



Rail Transportation Program

Michigan Tech Transportation Institute • Michigan Technological University



Annual Report

Sept 2016 - August 2017



Michigan
Technological
University

Michigan Tech Transportation Institute



Rail Transportation Program Vision:

“Develop leaders and technologies for 21st century rail transportation.”

Mission:

“To participate in the development of rail transportation and related engineering skills for the 21st century through an interdisciplinary and collaborative program that aligns Michigan Tech faculty and students with the demands of the industry.”



Director's Message

The Rail Transportation Program (RTP) at Michigan Tech is getting close to celebrating its first full decade of existence and we are starting to see the first indication of our legacy. A growing number of Tech graduates are earning their stripes in the industry and we are welcoming many of them back to Tech as guest speakers, advisory board members, and (of course) recruiters. Adding to the cadre of rail alums, it is my privilege to recognize our first graduate with the recently established Rail Transportation minor. Since his graduation from the Department of Civil and Environmental Engineering (with Rail Transportation Minor), Otto Freiberg has launched his career with CN Railway. We wish all the best to Otto and his undoubtedly successful future in the rail industry. He will be a great example to those students who have already announced their plans to complete the minor (we already have quite a few) and beyond.



The research side of our enterprise has witnessed both successes and disappointments over the past year. Unfortunately, our National University Rail Center (NURail) consortium was unsuccessful in renewing its funding, but on the other hand, we were able to strengthen our relationship with the Federal Railroad Administration (FRA) through a multi-disciplinary research in improving grade crossing safety. Paul Sanders also continued our industry research collaboration with Amsted Rail. As usual, our students received recognition beyond university borders. Steven Landry was awarded the NURail Student of the Year honor, Darian Reed received one of the competitive Summer Undergraduate Research Fellowships (SURF), and Aaron Dean received one of the Undergraduate Research Internships (URIP) from Pavlis Honor College.

It is not a surprise that our activities in technology transfer and outreach have continued to receive great attention. The highlight of the year was our ambitious goal to combine the Michigan Rail Conference, Transportation Research Board's Summerail event and the NURail Annual Meeting into a single event – Midwest Rail Conference. Almost 250 academics, industry representatives, government officials, and rail enthusiasts gathered in Kalamazoo, Michigan to discuss the latest trends, challenges, and opportunities in the rail transportation. A younger group of enthusiasts gathered in Houghton a month earlier to participate in the 7th annual Summer Youth Program in Rail and Intermodal Transportation. I think we can comfortably say that RTP is doing its fair share in increasing the visibility of rail transportation across stakeholder groups.

I hope this foreword has convinced you to continue reading this annual report. We thrive for consistency and continuity and try to remind our partners about their importance. One would expect that after ten years, our rail program would run on its own, but in reality, it seems that successes are forgotten quickly and every year brings along old and new challenges. This report is a testament that we haven't only survived another year of challenges, but once again mastered in turning them into successes that our faculty, staff, and especially students can be proud of.

~Pasi



Rail Transportation Advisory Board

The Rail Transportation Advisory Board (RTAB) remains a key contributor to the RTP's success. 2016-2017 saw the first change in the leadership of the Board, as Matt Glynn passed the baton to Martita Mullen. We also continued adding some new members, while unfortunately losing Richard Stewart to other activities. Thank you Richard!!

In addition to guiding yet another successful organization of our 3rd Rail Day and Expo and Railroad Night XII, the RTAB started looking into breaking down to smaller working committees as a way to bring more concentrated effort to our activities. We will get the Membership, Content, Financial, and Rail Day Expo committees running in full speed in 2017-2018. RTAB members for this reporting period and their company affiliations are presented below. The RTP wants to thank all the Board members for their indispensable guidance in the continuing development of the Program.



Martita Mullen
Chair
System Manager, Track Standards, CN



Tim Hoeffner (CE, '80)
Vice-Chair
Director, Office of Rail, MDOT



Brent Marsh (CE, '09)
Secretary/Treasurer
Watco Companies



Pasi Lautala (CE, '97 & '07)
Associate Prof., Director, Rail Trans. Program, MTU



Tim McKay (CE, '84)
Executive VP of Growth & Regional Development, DART



Matt Glynn (CE, '81)
Chief Engineer, Signals & Communications, CN



Kevin Kesler
Secretary/Treasurer
Chief of Rolling Stock R&D, FRA



Jon Cool
President, Michigan Railroads Association



Beau Ihnken (ME, '11)
Shop Supervisor
Loram Maintenance of Way



Brian Sykes
Chief Engineer, C&S Engineering, NS Railroad



David Thomson (CE, '83) President, Engineered Rail Solutions, LLC



Rob Bingham (BA, '06)
Marketing Manager, Midwest Region, Genesee and Wyoming, Inc.



Aaron Dean (ME, '18)
REAC President, MTU



2016-2017 Program Partners:



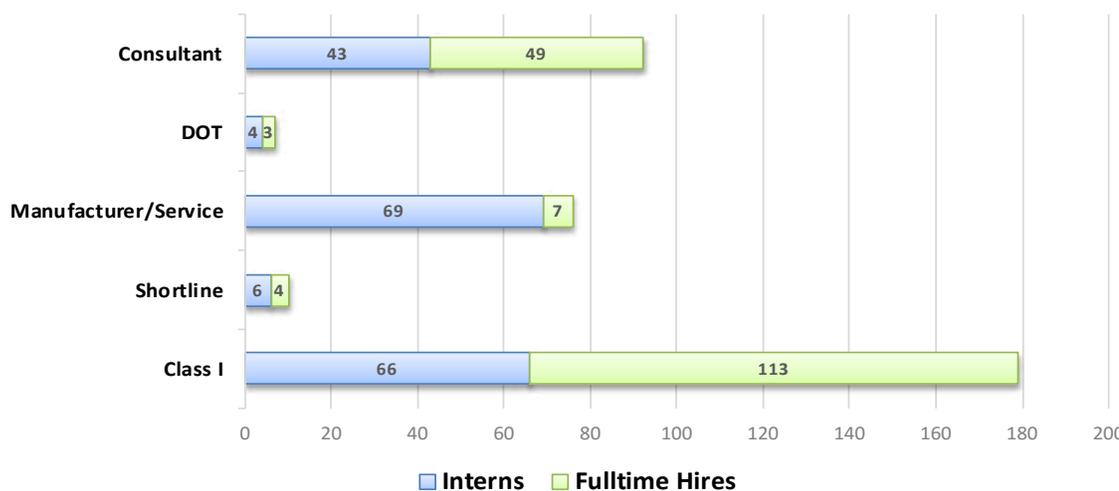
Thank you for your generous support in 2016-2017!

Rail Industry Partners and Supporters

In its role as Program Partner, CN Railroad continues to be a core enabler for the Rail Transportation Program. 2016-2017 saw an increase in our internship/full time recruitment coordination and we continued discussions to expand collaborative research efforts as well.

Besides CN, we want to thank again all other companies who take their time and bring their expertise to campus, either as part of Rail Day / Expo or as one of the numerous guest speakers that visit us annually. Without their commitment, it would be hard to demonstrate to our students, how success in the industry looks like.

Students Placed in Industry 2004 - 2017



2016-2017 continued our solid trend in internship and full time hires by the rail industry. Interns and full time hires combined, Michigan Tech has introduced over 200 students to the rail industry jobs over the past decade... with many of them continuing along their career paths today.

SIR Strategic Internships in Rail

The Strategic Internships in Railroads (SIR) partner program for interested rail industry companies began in 2012. The mission of the SIR program is to create continuous and consistent internship opportunities that introduce RTP students to the rail industry environment and promotes the value of RTP students to rail industry companies. Through their work, the interns actively contribute to advance the company objectives and goals.

2016-2017 SIR Companies with interns:





RTP Faculty & Staff



Dr. Pasi Lautala, P.E.

Dr. Lautala is the Director of the Rail Trans. Program and an Associate Professor in the Civil and Environmental Engineering Department. For past ten years, Dr. Lautala has been one of the leaders in re-establishing rail transportation education and related research in North American universities. He's an Associate Director of Education for the NURail Consortium, one of the seven members of the State of Michigan Commission for Logistics and

Supply Chain Collaboration and Chair of TRB ARO40 Freight Rail Transportation Committee. Since the fall of 2016, Dr. Lautala has also served as the Director of Michigan Tech Transportation Institute. Before his academic career, Dr. Lautala spent several years in the rail industry in the United States and Finland.



Dave Nelson, P.E.

David Nelson is our Senior Research Engineer and supports activities across the program. Dave has a BS in Civil Engineering and an MS in Mechanical Engineering which will help as we continue to push for multidisciplinary collaboration across the university. He also has an MS in teaching, including seven years of experience in primary and secondary schools. Dave's 20+ years of engineering and management experience with the

US Air Force, including a tour teaching at the US Air Force Academy, and his experience from the rail related projects with Maine Department of Transportation bring a unique set of skills and experiences to our program. Dave is actively involved in TRB's Highway-Rail Crossing Committee and AREMA's Committee 24, Education and Training.



