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Table of Acronyms

APSRC – Advanced Power Sports Research Center
CEE - Civil & Environmental Engineering
COE – College of Engineering
CH - Chemistry
CLS - Cognitive and Learning Sciences
CM – Chemical Engineering
CSEO – Center for Science & Environmental Outreach
CTT – Center for Technology & Training
ECE – Electrical & Computing Engineering
GLRC - Great Lakes Research Center
GMES – Geological & Mining Engineering & Sciences
KRC - Keweenaw Research Center
LTAP – Local Technical Assistance Program
MEEM – Mechanical Engineering-Engineering Mechanics
MSE – Materials Science & Engineering
MTRI – Michigan Tech Research Institute
MTTI – Michigan Tech Transportation Institute
RTP - Rail Transportation Program
SS – Social Sciences
SBES – School of Business & Economics
SFRES – School of Forest Resources & Environmental Science
SFI – Sustainable Futures Institute
TTAP - Tribal Technical Assistance Program
VPR – Vice President of Research Office
Director’s Message

You’ve probably heard the saying “the only constant thing is change.” This is certainly true for transportation and the Michigan Tech Transportation Institute (MTTI). The change may not be revolutionary, but it always keeps us on our toes. In MTTI’s case, the change in 2017 included a variety of things, such as the launch of our new web site (please do take a look), and changes in our governing documents to streamline our decision making and election processes. 2017 certainly brought growing attention to mobility, and MTTI jumped on board by co-organizing Michigan Tech’s first Mobility Summit in Houghton. With leading industry experts as keynote speakers, it was a great success. We also saw the continuing transformation of our membership, with the Center for Technology and Training taking its initial steps toward becoming an independent research center, and the success of new faculty in their research careers.

Transportation is becoming more interdisciplinary than ever, and we are finding new opportunities to both team up with other institutes and to introduce new faculty/staff members to the field. One example is the ENGIN Program, a Major Initiative funded by MTTI that integrates our Cognitive Learning Sciences Department with transportation research activities. We’re also seeing an increase in the number of projects that connect multiple centers toward a common goal, such as the Advanced Research Projects Agency-Energy (ARPA-E) project, led by the Advanced Power Systems Research Center (APSRC). I have no doubt that the future growth of our institute will be through collaborative activities like these that rely on the integration of multiple areas of expertise.

While transportation research is critical, MTTI has responsibilities beyond that. One is education of the next generation on the importance of transportation. We approach this in multiple ways, from sponsorship of summer youth programs and teacher continuing education, to hosting students interns from the Michigan Department of Transportation. Just like with our faculty researchers, we will need a new generation to take the reins of the transportation profession, and we’re doing our best to instill interest in transportation early in students’ K-12 and university classrooms.

This is the first publicly available MTTI Annual Report, and I hope you will enjoy reading it, whether you’re a transportation professional, or simply someone with general interest in the topic. We are always looking for new ideas and new members, so don’t hesitate to contact me or Pam Hannon, MTTI Coordinator, if you want to chat. Maybe you have the next new idea in transportation research for MTTI to help you with.

Pasi Lautala, PhD, PE
Meet the MTTI Leadership

MTTI is guided by a director that has been elected by members and approved by the Vice President of Research and in conjunction with a member-elected five-person Executive Committee (EC) that serves three-year terms.

The EC works with Director Pasi Lautala to ensure that MTTI stays true to the mission and vision of the institute. Typical EC duties include advisory roles to support decision making, oversight of special projects, policy development, and membership issues.

Pasi Lautala (CEE) was elected as the current MTTI Director in October 2016.

Vision
Partnering for the future of transportation.

