U.S. Department
of Transportation
Federal Railroad
Administration

Office of Research,
Development and Technology
Washington, DC 20590

Expanding Summer Youth Programs in Rail through Virtual Learning and a National Campus Network — Phase II

DOT/FRA/ORD-26/15

Final Report | August 2026

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
19 Aug. 2026		8/2021–7/2022

4. TITLE AND SUBTITLE
Expanding Summer Youth Programs in Rail through Virtual Learning and a National Campus Network – Phase II

5a. CONTRACT NUMBER
693JJ621C000014

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Department of Transportation
Federal Railroad Administration
1200 New Jersey Ave. SW
Washington, DC 20590

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
DOT/FRA/ORD-26/15

12. DISTRIBUTION/AVAILABILITY STATEMENT
This document is available to the public through the FRA website.

13. SUPPLEMENTARY NOTES
COR: Dr. Jason Wornoff

14. ABSTRACT
FRA supported Michigan Technological University (Michigan Tech), in collaboration with Pennsylvania State University Altoona and the University of Illinois, Urbana-Champaign (UIUC), to establish Tracks to the Future: Railroad Transportation and Engineering, a summer program for high school students. Phase I of this program was offered in the summer of 2022 at Michigan Tech, Penn State Altoona, and UIUC (Lautala et al, 2024). In Phase II, the program expanded to three additional universities: the University of South Carolina, University of New Mexico, and California State University, Fresno. The program included 105 students from 18 different states. Most participants were rising eleventh or twelfth grade students. Overall, the Phase II program continued the success of Phase I. Students and parents provided positive feedback for both the remote and in person activities. However, improvements can still be made in the registration process, program logistics, and travel expense reimbursement.

15. SUBJECT TERMS
Railway engineering education, workforce development, online education, hybrid education

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**		61	**Pasi T. Lautala**
					19b. TELEPHONE NUMBER *(Include area code)* **906-487-3547**

Acknowledgements

The research team acknowledges and thanks the following individuals and organizations:

- Dr. Jason Wornoff, Federal Railroad Administration for advice in targeted marketing and outreach strategies
- The American Railway Engineering and Maintenance of Way Association and rail industry magazines for marketing support
- Industry companies for supporting student travel to university sites:
    - Union Pacific Railroad
    - Via Rail Engineering
    - GATX Corporation
    - ENSCO, Inc.
    - Hanson Professional Services, Inc.
    - CN Railway
    - BNSF Railway
    - Genesee & Wyoming, Inc.
    - SW Bridge Engineers, LLC
- Industry companies/agencies for hosting field visits for student groups:
    - Escanaba & Lake Superior Railroad
    - Lake Superior & Ishpeming Railroad
    - Mineral Range Railroad
    - Eagle Mine
    - Pettibone
    - Railroaders Memorial Museum
    - East Broad Top Railroad
    - Rockhill Trolley Museum
    - Norfolk Southern Railway
    - California High Speed Rail Authority
    - South Carolina Railroad Museum
    - Sandia Peak Tramway

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FRA supported Michigan Technological University (Michigan Tech), in collaboration with Pennsylvania State University Altoona (Penn State Altoona) and the University of Illinois, Urbana-Champaign (UIUC), to establish a Tracks to the Future: Railroad Transportation and Engineering summer program for high school students. Phase I of this program was offered in the summer of 2022 at Michigan Tech, Penn State Altoona, and UIUC (Lautala et al, 2024). In Phase II, the program expanded to three additional universities: University of South Carolina (USC), University of New Mexico (UNM) and California State University, Fresno (Cal State Fresno). The program included 105 students from 18 different states. Most participants were rising eleventh or twelfth grade students.

All cohorts used a hybrid format where students first spent two days participating in live remote sessions via Zoom and completing hands-on activities mailed to them prior to program start. Students then traveled to one of the host campuses midweek for two days of on-campus activities and field visits. FRA funded the course development, the program fees for the students (including meals and housing), and field visit expenses at the host site. Rail industry companies provided limited travel support for students in need to reach the host site.

Phase II built on the experiences from Phase I and expanded the number of students and host universities. Overall, the Phase II program continued the success of Phase I. Students and parents provided positive feedback for both the remote and in person activities. However, improvements can still be made in the registration process, program logistics, and travel expense reimbursement.

1. Introduction

The Federal Railroad Administration (FRA) supported Michigan Technological University (Michigan Tech), in collaboration with Pennsylvania State University Altoona (Penn State Altoona) and the University of Illinois, Urbana-Champaign (UIUC), to establish a *Tracks to the Future: Railroad Transportation and Engineering* summer program for high school students (Lautala et al, 2024). Phase II expanded the program to three additional universities: University of South Carolina (USC), University of New Mexico (UNM) and California State University, Fresno (Cal State Fresno).