Dr. Bill Sproule, P.E.

Bill Sproule is a Professor in the Department of Civil and Environmental Engineering with over 40 years of service in government, consulting, and university research and teaching in Canada and the U.S. He assisted in the development of the current Rail Transportation Program at Michigan Tech and teaches various transportation courses. Dr. Sproule's interests include transportation planning, traffic engineering,

airport planning and design, public transit, automated people movers, and consulting engineering. Canadian born and a true ice hockey fan, Bill also teaches a class titled "Hockey History and Culture". Dr. Sproule has been recognized with several awards including a Michigan Tech Distinguished Teaching Award and the ASCE Horonjeff Award.



Kuilin Zhang

Kuilin Zhang is an Assistant Professor in the Dept. of Civil and Environmental Engineering at Michigan Tech. Dr. Zhang received his Ph.D. degree in Transportation Systems Analysis and Planning from the Department of Civil and Environmental Engineering at Northwestern University in December 2009 and came to Michigan Tech after working as a Postdoctoral Fellow in the Transportation Center at Northwestern and the Energy Systems

Division at Argonne National Laboratory. He is a member of Transportation Research Board (TRB) standing committees of Transportation Network Modeling (ADB30) and Freight Transportation Planning and Logistics (AT015). He directs a high-performance computing Laboratory on Sustainable and Intelligent Transportations (SITS-Lab), and teaches transportation planning and transportation systems analysis.



Hyungchul Yoon

Hyungchul Yoon is an Assistant Professor in the Department of Civil and Environmental Engineering at Michigan Tech. He received Ph.D. in civil engineering from the University of Illinois at Urbana-Champaign in 2016, focused on "Enabling Smart Cities: Post Disaster Response and Structural Health Monitoring". His research interests include developing smart sensing technologies including smartphones and unmanned

aerial vehicles (UAVs) for managing and monitoring civil infrastructure systems. Dr. Yoon has participated in multiple projects on railroads, especially to monitor railroad bridges by measuring the vibration response under in-service loads using wireless sensors and cameras attached to UAVs.



Chris DelReal

Chris DelReal is a 2010 graduate of Michigan Technological University's Computer Networking and System Admin. program. He now works with Michigan Tech's Tribal Technical Assistance Program as a web designer, technical advisor and code developer. Chris supports RTP's web services and developed the Rail Learning System to offer online railway engineering education resources.



Pam Hannon

Pam Hannon is the Coordinator of the Michigan Tech Trans. Institute and supports the Rail Trans. Program through proposal development and coordination, and research project management.



Amanda Kerttu

Amanda Kerttu has been working with RTP on a part-time basis since 2015. Her main responsibilities have included the logistics coordination and management for the Michigan/Midwest Rail Conference and development of RTP publications and promotional materials.



Student Intern/Co-op Highlights

RTP helped to place several students into rail industry internships in 2017. The following students had internships in 2017: Jackson Maslowski (CN), Katie Tigges (CN), Nathan Goering (CN), Haylee Lakenen (BNSF), Derek Owen (WSP), Aaron Dean (Pettibone), Clarice Hill (Loram), Mario Marachini (Remprex) and Alyssa Leach (UPRR). Some highlights are below.

Katie Tigges, Jackson Maslowski & Nathan Goering (CN)



Katie: This past summer I worked for Canadian National Railway (CN) as a track intern. I worked out of their US headquarters in Homewood, IL. I was lucky enough to travel to a few other locations from Superior, WI to Chiles, KY to work on a wide variety of projects. During my internship, I had the opportunity to work on estimating, speed increase projects, utility permit filing, and strain gauge testing. My main supervisor was an incredibly busy man so I mainly work for who ever needed help. The summer had some fun adventures and I got to meet some amazing people.



Jackson: This summer I worked with the design team for PTC as opposed to my previous summer where I worked out in the field for the signals department. I used Microstation to design track plans, route and aspect plans, crossing plans, control point plans, and other design work. This also included updating plans and verifying they were installed in the field correctly by going to cutovers. I also traveled a bit, going from Michigan subdivisions to Indiana, Chicago and down to Hammond, Louisiana to ensure proper installations.



Nathan: I spent the summer working as an intern in the CN Mechanical group to develop a program for monitoring the health of CN's fleet of railcars. I summarized cars by their purchase series, and gathered data for car expenses and distances traveled. I wrote a program which compiled this information and assigned scores through time for each car in a number of categories, which could then be easily compared to other railcars. The program will be used by asset managers and engineers throughout the CN network to evaluate trends and inform purchasing and maintenance decisions.



Haylee Lakenen (BNSF)



Haylee's internship with BNSF was based out of Galesburg, IL under the Chicago Division Engineer with a focus in track maintenance. She worked alongside Roadmasters, Foremen and Track Inspectors in the field to understand the work required to complete a project, day-to-day activities and to gain hands-on experience. She participated in the installation of track panels, a crossover panel and an overpass for three main lines; witnessed a surfacing gang, a rail gang, an undercutter gang, and a rail grinding train. Throughout the internship, she also gained experience with signals, transportation and structures. It was a great learning experience and she will be continuing with BNSF after graduation.



Alex Christmas (Quandel)



I was thrilled to intern at Quandel Consultants for the summer of 2017. Quandel specializes in railroad engineering solutions, so it was great to get right into my field of interest. I worked primarily on the Chicago-Quad Cities Passenger Rail Project, working on Grade Crossing Designs for the corridor. I spent most of my time working in Microstation, so I was able to focus on the development of my computer-aided drafting skills while getting my feet wet in Civil Design. It was an absolutely fulfilling experience that I will continue to build upon and recall with great reverence for years to come.



Aaron Dean (Pettibone Traverse Lift, LLC)

This past summer, I was able to obtain an internship working with Pettibone Traverse Lift, LLC, of Baraga, Michigan. With having past experience working for one of their customers (CN Railway), I was assigned to work on the Speed Swing product line. The Speed Swing



is a multi-purpose hi-rail crane built specifically for rail maintenance-of-way and track construction. My responsibilities consisted of minor design changes to improve the machine quality, updating technical drawings, and implementing some new designs of my own for improved safety and cost reduction. Working for Pettibone has given me valuable experience in the rail construction equipment industry and I have been able to remain with the company part-time during the school year.





Alumni Highlights

Brad Howard (ME, 2008)

Senior Data Scientist, Predikto

After graduating from MTU in 2008, I enrolled in graduate school at Texas Tech University pursuing my PhD in Mechanical Engineering with an emphasis in the modelling/simulation and optimization based prediction of dynamic systems. Graduating with a mechanical engineering degree from a Texas university, most of the opportunities are in Oil and Gas. In fact, I was set to accept a job offer in the oil and gas industry when I got a phone call from New York Air Brake (NYAB). At that time, I had no idea how big the rail industry was or what sort of jobs were available within it, but I took the interview out of curiosity. A few weeks later I accepted a job with Train Dynamics Systems Division with NYAB.

While at NYAB, I mostly focused on train dynamics and control, working as an R&D lead for multiple projects. Most notably, I helped lead efforts on an autonomous freight train project with Rio Tinto in Australia. I was tasked with continuous improvement and new development in both train dynamic simulation models and train handling/control algorithms.

Recently, I started working with a Predikto as a Senior Data Scientist, a predictive analytics company primarily focused on predictive maintenance for industrial assets in Transportation. I currently specialize in projects within the rail industry, to include locomotive health and failure prediction and the prediction of failures across different aspects of PTC.

Working in the rail industry for the past 5 years has been very rewarding. I have been able to work across multiple domains within the rail industry to include operations, safety, and IT/analytics. I have had the opportunity to travel all over the US, Australia, Brazil, and Germany. To me, the main advantage of the rail industry is its wide technical breadth, making it possible to be continually challenged.



Brad Howard



Dr. Ananyo Bandyopadhyay, P.E. (MS, ME 2011; PhD, MSE 2012)

Principal Investigator (Engineering), Transportation Technology Center, Inc. (TTCI)

During my four years of undergrad in Metallurgical Engineering at Jadavpur University in my hometown of Kolkata, India, I did an internship in a steel foundry where I worked on designing molds of locomotive wheels, side frames and bolsters of freight cars and worked in the metallurgy lab and steel melt shop. Then after my undergrad, I worked as a technical engineer in Vesuvius, India for two years before coming to Michigan Tech to pursue my MS and PhD. At Vesuvius, I worked on manufacturing of refractory used in continuous casting of steel. After my PhD, I joined Advanced Forming Technology (AFT) in Longmont, Colorado where I worked on manufacturing of precision metal parts through powder metallurgy and injection molding. I was doing research on manufacturing, sintering processes of various superalloys, stainless steels and other exotic materials. After working at AFT for 3 years, I was looking forward to doing more research with less involvement in the manufacturing industry. Thus, I pursued a career in railroad research at TTCI which brought me back to the rail industry after 12 years and I have been here for almost 3 years!