Mission
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.
Meet the Principal Members

MTTI membership is available to all Michigan Tech faculty and staff involved in or pursuing transportation activities. Members are classified into two groups based on their research activities: Principal Members and Affiliate Members. All others with interest in MTTI are eligible to be a Friend of the Institute. Our 2017 Principal Members include:

Colin Brooks  
Senior Research Scientist I  
Michigan Tech Research Institute

Tim Colling  
Director  
Center for Technology & Training

Qingli (Barbara) Dai  
Associate Professor  
Department of Civil and Environmental Engineering

Dave Hand  
Professor  
Department of Civil and Environmental Engineering

Tim Havens  
Associate Professor  
Electrical and Computer Engineering

Pasi Lautala  
Associate Professor  
Director  
Rail Transportation Program & MTTI

Thomas Oommen  
Associate Professor  
Geological and Mining Engineering and Sciences

Larry Sutter  
Professor  
Materials Science and Engineering

Andrew Swartz  
Associate Professor  
Civil and Environmental Engineering

John Velat  
Director  
Center for Rural and Tribal Resilience

Zhanping You  
Professor  
Civil and Environmental Engineering

Kuilin Zhang  
Assistant Professor  
Civil and Environmental Engineering
Award-Winning Students, Faculty, and Staff Recognized

TIM COLLING, Director of the Center for Technology & Training, has been appointed to the Michigan Governor’s Infrastructure Asset Management Advisory Board. “This gives the university a unique opportunity to advise on policy for infrastructure in Michigan, which will likely become the template for other states,” Colling said. Over the term of the appointment, Michigan Tech will be involved in meetings with the advisory board and governor’s office to outline a framework and process for integrated asset management, similar to what Michigan Tech has done with roads and bridges. The board’s activity is expected to result in legislation that will codify management practices for these other assets, and it is likely there will be a spending package related to the bill, either directly or indirectly, Colling added.

STEVEN LANDRY (second from left), a PhD student in the Applied Cognitive Science and Human Factors program working on the National University Rail Center (NURail) project, was selected U.S. Department of Transportation and the Council of University Transportation Centers’ (CUTC) Student of the Year. Steven was nominated by his advisor, Myounghoon Jeon, Associate Professor and Director, Center of Human-Centered Computing at Michigan Tech. Professor Jeon stated, “Steven’s research focuses on finding new ways to use technology to solve real world problems. His mission is to advance and promote human and technology interaction to ultimately save valuable resources (e.g., time and money).

BILL SPROULE (CEE) has been appointed by the Transportation Research Board (TRB) to be an Airport Cooperative Research Program (ACRP) Ambassador for a two-year term. ACRP is an industry-driven, applied research program that develops practical solutions to problems faced by airport operators. It is managed by TRB and sponsored by the Federal Aviation Administration (FAA).

ACRP Ambassadors are volunteers who serve as liaisons between the TRB and ACRP, the research community, and airports operators at conferences and industry events and will make presentations on the ACRP research process and products, and other airport topics, and promote opportunities for others to be involved in ACRP research panels and projects.

AARON DEAN, Rail Transportation Program (RTP) undergraduate student and research assistant, was awarded the DeVlieg Foundation Fellow through the Undergraduate Research Internship Program (URIP) for his project “Effectiveness of Using SHRP2 Naturalistic Driving Study (NDS) Data to Study Driver Behavior at Highway-Rail-Grade Crossings.”

Awarded a Summer Undergraduate Research Fellowship (SURF), CEE and RTP student DARIAN REED worked with Pasi Lautala to study the “Evaluation of Methods to Record Head Orientation in Driving Simulator and In-Vehicle Study Environments.”
News and Events

Michigan Tech Hosts Inaugural Mobility Summit

Michigan Technological University hosted the inaugural MOBILITY SUMMIT (left photo) on April 20, 2017. The Summit featured Michigan Department of Transportation (MDOT) Director Kirk Steudle (right photo; second from left) as keynote speaker, as well as Paul Rogers (center photo), Director of the US ARMY Tank Automotive Research Development and Engineering Center (TARDEC).

Rogers opened the Summit, focusing on the challenges associated with unmanned vehicles (UVs) today, citing the Army’s long history in UV research and development in comparison to the consumer industry’s relatively new entry into the field, and the steps to be taken before connected/automated vehicles (CV/AV) dominate the roadways.

Eighteen Michigan Tech researchers highlighted their mobility research with topics ranging from connected and autonomous vehicles to technology enabling mobility, infrastructure, education, cybersecurity, and human factors.

In addition, a poster session provided the audience with more in-depth information on mobility research featuring student and researcher projects, educational opportunities, and facilities available at Michigan Tech.