All cohorts used a hybrid format where students first spent two days participating in live remote sessions via Zoom and completing hands-on activities mailed to them prior to program start. Students then traveled to one of the host campuses midweek for two days of on-campus activities and field visits. FRA funded the course development, the program fees for the students (including meals and housing), and field visit expenses at the host site. Rail industry companies provided limited travel support for students in need to reach the host site.

1.1 Background

The rail industry has long acknowledged the challenge of replacing personnel approaching retirement age with new hires, many from college rail programs. Since students often arrive at universities and colleges with a predefined career in mind, it is critical for the rail industry to develop a pre-college program with a nationwide focus that can introduce students to the modern side of the industry, including critical safety aspects and the many high-tech applications and jobs available. Tracks to the Future can engage students before they determine their college careers and stimulate student interest in the rail industry.

Most pre-college experiences in railroading are focused on rail history and are sponsored by railroad museums or scenic railroads. There may be nationwide interest in rail transportation among students, but it is challenging to attract large groups of participants that share a specific geographic location. A nationwide university network that supports a hybrid program with combined virtual learning on rail transportation and site-specific campus visit for activities and field trips would be the most efficient approach to expand the reach of these pre-college rail industry programs.

1.2 Objectives

In Phase II, researchers expanded the program from the original three universities in Phase I to six total universities, doubling the available seats to 120. The team also fine-tuned the curriculum based on the lessons learned in Phase I.

1.3 Overall Approach

In Phase II, researchers used the Canvas learning management system and Zoom webinars as the main methods of delivery for the synchronous online portion of the program. A variety of instructional methods were used, including videos, team assignments, Kahoot![1] competitions to

[1] Kahoot! is an online educational gaming system with instructor prepared questions. Students compete to answer questions quickly and correctly. https://kahoot.com/schools-u/

keep the online program interesting, and a materials package mailed to all hybrid students for tabletop activities. The team also developed hands-on activities and competitions for the on-campus portion of the program, including field visits to rail industry facilities. The team scaled up the Phase II program for the additional participants.

1.4 Scope

In Phase II, the team concentrated on selecting three new host universities, training them to help deliver the curriculum, and improved the registration and logistics process to smooth program operations. The team also expanded attempts to recruit industry participation and support for student travel.

1.5 Organization of the Report

This report summarizes the preparations for, implementation of, and lessons learned from the second year of the Tracks to the Future program. Section 2 discusses marketing efforts to attract students to the program. Section 3 provides demographic information on the student participants. Section 4 discusses the curriculum and education methods used in the program. Section 5 summarizes lessons learned and recommendations for Phase III. Conclusions are made in Section 6.

2. Program Preparations, Marketing, and Registrations

In Phase II, the team fine-tuned marketing strategy. The following sections provide a summary and timeline of marketing efforts, as well as discussion on registration coordination between the host universities.

2.1 Marketing Activities and Deadlines

The research team deployed systematic marketing efforts for Phase II soon after the end of Phase I. Table 1 provides a list of marketing activities and deadlines conducted as part of the program preparations. Marketing was done through multiple media, including a web site, the summer youth program units within each host university, and specific targeted rail industry and stakeholder marketing through each university's rail transportation program and industry magazines. The team synchronized the marketing efforts with other summer youth programs at the host universities as much as possible.

Table 1. Marketing Activities

Item	Dates and Notes
Michigan Tech Summer Youth Programs website	Initial materials on web late 2022; Registration open early January
Michigan Tech website updated	January 7, 2023
Rail industry magazine calendars	January 20, 2023
Marketing Flyer completed	January 24, 2023
UIUC marketing (with flyers)	Email to contact list January 26, 2023 – 19,000 recipients
Email to list of railroad museums and tourist railroads (with flyers)	February 1, 2023 – approximately 300 locations
Email to Michigan Tech RTP contact lists (with flyers)	January 26, 2023, follow up early April 2022 – about 1,500 recipients
University partners marketing (email with flyers)	Late January-early February 2023, and ongoing through March

Marketing emails containing program flyers (Figure 1) were sent to approximately 25,000 email addresses through three rail programs and to more than 30,000 prospective students through Michigan Tech summer youth programs.

TRACKS To THE FUTURE

Hybrid Railroad Transportation and Engineering Program - 2023

Railroads are the high-tech and environmentally sensitive transportation mode! Don't believe us? Come and learn why railroads remain the most energy-efficient mode of transportation. Engage with faculty from Universities across the country as you uncover what forms modern railroad track, explore equipment from around the globe and analyze communications/control systems. This hybrid program entails virtual classroom sessions at your home on Monday and Tuesday, travel to the host site on Wednesday, and in-person activities on Thursday and Friday of your assigned session.