At TTCI, we have 52 square miles of area with over 50 miles of different test tracks with varying curvature and grades where cutting edge technological research takes place. The Facility for Accelerated Service Testing (FAST) at TTCI has a 2.7-mile loop where we have our own heavy axle load freight train that runs every night for more than half a year. The AAR sponsored projects include testing of latest generation rails, rail lubrication technologies at FAST and in revenue service of the different Class I freight railroads across USA and Canada.

I manage several projects at TTCI, including AAR sponsored research and commercial projects. My job responsibilities include data collection, failure and fatigue analysis, rail life modeling, metallography as well as writing technical articles for journals and magazines. Other engineers assist me in collecting data and conducting experiments. Often, I visit freight railroads and transit agencies when they have rail failure issues and they contact TTCI for solutions.

I cherish my memories at Michigan Tech and feel proud to be an alumnus. The education and tools I learned during my MS and PhD have paved the way for achieving continued success in my research. During my stay at Michigan Tech, I published six journal articles and numerous conference papers and that's something I still continue to do at TTCI.



Dr. Ananyo Bandyopadhyay





Recent Graduate Highlights

Rachel Klumpp (BS, BMGT, 2016)

Analyst - PTC (Positive Train Control) Operations Support (CN)

My job is focused on PTC implementation. I spend my days working with CN's operations and testing group participating on conference calls and working with the software build team. With the software team I work to compile all of the information they need (signals, switches, sidings, speeds, special operating conditions, etc.) into a set of checklists for specific geographic areas. I utilize hard and soft resources such as timetables, track charts, and SAP inquiries, and the knowledge of co-workers within my PTC team. These checklists will ensure all of the PTC components and processes are included in the final build. I devote half of my day to reviewing contracts CN has with other railroads and use CN's interactive railroad system map to pinpoint the locations of where we have a crossing with another railroad, where we maintain the signals and gates at a road crossing, where we have the right to access railroad tracks that don't belong to CN, and many other cases. The contracts can be challenging to decipher at times, as names of places, intersections, and roads have changed over time or the tracks may have been moved or removed completely. I am learning a lot, and my job keeps me on my toes!



Alex Lakenen (BS, ECE 2017)

Engineer Associate - Track Department (Union Pacific Railroad)

I recently started working with Union Pacific Railroad as an Engineer Associate in the track department. As a new engineering employee I am going through their Operations Management Trainee (OMT) Program which will last 12 months. In these 12 months I am training to become a Manager of Track Maintenance and have the opportunity to work with track inspectors and the various gangs across my service unit to become familiar with the territory and the daily tasks it takes to keep the railroad running smoothly. Through the training program we attend and complete several courses certifying us in mandatory trainings including FRA regulations, track inspector certifications, etc. In my two short months on the railroad I have learned a lot and am looking forward to the endless learning and career opportunities ahead.



John Promer (BS, ECE 2017)

Engineer Associate - Track Department (Remprex LLC)

After graduating in April '17, I accepted a job with the consulting firm I interned with the previous summer, Remprex LLC in their Engineering services department working with a few other MTU alumni. Since I started full time with them in June I have been doing a lot of construction management on various projects by myself and with coworkers. Some of these included pavement replacement and automated gate system installation. Part of the construction management entails monitoring contractor safety, quantity tracking, quality insurance and coordination via various channels.

While performing these job duties I have been learning different design decisions and how to best accommodate our clients' needs as they may change throughout the design and construction phases of the project. A key part of doing this has been the ability to ask questions and learn more on making different decisions, the reasons to justify them, and how to best implement them.





RTP Students

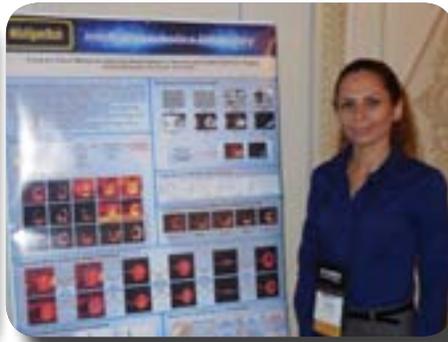
2016-2017 Graduates

Two students completed their projects and their MS degrees and one student completed her PhD dissertation in 2016-2017. RTP congratulates the graduates and wishes prosperous careers for all of them!!



Karl Warsinski
MS in Materials Science & Engineering

Evaluation of Thermal Stability of Austenite in Austempered Ductile Iron Using Differential Scanning Calorimetry



Hanieh Deilamsalehy
PhD in Electrical Engineering
Heterogeneous Multi-Sensor Fusion for 2D and 3D Pose Estimation Background



Soumith Oduru
MS in Civil Engineering
Life Cycle Assessment (LCA) of Ore Transportation Route Alternatives for Eagle Mine

Continuing Graduate Students

Sanpil Ko
PhD Candidate, Civil Engineering
Advisor: Dr. Pasi Lautala

Sanpil received his B.Sc. and MS degrees in Seoul, South Korea majoring in Transportation and Logistics. He worked for Korea Railroad Corporation (KORAIL) after graduation. The experience with this rail company led him to study more about transportation and railroad research. Sanpil is currently working with the PIRE Biomass project, funded by NSF. The title of this project is "OISE-PIRE: Sustainability, Ecosystem Services, and Bioenergy Development across the Americas". Most recently, Sanpil has concentrated on evaluating supply chain alternatives for biomass co-firing at existing coal power plants.

Steven Landry
PhD Candidate, Applied Cognitive Science and Human Factors

Advisor: Dr. Myounghoon Philart Jeon
Steven received his BA in psychology from Southeastern Louisiana University. He then worked at Louisiana State University's Visual Cognition Lab until he was accepted into the PhD program at Michigan Technological University studying Applied Cognitive Science and Human Factors, with a focus on auditory displays and data sonification. His dissertation investigates the relationship between movement, emotion, and sound through real time sonification of dancer gestures and physiological data. Steven is working on project funded collaboratively by the FRA and NURail to improve compliance and safety for drivers

at railway crossings. Steve is leading the research activities that use a driver simulator to investigate the actions of drivers as they traverse crossings.

Modeste Muhire
PhD Candidate, Civil Engineering
Advisor: Dr. Pasi Lautala

Modeste received his BS degree in Civil Engineering from California Baptist University in May 2012 and his MS from Michigan Tech University. After two years in the rail industry he returned to Michigan Tech for fall, 2016 to start his PhD studies related to grade crossing safety. Modeste is leading the driver behavior analysis at crossings that use SHRP2 Naturalistic Driving Study data.

Undergrad Student Researchers

Darian Reed is a second year Civil Engineering major and has worked with RTP since his freshman year. Darian has worked with RTP as an administrative assistant, but has also taken an increasing role in an ongoing FRA sponsored research project on railroad grade crossings. Darian has an extensive volunteering

background, including active participation in Operation Lifesaver and work with the Monroe County Historical Museum and the Monroe County Relay for Life program.

Aaron Dean is a senior in the Mechanical Engineering - Engineering Mechanics Department and the President

of the Railroad Engineering and Activities Club (REAC). Aaron has been working with RTP since his freshman year. For the past year he has concentrated on developing methods for analysis of the Naturalistic Driving Study data at grade crossings. For the summer 2017, Aaron worked as a summer intern for Pettbone.

Graduate Student Research Highlights

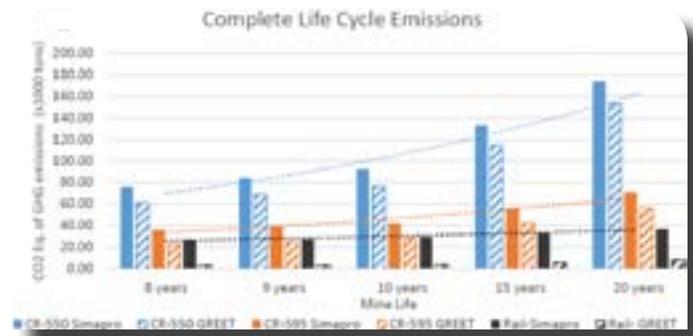
Soumith Oduru

Life Cycle Assessment (LCA) of Ore Transportation Route Alternatives for Eagle Mine

This research performed a comparative life cycle assessment of three different route alternatives for transporting copper/nickel ore from Eagle Mine, located in the Upper Peninsula of Michigan, to Humboldt Mill. The objective was to quantify and compare the potential environmental impacts of the transportation alternatives in terms of greenhouse gas emissions. The alternatives included the currently used highway route (CR-550), an alternative highway route (CR-595) considered in the planning stage of the mine, and a conceptual rail route designed at Michigan Tech for the purpose of this study.

The study estimated the potential greenhouse gas emissions from each route over various lifetimes. One variation (detailed LCA) covered the life cycle of all project components, including construction, operation and maintenance phases of infrastructure and vehicles. The other (simplified LCA) covered only the operation phase, including the life cycles of vehicles and fuels. The detailed LCA was performed using Simapro software in conjunction with the EcoInvent database, and the simplified LCA was performed using the Argonne Laboratories GREET model. One of the objectives was to investigate whether the simplified LCA could be conducted to reduce the resource demand without losing the integrity of the analysis outcomes.