Kirk Steudle closed the event by outlining Michigan’s Planet M, Governor Snyder’s initiative to recognize Michigan as a leader in mobility, and encouraged Michigan Tech to participate in the initiative. Steudle updated attendees on recent legislative actions affecting connected and automated vehicles in the state and highlighted the American Center for Mobility (ACM) as an example of Michigan’s leadership in the field.

MTTI Awarded Beyond Traffic Innovation Center by USDOT

Michigan Tech was selected by the U.S. Department of Transportation as one of the eighteen Beyond Traffic Innovation Centers (BTIC) in the nation.

According to the DOT, “These Centers will be recognized by the DOT as forward-thinking and influential institutions that are capable of driving solutions to the challenges and trends identified in Beyond Traffic 2015, the U.S. DOT’s report on current and future issues in transportation. The centers will contribute by convening decision-makers in their mega-region and coordinating related research, curriculum, outreach, and other activities.” The Michigan Tech Center was selected as one of three universities to serve in rural areas in the United States.

MTTI Recognized as One of the State’s Best Assets in Mobility R&D

Crain’s Detroit Business News recognized the Michigan Tech Transportation Institute as one of the best assets in Mobility R&D in Michigan.

MTTI Partners & Affiliates

MTTI actively recruits involvement from many departments, centers, programs, and institutes to promote transportation research at Michigan Tech. This strong partnership allows us to make lasting contributions to the nation’s transportation system.

Our Partners
Centers, Institutes, and Programs

- Advanced Power Sports Research Center
- Center for Rural and Tribal Resilience
- Center for Science & Environmental Outreach
- Center for Technology & Training
- Great Lakes Research Center
- Keweenaw Research Center
- Local Technical Assistance Program
- Michigan Tech Research Institute
- Rail Transportation Program
- Sustainable Futures Institute

Academic Departments

- Civil & Environmental Engineering
- Chemical Engineering
- Chemistry
- Cognitive & Learning Sciences
- Electrical & Computer Engineering
- Geological & Mining Engineering & Sciences
- Mechanical Engineering – Engineering Mechanics
- Materials Science Engineering
- Social Sciences
- School of Business & Economics
- School of Forest Resources & Environmental Science

Administrative Departments

- Industry Relations
- College of Engineering – Research and Innovation
- Vice President for Research Office
- American Public Transportation Association (APTA)
- National Road Research Alliance (NRRA)

External Memberships
Performance Metrics

Research Activity Overview

In FY17, MTTI researchers collaborated on proposal submissions to funding sponsors totaling $11,448,511. 49 proposals were submitted of which 23 were awarded funding for an approval rate of 47%. Research awards amounted to $3,315,179. MTTI currently has 52 projects in progress.
Major Initiatives

One of the goals of MTTI is to develop exploratory projects and initiatives that lead to new external research funding for the university. Two mechanisms for this goal are start-up funding and staff assistance.

Major initiatives are larger, often highly collaborative, multi-year activities that generate resources in the form of long-term external funding and conceivably lead to stable programs or centers.

In 2017, MTTI had two major initiatives in progress: the “Building the ENGIN (Exploring Next Generation IN-Vehicle INterfaces) Consortium at MTTI,” and the “Exploring the Science of Sustainability: Robustness and Resilience of Coupled Infrastructure and Natural Networks.” The former is highlighted below.

Building the ENGIN Consortium

The “Building the ENGIN (Exploring Next Generation IN-Vehicle INterfaces) Consortium at MTTI” is a three year initiative led by Principal Investigator Myounghoon (Philart) Jeon (CLS).

As passenger vehicles have become more than just a means of transportation, the design of in-vehicle technologies has become more than just the design of a space for driving. Today’s cars, SUVs, and light trucks can also be referred to as “offices on the move” or “personal communication centers” with more complex functions than ever before. Therefore, industry is quickly changing its direction and investing in future in-vehicle interface development. However, because academic driving research has traditionally focused mainly on safety issues, tremendous research and design areas remain unanswered, including work surrounding the user experience of drivers and passengers in the upcoming new era.