Program Schedule: (both sessions)	Monday/Tuesday Virtual Classroom @ Home	Wednesday Travel to Host University	Thursday/Friday Activities/Field Visits @Host University

Session Dates:
Session 1: **June 19-23, 2023**
Session 2: **July 10-14, 2023**

20 full scholarships are available at each site!

U of SC — South Carolina
U of New Mexico — The University of New Mexico
Fresno — Fresno State
Penn State — PennState Altoona
Michigan Tech — Rail Transportation Program (Michigan Tech Transportation Institute • Michigan Technological University)
UIUC — RAILTEC, University of Illinois at Urbana-Champaign

Open to high school students (**who will be enrolled in grades 9-12 in Fall 2023**)

Explore Interests. Spark Curiosity. Make an Impact.
To learn more and sign up, please visit mtu.edu/syp

Michigan Tech is an EOE that provides equal opportunity for all, including protected veterans and individuals with disabilities.

Figure 1. Tracks to the Future Program Flyer

2.2 Registration and Selection Process

In Phase II, the team used a similar registration process from Phase I. Interested students completed the application through a Michigan Tech Google Form (Appendix A). Students were asked to rank the host sites based on their preference and identify locations where they would not consider participating. They were also asked if they needed travel support to participate in the program.

Researchers received 182 unique applications by the deadline and used selection criteria to determine accepted applicants. First, the team removed all applicants who had already participated in the program, as well as international applicants, as they were not eligible. Eventually, 159 students were accepted to the program and asked to confirm their participation through official registration. Each student was assigned to either their first or second choice university host location. The team continued to accept students to a waiting list after the initial registration deadline; as students confirmed their registration, some declined the offer and others did not respond to the confirmation request. PSU, UIUC, and Cal State Fresno also determined they could take more students than the nominal 20 per co-hort. After back-filling from the program waiting list, the team arrived at a final count of 122 students spread over the six universities. Team members mailed a program package to each of the selected students.

3. Student Participation and Demographics

3.1 Summary of Participants

Table 2 provides a breakdown of students who confirmed their participation in the program, broken down between each cohort, grade level, and gender. Seventeen students withdrew after the program package was sent or did not participate in the on-campus training; 105 students completed the entire program. The team prioritized older students, so most participants were starting their junior or senior year in the fall of 2023.

Table 2. Tracks to the Future student demographics

	MTU Hybrid	PSU Hybrid	UIUC Hybrid	UNM Hybrid	Fresno State Hybrid	USC Hybrid	TOTAL
Total Students	**15**	**27**	**23**	**8**	**34**	**15**	**122**
12th Grade	4	4	9	2	16	6	**41**
11th Grade	4	7	6	3	7	5	**32**
10th Grade	5	11	2	2	7	1	**27**
9th Grade	2	5	6	1	4	3	**21**
Male	13	24	17	6	24	14	**98**
Female	2	3	4	2	10	1	**21**
Minority	6	12	6	3	31	5	**61**

3.1.1 Geographic Distribution

The program showed great geographic diversity, attracting students from 19 states (Table 3 and Figure 2). The highest number of participants came from California, Illinois, and New York.

Table 3. Student Demographics – Home State

Cohort/ State	AZ	CA	FL	GA	IL	MD	MI	MO	NC	NJ	NY	OH	OR	PA	SC	TN	TX	VA	WA
MTU Hybrid					8		6												
PSU Hybrid		1	1	1		3				1	10			6		1		2	1
UIUC Hybrid					16		1	1			1					1	1		2
Fresno Hybrid		33											1						
USC Hybrid	1			3		1			2		1	1		1	2	2	1		
UNM Hybrid		1			2			1									3		1
Totals	1	34	1	4	26	4	7	2	2	1	12	1	1	7	2	4	5	2	4