From the results obtained we concluded that, from an emissions perspective, CR-595 is the better alternative among the two road options, but overall, the rail option is superior, especially for longer mine lives. We also observed that in road alternatives the emissions arising from the operation phase are higher than those from the construction and maintenance phases and increase exponentially with mine life. On the contrary, operation phase emissions are much lower than construction phase emissions in the rail alternative and only increase marginally with an increase in mine life. The rail option also offers the potential for additional movements of forest products by rail. Infrastructure and maintenance emissions either remain static or only increase moderately in all options.



Karl Warsinski

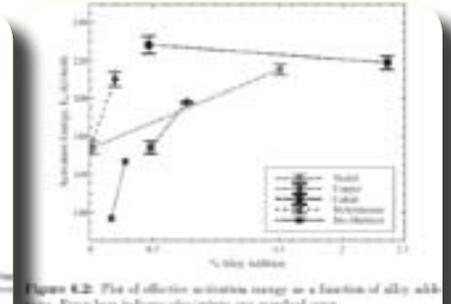
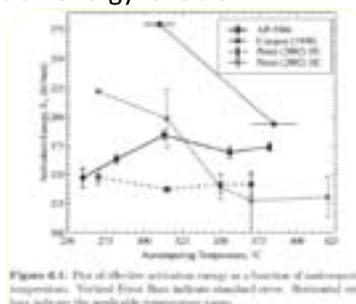
Evaluation of Thermal Stability of Ausferrite in Austempered Ductile Iron Using Differential Scanning Calorimetry

Austempered Ductile Iron (ADI) is an alternative worth consideration for railway applications, such as rolling stock wheels. However, it's prone to changes in microstructure and mechanical properties when exposed to elevated service temperatures which is a concern for railways. Differential Scanning Calorimetry has been used to evaluate the stabilizing effects of copper, nickel, molybdenum, and cobalt on the ausferrite structure. Previous studies have conflated the effects of various alloy additions, and little effort has been made to systematically catalog the effects of individual elements.

The focus of the current research has been to identify alloying elements that more strongly stabilize the ausferrite structure in order to improve service life of ADI at elevated temperatures. Nickel has been shown to have a moderate stabilizing effect, while copper and molybdenum cause a much sharper increase in activation energy. Cobalt has a high stabilizing effect at 0.5% addition by weight, but a further increase to 2.36% results in a slight decrease in activation energy.

Differential Scanning Calorimetry has been proven to be a useful tool for evaluating differences in the thermal stability of high carbon austenite in ADI. With relatively few scans, effective activation energies can be determined for comparison between alloys and heat treatments. The current study has indicated an increasing activation energy with increasing TA up to approximately 315°C, beyond which the activation energy levels off.

Each alloying element studied displayed a different effect on activation energy as related to alloy content. The low cobalt addition resulted in the greatest increase in activation energy, while a much higher cobalt addition results in a slightly lower activation energy (though still higher than the other alloys tested). Molybdenum showed the highest slope in activation energy vs. alloy addition, followed by copper, and finally nickel.





Student Activities

Railroad Engineering & Activities Club (REAC)



Every year, the Railroad Engineering & Activities Club (REAC) of Michigan Tech continues to build upon its goals to connect our students with the rail industry in no other way possible, and this past year was no exception. Through outreach events here on campus with our Railroad Night XII and 3rd Annual Rail Day Expo, to exciting field trips at rail industry facilities and yards, REAC has been busy and we are eager to share what we have been up to!

Chartered as the very first AREMA student chapter in 2006, this past year was celebrated as REAC's 10th anniversary as an AREMA student chapter. Today, there are over 20 AREMA student chapter organizations throughout North America. To help us celebrate, former AREMA President Brian Lindamood (Alaska Railroad), joined us for Railroad Night XII and gave the keynote address. On behalf of AREMA, Mr. Lindamood also presented REAC with a certificate of achievement in recognition of our tenth year milestone as an AREMA student chapter. For a complete summary of the event, see the next page.

Our monthly General Business Meetings (GBMs) have also been filled with great speakers from the industry. This year we had the pleasure of hosting presentations from the likes of: Clint Jones (Mineral Range Railroad), Cory Wyka (CN), Mike Larson (BNSF), Dave Thomson (Engineered Rail Solutions), Dan Schulte (Quandel), Ryan Hoensheid (MDOT), and Erik Czarnik (CN). These professionals shared their experiences working in the rail industry and offered valuable insight to our student members who are considering a career in rail.

Finally, our club has been on the road quite a bit this year. Thanks to generous industry support, we had the opportunity to travel all the way from Houghton to Orlando, Florida for the AREMA Annual Conference in September. Later that fall, our local field trip consisted of a visit to the Eagle Mine facilities in Humboldt, Michigan. We also had a chance to get our hands dirty; the Quincy Mine & Hoist Historical Society had us out for a work bee to help replace old ties along the cog railway that descends into the mine. In the spring, the Wisconsin Southern Railroad (WATCO Companies) invited us to Janesville & Madison, Wisconsin to tour their locomotive repair facility and explore recent bridge work they had completed along the line. These trips and volunteer experiences allow our students to gain valuable knowledge about the industry and help us to prepare for what we might expect as a young professional entering a career in rail.

Our club is continuing to grow, and we have increased our visibility on campus as one of the more recognized student organizations. Without the continued generous support from our program sponsors, the great things that we do would not be possible. Overall, REAC has had a very productive and exciting year, and we look forward to making the next year (or ten) equally rewarding.

Aaron Dean, REAC President



AREMA 2016



2017 Spring Trip



REAC - 10 Years as an AREMA Chapter... and Counting!

This year the Michigan Tech Railroad Engineering and Activities Club (REAC) celebrated 10 years as an AREMA student chapter. Past AREMA president, Brian Lindamood from Alaska Railroad, was on hand at Railroad Night XII to present the chapter a plaque commemorating the event. It's been a great run so far, REAC was born in 2005 when students from Pasi's Summer in Finland program lobbied to have a regular meeting time ... and field trips to rail industry sites. In 2006 REAC was chartered as the first AREMA student chapter. Since then activity has been non-stop! Spring field trips have included visits to Omaha, Chicago, Detroit, and Duluth. REAC has been represented at every AREMA conference, and REAC officers have been a major force in the development of the AREMA chapter program. Hundreds of students have participated in REAC events ... and the program is still going strong.



Duluth 2007



EMD Locomotive Plant - Chicago 2015

12th Annual Rail Night & 3rd Annual Rail Day Expo | September 22-23, 2016

The Michigan Tech Rail Transportation Program and Railroad Engineering and Activities Club (REAC) hosted another great opportunity for industries to interact with students from all disciplines across campus. This year's event took place on the campus mall, during the balmy September weather. We shifted the event to the weekend before the fall career fair to give students and industry a head start in discussing the opportunities the rail industry presents for jobs, intern-ships, and co-ops. Rail Day featured industry displays and presentations and a free lunch for students as they explored the many exciting opportunities available. Rail Industry Sponsors from eleven companies joined us to showcase all the rail industry has to offer, and to show our students that railroading is cutting edge, with jobs available for students from various disciplines!

Railroad Night XII held the preceding evening had special meaning this year, as AREMA formally recognized the 10th anniversary of REAC as the first AREMA chapter in the Nation. Railroad Night also featured Brian Lindamood from Alaska Railroad (the outgoing AREMA President) as our keynote speaker.



Keynote Speaker:
Brian Lindamood,
AREMA President



REAC officers with the "10 years of AREMA Student Chapter" plaque



Students engaged in conversation at Rail Day Expo



Students engaged in conversation at Railroad Night



Youth Activity Highlights

7th Annual Rail & Intermodal Transportation Summer Youth Program

July 9 - 14, 2017

Once again the RTP collaborated with the University of Wisconsin-Superior to host an outstanding group of students for a weeklong exploration of the rail industry and its connections to the rest of the transportation system. Fourteen students from five states traveled to Michigan Tech's campus, and engaged in a program of field trips and hands-on classroom activities ... with a few lecture sessions mixed in for good measure. The program visited facilities in the Upper Peninsula, and traveled to Superior WI and Duluth MN. Hands on work included building a scale model track section, working with maglev vehicles, and time working with a computer train simulation. We also introduced railopoly a new feature that had students moving Brio trains through a simulated rail environment to earn money, all the while learning about how signals, sidings, and other rail features affect the ability of trains to move through the system. As usual, the students had a great time, one student noted their favorite activity was, "... going to BNSF railyard because I have never got a behind the scenes look ... before." Although the most common response to the question, Five years from now what will you remember about SYP was some version of "the Friends I made", one student noted "Quite a lot, the locations, the lessons, and the people I've met".



