative data collection methods for change detection, including unmanned aircraft systems (UAS).
- Results will be compiled and presented in reports and presentations to industry at large.



RAILROAD IMPACT

- Further development of automated vision- and laser-based inspection technologies that can automatically isolate areas of the track structure that have changed since the previous inspection.
- Investigation into and implementation of deep learning and artificial intelligence techniques that can accurately process associated data and report on areas of relevant change to railroad decision makers.
- Development of technologies that will supplement traditional walking or hi-rail track inspection activities for safety assurance.

PROJECT PARTNER(S)

- Pavemetrics Systems, Inc.
- ENSCO, Inc.
- Harris Geospatial Solutions, Inc.
- Noble Drone Services, LLC
- Amtrak

COST & SCHEDULE

- Funding: $345,651
- Project Duration: August 2018 – August 2020

U.S. Department of Transportation
Federal Railroad Administration

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