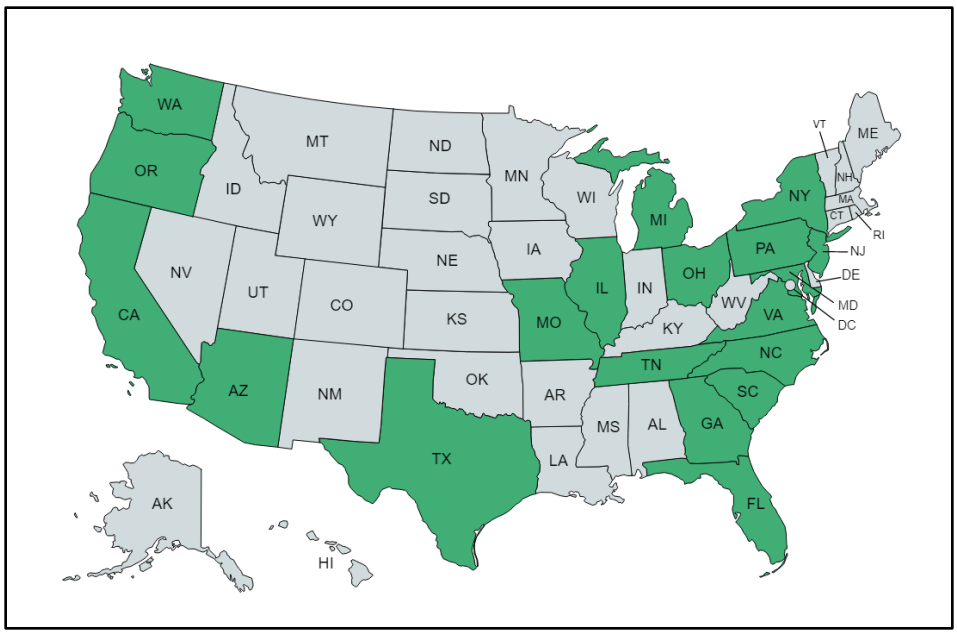


Figure 2. Student Demographics – Shipping location for program package

4. Curriculum and Educational Methods

4.1 Virtual Learning – Hybrid Days 1 and 2

As in Phase I, the hybrid sessions featured two days of synchronous virtual lessons conducted on the Zoom platform. The lesson materials were organized in Michigan Tech's Canvas learning management system (Figure 4). They included some traditional lecture material but also took advantage of various online tools for active learning (Menti,[2] Kahoot!, and Google Sheets) and competitions to maintain student interest. The hybrid days also included hands-on activities with materials prepared by the program staff and mailed to the students ahead of class (Figure 5). A group of online internet search tasks and summary activities were also used. Table 4 presents the virtual activities topics, organized under four modules.

Figure 3. Tracks to the Future Home Page in Canvas

Figure 4. Contents of Mailed Activity Package

[2] Mentimeter is an online tool for creating interactive presentation content.

Table 4. Hybrid Program — Virtual Curriculum

Module	Content
Pre-course Assignments	• Pre-Knowledge Assessment • Engineering and Belongingness Pre-Survey

1. What is Rail Transportation?	• Industry Panel Discussion (T2F Travel Sponsors)
	• Intro and History of Rail
	  ○ Welcome and Rail Industry Jobs
	  ○ Transportation Modes
	  ○ Railroad History
	  ○ What is a Railroad?
	  ○ Modern Rail

2. Rolling Stock and Locomotives	• Locomotives PowerPoint
	  ○ Locomotive Puzzle Activity
	  ○ Wheel Dynamics Activity
	• Railcars PowerPoint
	  ○ Bogie Parts Activity
	• Braking and Train Energy Management PowerPoint

3. Freight Operations	• Freight Operations PowerPoint
	  ○ State-to-State Activity
	  ○ Trucks vs Trains Activity
	  ○ Yard and Terminal Scavenger Hunt Activity
	  ○ Classification Yard Sorting Game Activity

4. Passenger Rail	• Passenger Operations PowerPoint
	  ○ Let's Go for a Trip Activity
	• High Speed Rail PowerPoint
	  ○ Passenger Rail Options in Foreign Countries Activity
	  ○ HSR Corridors (China vs US)
	• Urban and Transit Rail PowerPoint
	  ○ US Commuter Rail System Activity

The hybrid curriculum included the same modules used in Phase I, but some activities were either dropped or modified to ensure timely completion and improve collaboration between students. The following includes brief introductions on the four modules completed as part of the hybrid portion of the program. See Appendix F for module details.

4.1.1 Module 0: Pre-Course Assignments

The opening module required student to complete two survey documents, the pre-skills knowledge assessment and the pre-belonginess survey. These documents allow team researchers to assess whether the material and activities provided in the program produce any change in student knowledge or attitude. The survey documents are included in Appendix B.

4.1.2 Module 1: What is Rail Transportation

This module introduced the rail industry. This material was presented synchronously using Zoom, PowerPoint slides, and Kahoot! competitions.

4.1.3 Module 2: Rolling Stock and Locomotives

Module 2 focused on the rail cars and locomotives used across the rail industry. The presentation included PowerPoint slides in Zoom with embedded poll questions. It also featured two hands-on activities.

4.1.4 Module 3: Freight Operations

Organizers opened the second day of the home sessions with an introduction to Freight Operations. Instructors again used PowerPoint, with Kahoot! competitions interspersed throughout the presentation, as well as several videos and individual and group activities.

4.1.5 Module 4: Passenger Operations

Module 4 was conducted in three parts: Passenger Operations, High Speed Rail, and Urban Rail Transit. Each part included a PowerPoint presentation with embedded Kahoot! competitions, and a variety of student activities.