Student & Youth Other Events

October 2016

Oct 28: 15 students from REAC attended an Eagle Mine Mill tour in Humboldt, MI

November 2016

Nov 12: 7 REAC students spent the day at the Quincy Mine Hoist Association helping to replace old ties on their cog railway line

February 2017

Feb 20: RTP Students participated in a Transportation Engineering After School Program

March 2017

Mar 16: REAC students participated in the STEM Festival

June 2017

June 28: Darian Reed and Dave Nelson worked with 16 Detroit HS students for an KBIC Middle School Engineering Activity at the GLRC

July 2017

Jul 9-14: Summer Youth Program, see article on left side of page



Above & left: SYP students attend field visits

Thanks to our field visit hosts: BNSF Railway, Halvor Lines, Lake Superior & Ishpheming Railroad, Midwest Energy Resources Co., and the Lake Superior Railroad Museum and North Shore Scenic Railroad!



2017 SYP Program Sponsors:



Transportation Engineering After School Program

February 20, 2017

On Feb 20th, David Nelson, Aaron Dean, Modeste Muhire and Smruti Dash conducted a rail activity in support of the Transportation Engineering After School program for students in Grades 1 and 2. Fourteen students had a blast learning a little about trains and playing with our Brio rail and maglev train sets!



Students using the train sets

Awards & Scholarships



Steve Landry

NURail Student of the Year

Steven Landry, PhD student in Applied Cognitive Science and Human Factors, was selected as one of the NURail students of the year. As a result he went to the annual TRB conference with Pasi in early January. While there he presented the results of his research on In-Vehicle Auditory Warning Systems to the TRB Rail Crossing Committee (AHB60).

RTP Students Awarded Fellowships

Two of our REAC students/undergrad assistants won prestigious awards on campus this spring! Darian Reed was selected for a Summer Undergraduate Research Fellowship (SURF) with his proposal to compare head-tracking data from the Naturalistic Driving Study with similar work in the driving simulator at Michigan Tech. Aaron Dean was selected to continue work started in last year's SURF with a new award through the Undergraduate Research Internship Program (URIP). Both students work will aid with our research project looking at driver behavior at highway-rail grade crossings, using the data from the SHRP2 Naturalistic Driving Study. Congratulations



Darian Reed



Aaron Dean

Scholarship Winners

Each year the RTP offers internal scholarships funded by industry partners and students compete for AREMA scholarships including Michigan Tech Alum AREMA Scholarships.

AREMA Scholarships

Derek Owen	CEE	Committee 24 - Education & Training Scholarship
Aaron Dean	ME	Michigan Tech Alumni Scholarship
Alexandra Lakenen	CEE	Michigan Tech Alumni Scholarship
Alyssa Leach	CEE	Michigan Tech Alumni Scholarship
Modeste Muhire	CEE	Committee 12 - Rail Transit Scholarship

CN Michigan Tech Scholarships

Derek Owen	CEE
Haylee Lakenen	CEE

APTA Scholarship

Derek Owen	CEE	2017 Parsons Brinckerhoff/Jim Lammie Scholarship
------------	-----	--

**Congratulations to
all the winners!**



RTP Education

Rail Transportation Minor

Established in the fall of 2016, the Rail Transportation Program worked with Michigan Tech to create the Rail Transportation Minor. Open to students from all disciplines, students are required to complete our basic rail classes, a communications or leadership course and nine technical elective credits. The three focus areas to choose from include the Civil Track, Mechanical Track and the Electrical Track.

Due to the Rail Minor, Tech is also undertaking a reorganization of the rail related courses offered in the university. Introduction to Rail Transport (CEE 3490) will become the new core course to introduce all students to the railway transportation industry. It will also become the prerequisite for the second core course, Railroad Engineering (CEE 4404). As such, some of the materials from CEE 4404 will be transferred to CEE 3490, allowing a more in-depth coverage of topics in CEE 4404. The minor will also include interdisciplinary study in the form of Transportation Logistics and Management (OSM 4700) from the School of Business and Economic, a required course for all students regardless their discipline.

The introduction of the Rail Transportation Minor has received an enthusiastic response from the students. Several students have announced their intention to study toward the minor and in December, 2016, Otto Freiberg became the first graduate from Michigan Tech with the Minor. You can find out the details of Otto's career selection since his graduation below.

Michigan Tech's 1st Rail Minor Recipient

Otto Freiberg (BS, Civil Engineering with minor in Rail Transportation, 2016)

(Canadian National)

After graduating in December of 2016 with a Bachelors Degree in Civil Engineering and my minor in Rail Transportation, I took a position within the Positive Train Control (PTC) Design Department at CN Railway. My day to day has varied drastically and I've been fortunate to be in a position where I can learn from a number of mentors. A large portion of my work is done within Microstation, both updating existing designs and creating new designs for "dark territories". Being the designer on a number of projects has also allowed for field time, as I provide cut-over support to the locations under my design responsibilities.

Currently, my largest project is the surveying and updating of plans for many of the southern region's subdivisions. Due to FRA regulations, all designs must be kept up-to-date with what is existing in the field. Unfortunately, the movement towards PTC in combination with other changes require quite a few revisions to the designs. This project has been a great learning experience for managing multiple teams, as well as allowing me to see much of CN's



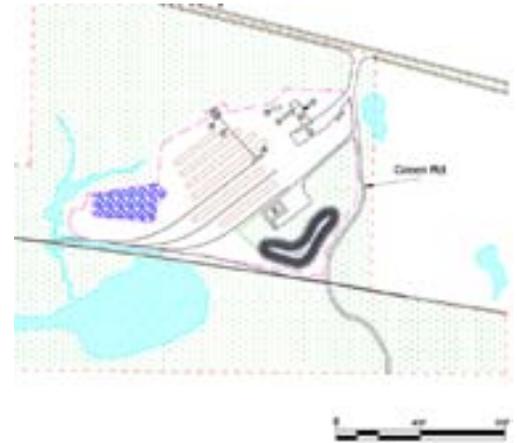
Student Projects

Student projects are an important part of RTP activities. RTP led two rail related civil/environmental senior design projects during the 2016-17 school year.

Peshekee Logyard Improvements

During the fall semester a team of 15 students worked on improvements to the Peshekee logyard owned and operated by J.M. Longyear, LLC. The main focus of the project was increasing log car storage from the current five car capacity to 25 cars, along with an operations plan for staging cars in the yard. The improvements also included a transload warehouse and loading dock, and a fuels transload facility to diversify operations on the site.

Their work included rail and highway transportation improvements, preliminary plans for a rail served transload warehouse and fuels transload area, and environmental permitting requirements for the proposed work. Suggested improvements included 3950 linear feet of trackwork valued at \$1.5 million, \$560,000 in site improvements, \$230,000 for equipment and tanks to support the fuels transload operation, and \$150,000 for the transload warehouse. An additional \$200,000 was recommended to procure a trackmobile to improve rail operations in the expanded site. Environmental costs were reduced by the team's recommendation for wetland preservation in place of more costly remediation methods.



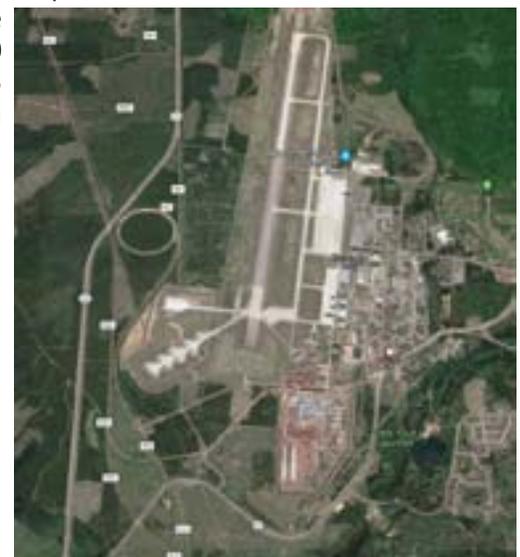
Peshekee Logyard Team and Site Plan

Sawyer International Airport Rail/Highway Access

During the spring semester fourteen students from the Civil and Environmental Engineering Department worked with Steve Schenden, Sawyer International Airport Director of Operations, and Eric Anderson, Manager of Planning, Community Development, Forestry & Recreation for Marquette County to provide conceptual and preliminary work on rail access to a proposed refinery site and rail and highway access to a proposed warehouse site.

The refinery access team recommended a new 3.5 mile loop track at a price of nearly \$9million. The warehouse team found that rail access would require \$6.5 million for the full build out. but a phased approach could bring initial construction down to about two miles of rail at \$4.5 million, with the remaining work completed as traffic at the warehouse site developed. Highway access and parking facilities for the new warehouse complex would require 3,500 linear feet of new roadway, and 160,000 square feet of new parking and support pavements at a price of nearly \$3.5 million. SAI also asked our environmental team to look at a recent study on PFC contamination on the airport site produced by the US Air Force Civil Engineering Center. The team produced a detailed report, including recommendations for additional testing and monitoring.

The project provided students with experience working on a real-world project. Airport and County representatives will use the student work as a base for discussions with prospective airport tenants.