To bridge the gap between industry demand and academic research, the ENGIN: Exploring Next Generation IN-Vehicle INterfaces consortium was established at Michigan Tech. The consortium has paved a path for innovative research and educational programs in the driving domain, with a goal of eventually leading to a sustainable, recognized driving research center at MTTI.

To promote team building, research dissemination, and provide networking opportunities on Michigan Tech’s campus, the ENGIN team formed a driving research seminar series and organized five driving research workshops, demos, and tutorials in international conferences. The team also participated in a workshop on “user interfaces of automated vehicles” with world-renowned researchers, submitted six proposals and twenty-two papers, and graduated two MS students and two PhD students. ENGIN students were awarded the best student paper award at the International Conference on Auditory Display for *Towards an in-vehicle sonically-enhanced gesture control interface: A pilot study*, and graduate student Steven Landry was awarded “CUTC Student of the Year” by the US Department of Transportation.

# Ongoing MTTI Projects

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<td>Driver Behavior at Highway-Rail Grade Crossing Using NDS and Driving Simulators</td>
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Implementation of Unmanned Aerial Vehicles (UAVS) for Assessment of Transportation Infrastructure – Phase II

**PI: Colin Brooks (MTRI)**

**Sponsor: Michigan Department of Transportation**

As unmanned aerial vehicle (UAV) technology has advanced to become more capable at lower cost, it offers transportation agencies a more rapid and safer alternative to collect data for a variety of applications, including condition assessment, traffic monitoring, construction, asset management, operations and other applications. In Phase I of this project, the Michigan Tech team was able to test multiple sensors on a Michigan-made multirotor UAV platform, along with other UAV’s, enabling the collection of data types such as optical light detection and ranging (LiDAR), and thermal to achieve a detailed view of a bridge deck both on the surface and subsurface. These methods were developed to represent the type of data collected through the Michigan Department of Transportation (MDOT) manual inspections.

Under Phase II, UAV technology was further developed to implement these technologies into MDOT day-to-day operations. Five bridges, three road corridors, and one construction site were analyzed, producing several standard geospatial outputs created from the UAV imagery, including an optical, thermal, digital elevation model, hillshade, detected spalls and delaminations, and point cloud datasets. Additionally, a detailed cost-benefit analysis indicated that UAVs can provide better estimates of distress, leading to lower maintenance costs. By successfully continuing UAV research and development for MDOT, the Michigan Tech team will support MDOT’s business models and decision making processes.
Fiber-reinforced High Performance Rubber Concrete for Concrete Structure Construction and Repair

**PI:** Qingli Dai (Civil & Environmental Engineering)

**Sponsor:** Michigan Department of Environmental Quality

In the recent decade, the reuse of scrap tire rubber in concrete has attracted the interest of researchers and practitioners. These efforts can reduce the environmental impact of tire disposal while improving static and dynamic fracture toughness and decrease brittleness of concrete. Mixed rubber particles of mesh size 10-30# will introduce the uniformly distributed “elastic entrained particles,” which can reduce internal expansive stress due to freeze-thaw damage and chemical attack for improved durability. Additionally, the surface-treated rubber particles have good bonding strength with cement paste.

This project first develops a mixture design for polyvinyl alcohol (PVA) fiber reinforced concrete with exceptional mechanical and durability performance. The PVA fiber contains hydrogen groups which can form strong surface bonds between PVA fibers and the cement mixture. Following current rubber particle treatment for improved bonding strength with cement concrete, this research will extend to development of PVA fiber or other synthetic/steel fiber reinforced concrete with a high content of rubber particles (up to 50% volumetric replacement of fine aggregates). With increased amounts of rubber particles in concrete, the PVA/synthetic/steel fibers will be added as reinforcement to meet strength and stiffness requirements. Fiber-reinforced high performance rubber concrete will not only improve elasticity and enhance fracture toughness by interfering with crack propagation, but will also reduce the transport property and improve durability under freeze-thaw and chemical attack conditions.
There are 23,446 municipal, town, township and county governments, and 35 federally recognized American Indian governments in EPA Region 5. Even though this region is one of ten EPA regions, it has approximately 26% of the United States’ more than 89,000 local government units, and 10% of the American Indian governments in the lower 48 states. A large majority of the governments in Region 5 are considered very rural, with county populations of less than 50,000.