4.2 On-Campus Activities and Field Visits – Days 4 and 5

After virtual modules were completed, students spent Wednesday traveling to their host university for two days of on-campus activities and field visits. The schedule and program content of on-campus days were determined independently by each host university, but each school was provided with instructions for various activities that could be completed on these days. The following details Michigan Tech's example of on-campus activities, broken down to three morning and afternoon modules that each included different hands-on activities. Activities at other host universities followed a similar pattern.

4.2.1 Module 5: Morning Session

Small groups (i.e., 2-3 people) completed the on-campus activities and each group rotated between the three activity sites.

4.2.1.1 Trainz Simulator

Students partnered up to accomplish the tutorials included with the Trainz 2019 locomotive simulator, then spent some time operating trains in the simulator environment (time permitting) and reflecting on lessons learned from being a locomotive engineer (Figure 5). At Michigan Tech, many of the students returned to the computer lab in the evening on their own time to explore more of the Trainz environment.

Figure 5. Trainz Simulator

4.2.1.2 Wooden Track Operations

Students used Brio track pieces and rolling stock to illustrate rail operations in a game scenario. Starting with a single track with no sidings, students ran trains between two terminals. Each completed operation earned game money that the students then used to add infrastructure, including sidings, signals, and additional track.

4.2.1.3 Track Construction

Students built a model track section, including sub-ballast, ballast, ties, and rail. They received a firsthand feel for how adding ballast around the ties stabilized the structure laterally, longitudinally, and vertically (Figure 6).

Figure 6. Track Model Construction at Michigan Tech (left) and UIUC (right)

4.2.2 Module 6: Afternoon Session

The afternoon session concluded the classroom portion of the program with another round of hands-on activities.

4.2.2.1 Train Resistance and Car Weight and Size

This activity required students to work with a model rail car and a variety of different "load" materials (Figure 7). In the first part of the activity, students varied the weight of the load and measured the force required to move the car on a steel rail system and on a mat designed to simulate a rubber tire on pavement. In the second part, students used a variety of loads with different densities to illustrate how the volume of some materials can control the capacity of a rail car while the weight of other materials controls the capacity.

4.2.2.2 Mag-Lev

Students used magnets to illustrate the attraction and repulsion created between north and south poles, then built a mag-lev car to run on an inclined track. With two tracks available at both locations, races inevitably occurred!

4.2.2.3 Intermodal Operations

Students again used Brio track pieces and rolling stock, this time to illustrate the difference between truck only and combined truck and rail operations (Figure 8). Students moved

containers from a port location to an intermodal terminal using trucks on a highway, moving one container at a time, while a competing group loaded a train with containers double stacked.

Figure 7. Car Weight and Size

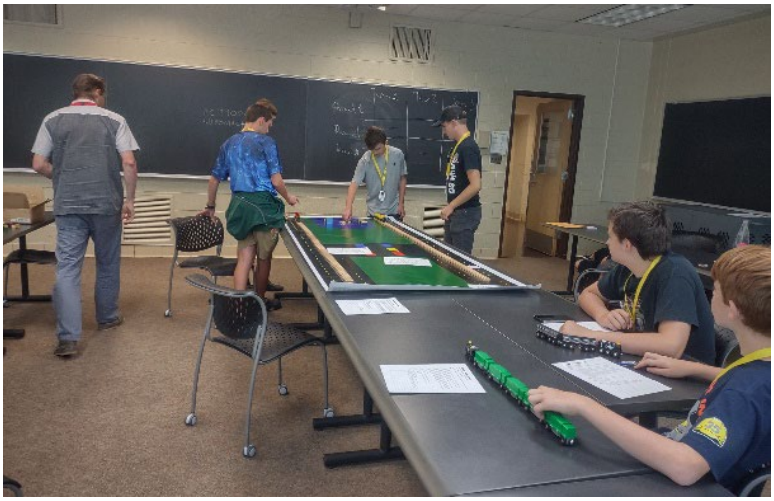


Figure 8. Intermodal Operations

4.3 Field Trips

Each university provided their own set of field trips as part of the on-campus portion of the program. The field trips by each host university are summarized below.

4.3.1 Michigan Tech

The Michigan Tech field trip started on Thursday evening with a bus ride from Houghton to Escanaba**.** Students spent the night in an Escanaba hotel, and then started the field trip schedule with a visit to the Escanaba and Lake Superior (E&LS) car repair shop **(**Figure 9**).** After a brief stop to see a steam locomotive housed at a CN Railway yard, the group traveled to Eagle Mills for a tour of the Lake Superior and Ishpeming (LS&I) Railroad facilities, including the car and locomotive shops, dispatch, a locomotive cab tour, and the loading area at the mine. The group

then visited the Eagle Mine Rail Copper/Nickel Concentrate Transload facility**.** Students also were able to watch the Mineral Range Railroad arrive to pick up a load of nickel and copper concentrate cars**.** The final stop on the way back to Houghton was at the Pettibone/Traverse Lift Company in Baraga for a tour of the shop with the lead design engineer for the Pettibone Speed Swing**.**