SAI Refinery Team and Photo



Conference Highlights

AREMA 2016

August 28 - 31, 2016

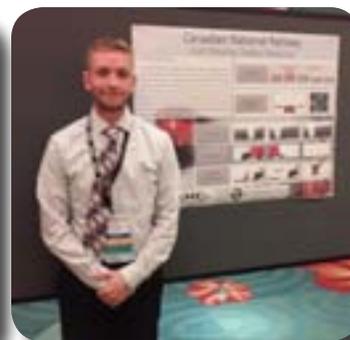
In late August, Dave Nelson and ten Michigan Tech students participated in the American Railway Engineering and Maintenance of Way Association's (AREMA) annual meeting. Four students presented their work in the poster competition and Aaron Dean won the first prize in the Undergraduate Division for his work on *"Using Naturalistic Driving Study Data to Understand Driver Behavior at Grade Crossings."* Derek Owen was the "people's choice" winner for presenting the poster on *"Improving the Cold Weather Rail Defect Detection."*

Aaron Dean and Nelson also presented a paper by Dean, Nelson and Lautala on *"Harnessing Undergraduate Students as Rail Industry Technology Developers/Problem-Solvers,"* and Nelson presented a paper by Jeon, Landry, Nelson and Lautala on *"Driver Behavior at Highway-Rail Grade Crossings Using Naturalistic Driving Study Data and Driving Simulators."*

The annual AREMA Conference Michigan Tech Alumni gathering was held on Sunday evening at the local TGI Fridays in Orlando. There was a small turnout, but a lively crowd of about fifteen participated.



Dave Nelson with David Becker



Derek Owen and his award winning poster

96th Annual Meeting of the Transportation Research Board

January 8-12, 2017

In January, Pasi Lautala and Steven Landry traveled to 96th Annual TRB Meeting in Washington, D.C. Lautala became the Chair of TRB AR040 Freight Rail Transportation Committee. He also presented a poster of the paper co-authored with Tyler Dick *"Railway Engineering Education Symposium: Evolving to Rebuild a Growing Rail Academic Community"*. Steven Landry received the UTC Student of the Year award and presented his research *"Getting Active With Passive Crossings – Investigating the Use of In-Vehicle Auditory Alerts for Highway-Rail Grade Crossings"* in the ABH60 Highway/Rail Grade Crossings committee meeting.



Pasi Lautala with Steven Landry at TRB

Joint Rail Conference

April 4-7, 2017

Pasi Lautala, Aaron Dean and Soumith Oduru attended the 2017 ASME/ASCE/IEEE 2017 Joint Rail Conference in Philadelphia, PA, April 4-7. Both Dean and Oduru received ASME scholarships to participate in the conference and altogether, RTP representatives presented four technical conference papers (see list of publications for details).



Soumith Oduru and Aaron Dean with Monique Stewart, the ASME Scholarship Chair at JRC 2017



Passenger Railway Engineering Education Symposium

July 10-12, 2017

Bill Sproule represented Michigan Tech at the July 2017 Passenger Railway Engineering Education Symposium at the LA Technical Trade College in Los Angeles. The Symposium was sponsored by AREMA and APTA and provided engineering faculty members with the opportunity to learn about the passenger rail industry. This year over 25 faculty from across the U.S. met for three days of lectures on the planning, design, and construction of intercity passenger and urban rail transit and discussions on teaching techniques and student project ideas. In addition to lectures, panels, and networking events, tours of LA transit projects were an exciting part of the symposium. Bill participated on panel sessions for "Starting a Program" and "Growing a Program in Rail Transportation" as he was able to contribute Michigan Tech experiences with our Rail Transportation Program.

Midwest Rail Conference

August 15-17 2017

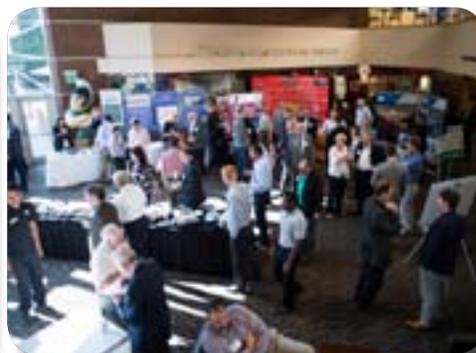
From Aug. 15-17 the Michigan Tech Rail Transportation Program (RTP) worked with Michigan Department of Transportation, the National University Rail Center and the Transportation Research Board Freight Rail Transportation Committee (AR040) to organize the inaugural Midwest Rail Conference.

Under RTP's leadership the planning committee that consisted of rail industry, government agencies, and other stakeholders interested in promoting the industry brought together more than thirty speakers and almost 250 participants in Kalamazoo, Michigan to focus on the conference theme, *Midwest Connections: Passenger and Freight Rail Look to the Future!* RTP Faculty, Staff and Students led the conference coordination and logistics. Dr. Pasi Lautala functioned as Conference Co-chair, David Nelson and Amanda Kerttu were the lead coordinators and six students (Aaron Dean, Darian Reed, Sangpil Ko, Alawudin Salim, Alex Christmas and Kyle Dick) came to Kalamazoo to assist....and to enjoy the conference.

The conference opened on Tuesday morning with a golf outing with proceeds going to the conference's student scholarship fund. Tuesday afternoon was filled with committee and organizational meetings, and the day was capped off with an evening reception at the Bell's Brewery Backroom that featured the Norfolk Southern Lawmen Band. Wednesday featured the technical content of the conference at the Western Michigan University Fetzer Center. The program included a dozen plenary and breakout sessions featuring industry experts in a host of passenger and freight rail topics. The keynote address was given by Joseph McHugh, VP of State Supported Services-Business Development for Amtrak. The event wrapped up with a full day of field trips featuring the MDOT/Amtrak Wolverine Higher Speed Rail Corridor, and a visit to the Little River Steam Railroad in Coldwater, Michigan.



Silver Lantern Award Recipients



Conference attendees visit sponsor tables during a break at the Midwest Rail Conference 2017.

Guest Speakers

/ Visitors

November 2016

Nov 8: Clint Jones from Mineral Range Railroad spoke to REAC about his experiences in the railroad industry, the Mineral Range Railroad, and shortline railroading in the Upper Peninsula

December 2016

Dec 6: Cory Wyka from CN talked with REAC about positive train control implementation on CN territory in the US.

February 2017

Feb 6: Henry Posner from the Railway Development Corporation presented to the OSM 4700 students

March 2017

Mar 14: Dan Schulte (Quandel) and Ryan Hoensheid (MDOT) presented Re-Engineering the MDOT Michigan Line to REAC

Mar 22: Casey Potts and Jordan Dantzer from Surveying Solutions, Inc. presented on their lidar work with the MBTA to REAC

April 2017

Apr 5: Joe Petrocik from Eagle Mine talked with the OSM 4700 class about Eagle Mine transportation logistics

Apr 11: Erik Czarnik from CN discussed with REAC his work with CN since graduating from Tech

Apr 12: Ken Filpus from MDOT was on campus to talk about MDOT projects with CE 4407 students



Other Events / Professional Development / Workshops

September - 2016

Sept 13-16: Pasi Lautala presented the biomass transportation logistics related work at the 2nd RCN Conference on Pan American Biofuels & Bioenergy Sustainability in Buenos Aires, Argentina

Sept 17-19: Pasi Lautala participated in the Intermodal Association of America (IANA) Annual Expo in Houston, TX

Sept 29: Pasi Lautala participated in the Commission for Logistics and Supply Chain Collaboration meeting in Lansing, MI

November- 2016

Nov 11: Dave Nelson participated in a workshop sponsored by the Association of Tourist Railroads and Railways Museums on rail camps and other K-12 student activities.

Nov 16: Pasi Lautala attended the Wisconsin Rail Day in Madison and gave an Invited talk on Michigan Tech's grade crossing research program

December - 2016

Dec 2: Dave Nelson visited Sawyer International Airport to discuss potential senior design projects

January - 2017

Jan 12-17: Pasi Lautala and Steve Landry attended the 96th TRB Annual Meeting in Washington, DC.

Jan 27: Dave Nelson and 14 senior CEE majors visited Sawyer International Airport for a senior design field trip

February - 2017

Feb 9-10: Dave Nelson and Aaron Dean traveled to Virginia Tech Transportation Institute to coordinate NDS data acquisition

Feb 23-25: Dave Nelson attended AREMA Committee 24 meeting in Jacksonville, FL.

March - 2017

Mar 16: Pasi Lautala participated in the Michigan Forest Products Council meeting on the future of Lake States Rail Lines in Escanaba, MI

Mar 17: Aaron Dean presented SURF and URIP work at the Undergraduate Research Symposium at Michigan Tech

Mar 29: Pasi Lautala attended a Commission for Logistics and Supply Chain Collaboration meeting, Lansing, MI

Mar 31- Apr 2: REAC Spring Field Trip to Janesville and Madison, hosted by Wisconsin Southern Railroad

April - 2017

Apr 4-7: Pasi Lautala, Aaron Dean and Soumith Oduru attended the Joint Rail Conference in Philadelphia, PA

Apr 20-21: Sangpil Ko presented a poster at the TRF Annual Forum in Chicago, IL

Apr 23-28: Pasi Lautala visited rail program at USC

May - 2017

May 14-19: Pasi Lautala attended PIRE annual meeting in Oregon

May 15: Dave Nelson visited with SAI and Marquette County staff to set up senior design project

May 17-18: Pasi Lautala attended the Innovations in Freight Data Workshop in Irvine, CA

May 24-25: Pasi Lautala attended the Commission for Logistics and Supply Chain Management in Lansing, MI

June - 2017

Jun 19-23: Pasi Lautala attended RIVIT Conference in Champaign, IL

August - 2017

Aug 14-15: Dave Nelson and Modeste Muhire presented during the FRA Crossing Needs Workshop in St. Louis, MO.