Each of these government units is responsible for the maintenance and operation of government owned, operated, and regulated environmental systems such as drinking water, storm water, and sanitary sewer systems. The large number of these systems owned by small government entities with limited resources, combined with their current condition and their proximity to the Great Lakes, mean that purely cost-based decisions can have a large impact on 90% of the fresh water in the USA.

The EPA awarded Michigan Tech the Great Lakes Environmental Infrastructure Center (GLEIC) serving as the EPA’s Great Lakes Region (Region 5) Environmental Finance Center. The GLEIC helps local, state and tribal governments and their private sector partners meet financial and environmental responsibilities to reduce water pollution, air pollution, and solid waste. The GLEIC promotes and supports the efficient management, maintenance, operation, and finance of municipally owned or controlled environmental systems. These systems include infrastructure such as drinking water, storm water, waste water, and transportation systems, but also include community programs such as land-use planning, recycling, and solid waste and energy use reduction programs.

GLEIC accomplishes its mission by providing continuing education and direct technical assistance to local and tribal agencies within the Great Lakes region. GLEIC also completes demonstration projects and research designed to highlight best management practices.
Coordinated Transit Response Planning and Operations Support Tools for Mitigating Impacts of All-Hazard Emergency Events

PI: Kuilin Zhang (CEE)
Sponsor: University of Chicago

The nation’s critical infrastructure is aging and vulnerable to natural and anthropogenic disasters. The American Society of Civil Engineers’ “Report Card for America’s Infrastructure” issued in 2013, has assigned an overall grade of “D+” to the US transportation system (grade for transit is D) and needs an estimated investment of $3.6 trillion by 2020.

We propose a performance- and engineering-based approach to address the robustness in resilient transit systems by conducting vulnerability (static vulnerability is an antonym of robustness) analysis of transit systems under different hazard scenarios and determining optimal investment strategies and policies using a chance-constrained optimization formulation to respond to different performance measure constraints.

Robustness and resiliency are two different but relevant features in a resilient system. A system is robust when it can continue functioning under natural disasters or other emergency without total damage of the original system. A system is resilient when it can adapt to natural disasters or other emergency by adaptively changing operations to recover the system to the original level. In order to increase the resiliency of public transportation systems, we aim to identify and develop methods in terms of system robustness to provide a resilient transit system under the impact of different levels of natural hazards or other emergency situations.
Thermally induced water flux is the phenomenon that water moves in porous materials due to temperature gradients. This phenomenon ubiquitously exists in porous materials whenever both heat transfer and water movement are present. In classic soil mechanics, it is not as core a topic as mechanical response or ground movement, possibly due to the fact that non-isothermal geotechnical applications were less common in traditional geotechnical engineering. However, this situation is changing as the geotechnical community has been confronted with challenges from more and more applications involving non-isothermal soil behavior such as low-enthalpy geothermal energy recovery, climate effects on geomaterials, behavior of geomaterials under extreme conditions, and non-conventional fossil fuels such as gas hydrates and shale gas. Despite the significance, a solid and comprehensive knowledge base for this phenomenon has been missing.

This project aims at very fundamental yet long-haunting scientific questions: why and how does water move due to temperature gradients in porous materials? The proposed research is highly transformative as it explores several new theoretical (theories at both macro and micro scale), experimental (contact angle and thermally induced flux measurements), and numerical innovations (molecular simulations for water-mineral system), and integrates them into a new concept: multiscale-driven multiphysics for a solution to the issue. The research tasks are designed based on the PI’s preliminary work and will be implemented with clearly defined criteria for risk and success assessment and project management. If successful, a complete theoretical and implementation framework will be obtained based on a clear understanding of mechanisms underlying thermally induced water flux. For the long run, the project also serves as an exploratory effort to examine the concept of multiscale-driven multiphysics, which may produce solutions to critical historical issues and upcoming challenges arising from upcoming applications in sustainability, energy, and environmental needs, which are having more and more impacts on non-isothermal soil behavior.
Improvements to the TRAC Program Pilot Project