Figure 9. Michigan Tech Student Cohort at Escanaba and Lake Superior Railroad Car Shops

4.3.2 Penn State Altoona

Penn State Altoona offered three field trip experiences (see Figure 10**)**. On Thursday afternoon, students visited the Railroaders Memorial Museum, where they had a chance to tour the museum and the Harry Bennett Memorial Roundhouse to see various rolling stock and the progress that has been made on restoring the PRR K4 1361 Steam Locomotive. Students learned about the history of the railroad industry in Altoona and about various technical aspects of developing railroad innovations and standards. On Friday, students boarded a charter bus and traveled to Rockhill, PA, for the next two field experiences. In the morning, the group visited the East Broad Top Railroad, the only original narrow-gauge railroad east of the Rocky Mountains. Students first visited the freight office, roundhouse, and machine shop to see how the railroad originally maintained its fleet of cars and locomotives. They then rode an excursion train behind steam locomotive No. 16. After a quick box lunch, the group walked over to the Rockhill Trolley Museum where students were given tours of the two car shops to see how various railcars and trolleys were being restored. Finally, the students took rides on the trolley cars, and each student had an opportunity for hands-on training to learn how to operate the trolley themselves. This was a highlight for many of the participants.

Figure 10. Penn State Student Cohort

4.3.3 University of Illinois at Urbana-Champaign

The UIUC field trip was held at the Norfolk Southern (NS) Railway's Decatur Terminal (see Figure 11). The field visit included a bus ride to the facility in Decatur, IL, approximately 50 minutes west of Champaign-Urbana. Students first attended a job safety briefing and overview of the NS Decatur Terminal in the Division Office. Next, the group headed outside where they visited the fueling racks and locomotive maintenance facility. NS then provided an opportunity for questions and answers during a working lunch period. After lunch, the students were split into two groups that rotated between the yard tower and the mechanical shop. NS's facility in Decatur contains the largest flat switching yard in the United States; there are two separate facilities for eastbound and westbound traffic, each of which is controlled by a separate yard tower. The students were able to visit with the Yardmaster and learn about the planning and control of yard operations. The mechanical site visit allowed the students to observe the mechanical shops and spend time observing the lead tracks outside of the facility, where they were able to operate a switch (i.e., turnout) by hand. NS highlighted the students' visit in their internal newsletter and on social media (Appendix B).

Figure 11. UIUC Student Cohort

4.3.4 University of South Carolina

The USC program included a field trip to the South Carolina Railroad Museum (SCRM) in Greensboro, SC (see Figure 12**)**. The SCRM was established in 1973 with a mission to preserve and interpret railroading in South Carolina. Participants started the day with a hands-on experience of preparing a train for departure and starting a locomotive, followed by a demonstration on configuring and operating the air-brake system of the train**.** The group then departed on an hour-long guided tour train ride on five miles of operating track to Rion Station**,** and the tour guide discussed the progress of the various restoration projects along the way while briefly introducing the history of each project. At the Rion Station facility, the group attended a lecture on the history of railroads in South Carolina**.** During the return trip, the students had the opportunity to ride in the locomotive cab and observe the operations**.** Upon their return, the group toured the many pieces of rolling stock donated to the museum by the Charleston chapter of the National Railway Historical Society. The equipment includes freight and passenger cars as well as a steam locomotive that once belonged to the Hampton and Branchville Railroad**.** The museum building exhibits a wide variety of equipment, displays, running scale model trains, and related items**.** At the end of the museum trip, the group returned to the USC campus and participated in a guided tour of the Swearingen Engineering Center and the Railway Infrastructure Testing Laboratories at USC.

Figure 12. University of South Carolina Student Cohort

4.3.5 California State University – Fresno

Cal State Fresno's participants toured the California High-Speed Rail Authority (CAHSRA) Hanford Viaduct construction site and the adjacent Dragados Flat-Iron pre-cast concrete girders plant (see Figure 13).

The Hanford Viaduct is the largest high-speed rail structure in California's Central Valley, spanning nearly 6,330 feet in length. When complete, it will carry high-speed trains over the San Joaquin Valley Railroad and California State Route 198. Construction was proceeding during the field trip and the students were able to ask questions, watch, and learn as the reinforced concrete beams were handled by cranes and lowered into place.

Figure 13. University of California, Fresno, Student Cohort at the CAHSRA Hanford Viaduct Construction Site

4.3.6 University of New Mexico

UNM sponsored activities such as building a wireless sensor that can measure the vibration of a train while riding it from Albuquerque to Santa Fe. The group (see Figure 14**)** was mentored by Smart Management of Infrastructure Laboratory researchers.[3] The three day itinerary included evening educational activities and riding the Sandia Peak Tramway. The students observed Augmented Reality research that may increase the safety of field inspectors.