Aug 15-17: Midwest Rail Conference, see page 20 for details

National University Transportation Center

In 2012, the seven university consortium, including Michigan Tech, was awarded the first National University Rail Transportation Center (NURail) by the USDOT Research and Innovative Technology Administration (RITA). After 2013 competition, NURail also became a Tier-1 University Transportation Center.

The primary objective of the NURail Center is to improve and expand rail education, research, workforce development, and technology transfer in the U.S. The grant has supported various educational and student activities and projects covered in this report. Three projects were completed in 2016-2017 and one new project was started. Many of the projects receive (have received) complimentary funding from non-federal sources.



NURail Researchers



Tim Havens
-Associate Professor,
Dept. of Electrical &
Computer Engineering



Thomas Oommen
-Associate Professor,
Dept. of Geological
Engineering



Dr. Paul Sanders
-Associate Professor,
Dept. of Material
Science & Engineering



Myounghoon Jeon
-Associate Professor,
Dept. of Cognitive &
Learning Sciences



Pasi Lautala
-Associate Professor,
Civil & Environmental
Engineering

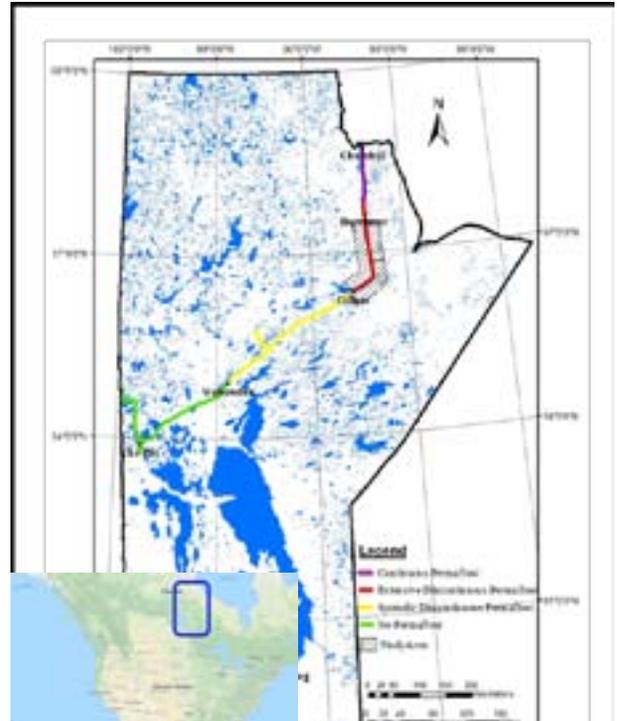
NURail

Completed NURail Projects

Rail Embankment Stabilization for Cold Climate Railroads – Case of Hudson Bay Railway (P.I. Dr. Thomas Oommen): This research project focused on evaluating the effects of permafrost thawing on the Hudson Bay Railway (HBR) track structure. HBR is located in the Canadian province of Manitoba, and connects The Pas near Lake Winnipeg with Churchill on the Hudson Bay. In recent years the rail line has suffered significant degradation as the underlying permafrost in some areas has become increasingly less stable. The project had three main objectives: 1) Define a rating system for severity of railway conditions in permafrost affected areas; 2) produce a “Best Practices Guide” to diagnose, document, and perform corrective actions addressing each severity rating; 3) investigate long term solutions for embankment stability. Literature review, field visits, and remote sensing data were all used to help define the problem areas.

The study revealed that major portions of the railway have permafrost that is on the borderline of thawing, and many areas are ice-rich, meaning that the underlying permafrost is interspersed with frozen chunks of ice, which get dissipated and create voids when thawed. This results in sinkholes manifested at the ground surface.

Several factors were identified that contribute to the permafrost thaw observed in the corridor. First, average air temperatures in the area have increased, leading to a deeper thaw each year. Second, poor drainage conditions lead to ponding of water near the track structure allowing the sun’s heat to more readily transfer to the underlying permafrost. Finally, wildfires in the study area have damaged the organic soil layer, leaving the underlying permafrost with less protection from summer heating conditions. The project developed a rating system for identifying areas with low, moderate, or high susceptibility to permafrost degradation. Although no final recommendation for stabilization was provided, several methods that have been used in other regions were discussed.



Location of the Hudson Bay Railway from The Pas to Churchill showing the varying permafrost conditions in the different colors.

Alloy Design and Testing of Austempered Ductile Iron for Rail Wheels (P.I. Dr. Paul Sanders): Austempered ductile iron (ADI) is a promising material for use in railway applications. ADI has been proposed for rail car wheels, but issues with changes in the microstructure of the material, especially when exposed to elevated temperatures, have prevented use for this application. This project investigated using a variety of alloys to stabilize the material. A more detailed description of the project is provided on Page 11.

Life Cycle Assessment (LCA) of Ore Transportation Route/Mode Alternatives for Eagle Mine (P.I. Dr. Pasi Lautala): This project continued the research initiated under Copperwood Mine case study and applied similar techniques for ore transportation options at the Eagle Mine in Marquette county. It also investigated whether a simplified LCA methodology could be applied for the analysis without jeopardizing the outcomes. A more detailed description of the project is provided on Page 11.

New NURail Project

Driver Behavior at Highway-Rail Grade Crossings Using NDS Data and Driving Simulators (P.I. Dr. Pasi Lautala):

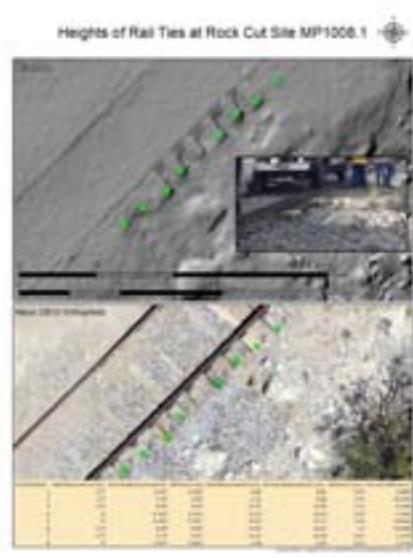
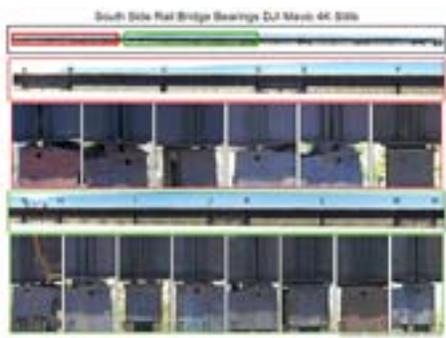
This project was initiated in September, 2016. The two-year project is collaboratively funded by the Federal Railroad Administration (FRA) and the National University Rail Center (NURail). A more detailed description of the project is provided in Page 22.



Research Highlights

Evaluating and demonstrating Unmanned Aerial Systems for railway infrastructure assessment in Texas

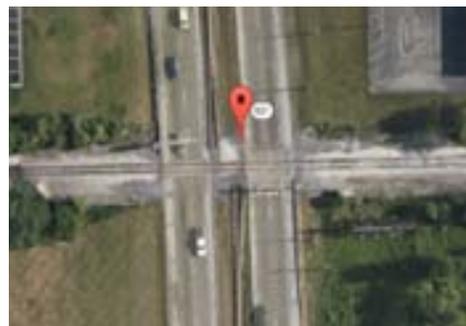
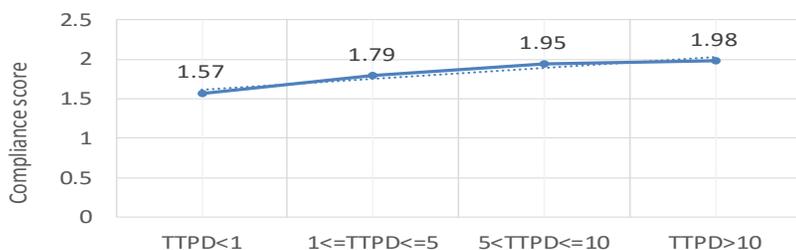
Advances in the capabilities of unmanned aerial systems (UAS) and sensors have made it easier to collect high-resolution remote sensing data to assess transportation infrastructure. In collaboration with the project leads at the University of Texas at Arlington (UTA), research scientists from the Michigan Tech Research Institute (MTRI) have been evaluating and demonstrating UAS sensing applications for the Texas Department of Transportation (TxDOT) at three sites during 2017. These have helped develop a UAS Flight Operations Manual for safe and effective use of UAS to meet TxDOT data needs. As part of the project, sites along a railway in southwest Texas were flown by UTA and MTRI scientists to map and assess a railroad crossing, a rail trestle bridge, a washout area, and a rock cut for a railroad undergoing rehabilitation to return to service. Evaluating crossing roughness, bridge fascia attributes, width of washout areas, and exposure of rail ties were all completed using these sites. Figure 1 shows a UAS-collected picture of the rail trestle bridge; UAS enabled rapid and safe collection of imagery over, alongside, and underneath the bridge. Figure 2 shows how the UAS-collected imagery was used to take photos of bridge bearings that could be evaluated for condition issues by bridge experts. Figure 3 demonstrates how the UAS imagery and height data (created using photogrammetry) was used to calculate rail tie exposure near an eroded area along a rock cut. Additional data analyses are planned and will be documented throughout the project.