Pl: Chris Gilbertson (CTT)
Sponsor: Michigan Department of Transportation

Transportation and Civil Engineering (TRAC) is a program designed to give middle and high school students a chance to learn about civil engineering and how their science, technology, engineering, and math (STEM) classes relate to real world situations. The goal of TRAC is to show transportation as an exciting field; relevant in today’s society and full of advanced technology. Seven TRAC modules were developed and last updated in 2002 by the American Association of State Highway and Transportation Officials (AASHTO): Bridge Builder, Highway Development and the Environment, Highway Safety, Magnetic Levitation, Motion and the Transportation Engineer, Roadway Design and Construction, and Traffic Technology. These modules were designed to assist teachers, provide information to classroom volunteers, and equip the classroom for hands-on learning activities.

All seven of the TRAC PAC modules are used in the classroom and reinforced with guest speakers and field trips to significant transportation facilities such as the Mackinac and International Bridges, and the Soo Locks.

In December 2015 the CTT was awarded a two-year project from MDOT to modernize the TRAC curriculum. The final submittal included classroom kits that featured updated technology, new hands-on activities, reorganized activities for consistent format, and online access to newly developed training materials (technology update from CD’s). This project provided service learning opportunities for student interns and helped showcase how cooperation between students and staff of diverse backgrounds can form an effective team and draw on each other’s skills and experiences to successfully complete a task. Interns from civil engineering, scientific and technical communication, school of technology, and computer science all contributed to the project. In total 13 CTT interns worked on some aspect of the project with 4 of them playing a significant role in the development of new activities, interacting with the MDOT project manager, and contributing to the overall success of the project. A scholarly article was submitted to the Transportation Research Board (TRB) and presented to the TRB Standing Committee on Education and Training in Washington DC by Drew Roberts, CTT Engineering Intern.
Remote Sensing Based Assessment System for Evaluating Risk to Transportation Infrastructure Following Wildfire

**PI:** Thomas Oommen (GMES)  
**Sponsor:** University of Arkansas

Michigan Tech partners with the University of Arkansas and Idaho State University to aid in developing an empirical model to predict the probability of mudflow/rockslide for evaluating risk to transportation infrastructure following wildfires.

Wildfires are an unfortunate fact of life throughout much of the western United States, and their damage doesn’t end once the flames are extinguished. The fires leave behind scorched trees, burned forest debris, and denuded soil that makes the areas left in their wake highly susceptible to landslides or mudflows in the months and years afterward. The ability to predict and mitigate these hazards is crucial in protecting public safety and infrastructure. Michigan Tech researchers are developing a machine learning based model that advances the current state-of-the-art of debris flow prediction.

The empirical model developed by Michigan Tech researchers will be added to a decision-support system that has already been established by researchers at Idaho State University and the National Aeronautics and Space Administration (NASA). Since the beginning of this project, we have had several requests from different agencies to provide debris flow model predictions for recently burned areas in their jurisdictions. So far, we have generated twenty model prediction outputs across six States over the past two years. Screenshots of these can be found on the NASA RECOVER platform (http://giscenter.isu.edu/Research/Techpg/nasa_RECOVER/index.htm) as well as the project’s website (http://wildfire-landslide-risk-dss.uark.edu/models/). Initially, it took about three days to produce these model outputs when requests came in, but we have been able to streamline our processes to cut this time to an average of 5 hours by building a semi-automated model to extract the needed data from the fire affected site.
MTTI Project Highlights

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

*PI:* Pasi Lautala (CEE/RTP)
*Sponsor:* Federal Railroad Administration

This project shifts the paradigm of grade crossing safety research from warning device evaluation or remote crossing monitoring, to a direct and detailed observation of drivers.

This two-year project is divided into two phases with an overall objective to investigate driver behavior at Highway-Rail Grade Crossings using two distinct, but complementary, techniques. Phase I will use data collected under the Strategic Highway Research Program Naturalistic Driving Study (NDS) to look at how normal drivers react at crossings in everyday driving situations. Phase II will use the understanding developed in the first phase to create scenarios that resemble environments similar to those found in the NDS for use in our driving simulator environment.