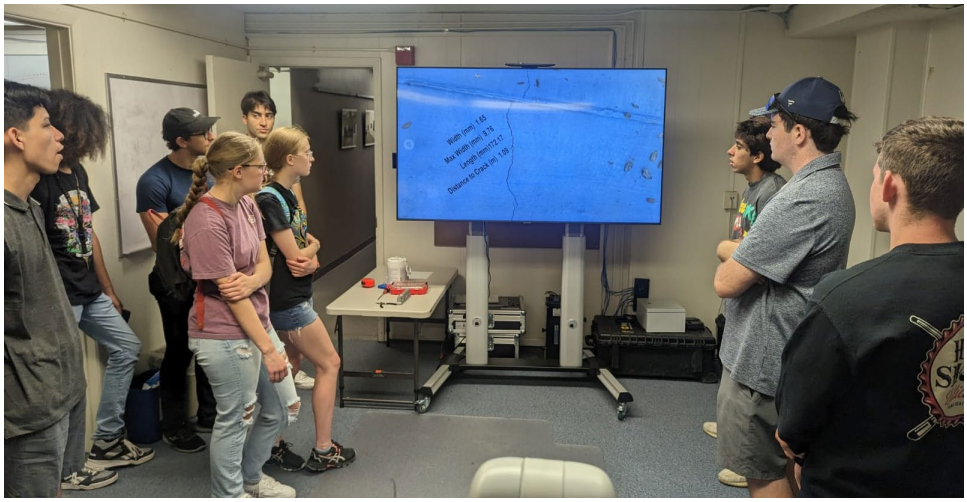


Figure 14. University of New Mexico Student Cohort

4.4 Assessments and Surveys

In Phase II, instructors assessed student knowledge of railway topics before and after the program . They also assessed students' level of belongingness and identity before and after the program to measure changes in attitude about the rail industry and potential careers.

4.4.1 Knowledge Assessment

The knowledge assessment and the engineering belongingness survey are shown in Appendix C and Appendix D, respectively. The pre- and post-assessment questionnaires were identical except for the introduction. Both knowledge assessments consisted of 19 questions with a variety of formats: true/false, multiple choice, and short answer. On questions where the students were asked to list as many items as they could, the team capped the scoring at 3 points each. Table 5 below shows the knowledge results for Phase II students. The PPI score is the percent of possible improvement and is calculated by subtracting the pre-score from the post-score and dividing the result by the difference between the pre-score and 100 percent. The "Score Range" and "% Range" rows show the difference between the lowest and highest score of the assessment.

Table 5. Knowledge Assessment Scores

[3] Smart Management of Infrastructure Laboratory researchers are developing new methods and means to impact youth in Science and Technology research. This group connects high schoolers with research and new technologies to encourage them to join the University of New Mexico for future college careers in science and engineering. Moreover, students can engage in hands-on experience while demonstrating the practical applications of engineering in the real world.

Phase II	Pre-score	Post-score	Improvement	PPI Score
Mean Score	11.4	15.8	4.4	
Mean %	49.7	55.1	5.4	
Median Score	12.7	18.3	5.6	
Median %	61.2	79.7	18.5	
Score Range	22	22.7		
% Range	95.6	98.6		
	n=96	n=43		
Phase II Matched		**n=40**		
Mean Score	11.9	16	4.1	
Mean %	51.6	69.5	17.9	37.4
Median Score	13.2	18.5	5.3	
Median %	57.2	80.4	23.2	46.1
Score Range	19	22.3		
% Range	83	97		

Note that the team had problems collecting viable data in Phase II. Although nearly 80 percent of the students completed the pre-assessment, less than half completed the post-assessment. It appears that many of the students completing the post-assessment were rushed and did not complete all questions. For example, 10 of the 40 in the matched pair set scored lower on the post- than the pre-assessment, and three students who had perfect scores (e.g., named all 7 Class I's and 10 passenger systems in pre-assessment) did not name any on the post-assessment. This is reflected in the much higher range of scores during Phase II.

Overall, students showed improvement in their knowledge after the week, with similar results in both Phase I and II.

4.4.2 Engineering Belongingness Survey

Researchers collected 52 pre-surveys and 32 post-surveys, and 23 matched pairs. One pre-survey respondent only answered one question, so this response was removed from the data.

Table 6 presents the outcomes and statistical analysis, where the median is used as the main explanatory variable for the data. Overall, the median increased or stayed the same for all the questions except one, "I enjoy learning rail transportation /engineering," where the median dropped one point, moving from Strongly Agree to Agree.

The median increased by two increments on three questions that all moved from Neutral to Agree:

- "A career in rail transportation/engineering will give me the kind of lifestyle I want."
- "A degree related to rail transportation/engineering will allow me to get a job where I can use my talents and creativity."
- "I have a lot in common with the other students in this summer program."