Driver Behavior at Highway-Rail Grade Crossings Using NDS Data and Driving Simulators

In September 2016, RTP received a two year grant to study driver behavior at highway-rail grade crossings. The project will utilize data from the Strategic Highway Research Program, Naturalistic Driving Study (NDS) to document what drivers are doing as they approach crossings. The NDS provides access to sensor data for over five million trips completed between 2013 and 2015. The data includes speed, acceleration, brake, and throttle data that can be used to assess driver reaction to the traffic control devices currently in use at crossings. It also includes head rotation data that can be used to investigate driver looking behavior in the approach to crossings. Phase one of the project involves collection and analysis of the NDS data. Phase two of the project will tie the NDS results to our ongoing research using driver simulators at Tech. We will build scenarios found in the NDS crossings in the simulator, and compare driver behavior in the simulator environment with the behavior we observe in the NDS. Together these two research tracks should help us document drivers' actions at crossings, and give us an opportunity to investigate potential improvements.

Compliance score vs Total Trains Per Day





Publications/Conferences

Journal Publications

- Jeon, M., Landry, S., Lautala P., Nelson, D., Design and Assessment of In-Vehicle Auditory Alerts for Highway-Rail Grade Crossings, Transportation Research Part F: Psychology and Behaviour (under review since October, 2016)
- Lautala P., Dick T., Railway Engineering Education Symposium: Evolving to Rebuild a Growing Rail Academic Community, Transportation Research Record: Journal of the Transportation Research Board, No. 2608. (2017) DOI: 10.3141/2608-11
- Addison, P., Lautala, P., Oommen, T., Using Track Surface Roughness as a Quality Measure for Railway Maintenance in a Permafrost Region, Transportation Geotechnics (2016) <http://www.aimspress.com/article/10.3934/geosci.2016.4.329>

Conference Papers / Presentations

- Dean, A., Lautala, P., Nelson, D., Effectiveness of Using SHRP2 Naturalistic Driving Study Data to Analyze Driver Behavior at Highway-Rail Grade Crossings, ASME/ASCE/IEEE 2017 Joint Rail Conference, Philadelphia, PA, April 4-7, 2017
- (R) Oduru, S., Lautala P., Incorporating Life Cycle Assessment (LCA) in Freight Transportation Infrastructure Project Evaluation, ASME/ASCE/IEEE 2017 Joint Rail Conference, Philadelphia, PA, April 4-7, 2017
- (R) Muhire, M., Lautala P., Nelson, D, Dean, A., Selection of Representative Crossings Database for the Evaluation of Driver Behavior Over Highway-Rail Grade Crossings, ASME/ASCE/IEEE 2017 Joint Rail Conference, Philadelphia, PA, April 4-7, 2017
- (R) Deilamsalehy, H. Havens, T., Lautala P., Sensor Fusion of Wayside Visible and Thermal Imagery for Rail Car Wheel and Bearing Damage Detection, ASME/ASCE/IEEE 2017 Joint Rail Conference, Philadelphia, PA, April 4-7, 2017
- (R) Lautala P., Dick T., Railway Engineering Education Symposium: Evolving to Rebuild a Growing Rail Academic Community, Transportation Research Board 96th Annual Meeting of the National Academies, Washington, DC, January 8-12, 2017 (Accepted for presentation. Transportation Research Record publication pending submittal of final version)
- Ko, S., Fan, J., Lautala, P., Shonnard, D.R., Economic, Environmental, and Social Cost Optimization of Biomass Supply Chain for Electricity Generation in Wisconsin, USA, AIChE Annual Conference, San Francisco, CA. November 8-13, 2016.

Invited Presentations

- Wisconsin Dept. of Transportation Annual Freight Railroad Day, "Highway-Rail Crossings: Projects and Research" (November, 2016)

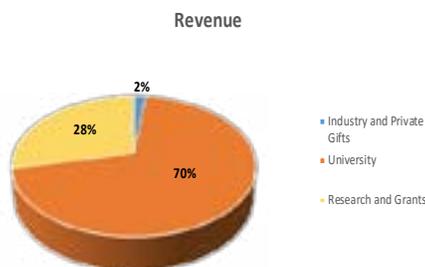
RTP in the Press

- October 31, 2016: Aaron Dean highlighted in the Pavlis Honors College Blog, <http://blogs.mtu.edu/honors/2016/10/31/meet-aaron-dean/>
- November 2016: Michigan Tech's Rail Transportation Program is covered extensively in the November Railway Track and Structures. Rail Engineering's Educated Effort, page 26 https://issuu.com/railwaytrackstructures/docs/november2016de_reduced
- November 2016: The 4th Annual Michigan Rail Conference was covered by MRA, <http://michiganrailroadsassociation.com/wp-content/uploads/2014/01/MRA-2016-Fall-Newsletter-FOR-WEBSITE.pdf>

Finances

RTP Funding

Financial support for the Rail Transportation Program is received internally at Michigan Tech from the Department of Civil and Environmental Engineering (CEE) and from the Provost. External funding consists of sponsored program research projects and contributions and gifts from industry partners and private individuals.



RTP Expenditures

Expenditures to support the rail transportation activities have been divided into several categories:

Faculty, Staff and Consultants (Research)-

Expenses include: wages, salaries, and subcontracts plus overhead charges specific to sponsored research projects.

Director and Staff (RTP)-

Expenses include: director and staff salaries and other direct expenses used to support and continue development of the Rail Transportation Program.

Student Support and Activities-

Includes direct student expenses, such as tuition and stipends, conference fees, field visits, travel, and sponsorship for student events and REAC activities.

Travel and Conferences-

Includes all non-student support for travel and participation in rail and educational conferences and meetings to facilitate the development of the rail transportation program. This includes travel expenses incurred in sponsored research projects.

Administrative, Promotional, and Resource Development-

Expenses incurred in the operation and development of the rail program, such as marketing, material development, and purchase of program resources.

RTP Expenses



About the Michigan Tech Transportation Institute

The Michigan Tech Transportation Institute will provide the operating structure, resources, recognition, and leadership, in a collaborative environment, that supports research, education, and outreach leading to sustainable solutions for transportation.

MTTI is an umbrella organization bringing together the cross-disciplinary centers and principle investigators conducting transportation related research and education initiatives that address national and global needs. Principal Investigators conduct transportation research under MTTI within six transportation focused areas:

- Transportation Structures including bridges and pavements. Other related areas include geotechnical, construction, and nanotechnology related to sensors.
- Transportation Materials including concrete, asphalt, steel, wood, and aggregates. Other related areas include construction, geotechnical, and nanotechnology related to sensors and materials.
- Transportation Systems including waterways, traffic/safety, construction, rail, air, public transportation, freight, intelligent transportation systems, vehicle infrastructure integration, nanotechnology related to sensors, and radio frequency identification devices.
- Environmental Aspects of Transportation includes environmental impacts, energy, carbon dioxide and other pollutants, fugitive dust, wildlife, flora and fauna, and carbon credits.
- Social Aspects of Transportation includes policy, planning, human factors, history, economics, and archeology.
- Transportation Technology Transfer includes all outreach, management systems, and workforce development programs.

Director, Pasi Lautala, MTTI

ptlautal@mtu.edu, 906-487-3547

www.mtti.mtu.edu



**Michigan
Technological
University**

Michigan Tech Transportation Institute

About Michigan Technological University

Michigan Technological University is a leading public research university, conducting research, developing new technologies, and preparing students to create the future for a prosperous and sustainable world. Michigan Tech offers more than 120 undergraduate and graduate degree programs in engineering, forestry and environmental sciences, computer sciences, technology, business and economics, natural and physical sciences, arts, humanities and social sciences.



© Copyright 2016 by Michigan Technological University.

To obtain permission to reprint any articles or graphics from the *Michigan Tech Rail Transportation 2015-2016 Annual Report* please contact the RTP at rtp@mtu.edu.

Michigan Technological University is an equal opportunity educational institution/ equal opportunity employer, which includes providing equal opportunity for protected veterans and individuals with disabilities.

www.mtu.edu



**Michigan
Technological
University**



Rail Transportation Program

Michigan Tech Transportation Institute • Michigan Technological University