The research will look for two basic results. First, we will develop and use the organized NDS crossing database to examine behavioral trends at the crossings. Second, we will compare driver behavior in the simulator with that found in the NDS data to determine the level of correlation between the two environments. Our hypothesis is that a strong correlation would allow us to outline how to use the simulator environment in the future to predict driver response to a variety of crossing parameters. Results found in both phases will suggest topic areas for future research and analysis, as well as directions toward development of more efficient traffic control devices at crossings.
Education and Workforce Development

MTTI faculty and staff are committed to providing opportunities for students to explore their role in creating the transportation of the future through financial sponsorship of educational youth programs. The past year included funding for:

- **“Design a Sustainable Future” Teacher Institute**
  Teachers of grades 4 – 8 convened on the Michigan Tech campus for a workshop providing them with the tools for sharing STEM education with their students including product life cycles, building design, renewable energy sources, low impact site design, water reuse, and smart transportation. This workshop is facilitated by the Center for Science and Environmental Outreach (CSEO).

- **KBIC Middle School Exploration**
  This three-week engineering exploration camp at Michigan Tech answered the question of “What is Engineering?” for sixteen local middle school students. Explorations included chemical engineering, biomedical engineering, civil engineering and bridge building, transportation engineering, environmental engineering, and materials engineering. This event was facilitated by CSEO.

- **Natural Resources & Engineering Career Exploration**
  Michigan Tech hosted a six-day trip to explore environmental science and engineering majors for all high school students in Detroit and Wayne Counties. Included in the exploration were forestry, natural resources, wildlife, engineering, and water quality activities. 15 participated in this CSEO-hosted exploration.

  “[NREC] introduced me to new fields that I enjoy and I'm finding out what I like and don’t like overall. It gave me a better understanding of how I want to live my life in the future”

  — NREC Participant

- **Rail and Intermodal Transportation Summer Youth Program**
  A week-long exploration for students entering grades 9 – 12, the program is a collaboration between Michigan Tech’s Rail Transportation Program (RTP) and the University of Wisconsin-Superior. Hands-on and classroom activities include exploring the effects of rail stability, operating a computer locomotive simulator, and investigating logistics management operations with field experiences in Michigan, Wisconsin, and Minnesota.

- **Campus Tour – MDOT Youth Development Mentoring Program**
  MTTI organized a tour of Michigan Tech’s campus transportation sites for students participating in the Michigan Department of Transportation Youth Development Mentoring Program. Twelve students and their advisor experienced the driving simulator; visited the RTP library and web center; toured the traffic, pavement, remote sensing, and unmanned vehicles laboratories, as well as the asset management technologies of the Center for Technology & Training. The focus of the visit was to provide insight into the multiple areas of transportation that can be investigated at Michigan Tech for future students.
Selected Publications

QINGLI DAI (CEE)

PASI LAUTALA (CEE/RTP)

THOMAS OOMMEN (GMES)
Selected Publications


**LARRY SUTTER (MSE)**


**ZHANPING YOU (CEE)**


**KUILIN ZHANG (CEE)**


Financial Review

Revenue
Funded entirely with “soft,” or contract money, MTTI revenues are derived from external research projects through federal, state, university, and industry sponsors.

Expenditures
MTTI is allocated Institutional Research and Development (IRAD) Funds by the Office of the Vice President for Research (VPR); these funds are used for operating expenses and for strategic investment for membership. The main priority of the Director and EC in allocating MTTI funds for investments is to increase transportation related research funding at the University. Resources are available to membership for major and minor (seed funding) initiative research projects, proposal preparation support for larger proposals, data collection, proof-of-concept studies, equipment purchase, member travel, external speaker expenses, and required cost share.
Michigan Technological University is a leading public research university, home to more than 7,000 students from 60 countries around the world. Founded in 1885, the University offers more than 120 undergraduate and graduate degree programs in science, technology, engineering, and mathematics. Our beautiful campus in Michigan’s Upper Peninsula overlooks the Keweenaw Waterway and is just a few miles from Lake Superior.

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