In the matched pairs, two questions dropped one point, from Strongly Agree to Agree:

- "I am interested in learning more about rail transportation/engineering."

- "I enjoy learning rail transportation/engineering."

One question increased by two points, from Neutral to Strongly Agree:

- "A career in rail transportation/engineering will give me the kind of lifestyle I want."

Researchers saw a very small change in the mean values between pre- and post-surveys, most in the positive direction. Although seven measures decreased (highlighted yellow in Table 6), only one was by more than half a point. Nine increased – two of them by more than a full point.

Table 6. Engineering Belongingness Survey Scores

	All data records						Matched Pairs Only					
Questions	**Post Mean**	**Pre Mean**	**Delta**	**Post Median**	**Pre Median**	**Delta**	**Post Mean**	**Pre Mean**	**Delta**	**Post Median**	**Pre Median**	**Delta**
A career in rail transportation/engineering will give me the kind of lifestyle I want.	5.25	3.98	1.27	6	4	2	5.43	3.91	1.52	6.0	4.0	2.0
A degree related to rail transportation/engineering will allow me to get a job where I can use my talents and creativity.	5.72	4.14	1.58	6	4	2	5.78	4.14	1.83	6.0	5.0	1.0
A degree in rail transportation/engineering will allow me to obtain a job that I like.	5.34	5.20	0.14	6	5	1	5.57	5.18	0.61	6.0	5.0	1.0
I can relate to people around me in this summer program.	5.50	4.94	0.56	6	5	1	5.74	4.95	1.00	6.0	5.0	1.0
I have a lot in common with the other students in this summer program.	5.06	4.67	0.39	6	4	2	5.26	4.68	0.78	6.0	4.5	1.5
The other students in this summer program share my personal interests.	4.91	4.82	0.09	5	5	0	5.04	4.73	0.52	6.0	4.5	1.5
My parents see me as a rail transportation engineer.	4.78	4.86	-0.08	6	5	1	5.09	5.00	0.30	6.0	5.0	1.0
My instructors see me as a rail transportation engineer.	4.91	4.49	0.42	5	4	1	5.09	4.59	0.70	5.0	4.0	1.0
My peers see me as a rail transportation engineer.	4.59	4.29	0.31	5	4	1	4.91	4.45	0.65	5.0	4.5	0.5
I am interested in learning more about rail transportation/engineering.	5.31	5.94	-0.63	6	6	0	5.52	5.95	-0.17	6.0	7.0	-1.0
I enjoy learning rail transportation/engineering.	5.69	5.90	-0.21	6	7	-1	5.91	5.95	0.22	6.0	7.0	-1.0

Questions	All data records						Matched Pairs Only					
	Post Mean	Pre Mean	Delta	Post Median	Pre Median	Delta	Post Mean	Pre Mean	Delta	Post Median	Pre Median	Delta
I find fulfillment doing rail transportation/engineering.	5.28	5.31	-0.02	6	6	0	5.43	5.41	0.26	6.0	6.0	0.0
I am confident that I can understand rail transportation/engineering in this program.	5.69	5.94	-0.25	6	6	0	5.96	5.95	0.26	6.0	6.0	0
I am confident that I can understand rail transportation/engineering outside of this program.	5.44	5.84	-0.40	6	6	0	5.57	5.86	-0.04	6.0	6.0	0
I understand concepts I have studied in rail transportation/engineering.	5.41	5.16	0.24	6	5	1	5.61	5.41	0.43	6.0	6.0	0
Others ask me for help in rail transportation/engineering.	3.69	4.06	-0.37	4	4	0	4.13	4.09	0.22	5.0	4.0	1

Scale 1-7 1 = Strongly Disagree 7 = Strongly Agree

Pre-Survey n = 52 Post Survey n = 32

4.4.3 Program Survey and Student Feedback (Michigan Tech only)

Summer Youth Programs at Michigan Tech conducted a survey to obtain on Tracks to the Future. The questions and related results for the Michigan Tech cohort are included in Appendix E.

Overall, students seemed highly satisfied with the program, as 100 percent of the students would recommend the exploration to others and 91 percent rated the experiments and hands-on activities as Excellent (the remaining 9 percent rated them as Good). Over 90 percent of the students were also extremely or very inspired to learn more about rail exploration and 90 percent of students gave an Excellent rating to the instructor.

Some of the suggested improvements from the students included:

- More engaging online sessions
- More time on campus
- Consolidated email communications
- More time on passenger rail/public rail transit
- More focus on history of rail
- More hands-on learning

5. Lessons Learned and Recommendations for Next Phase

Phase II built on experiences from Phase I in 2022 and expanded the number of students and host universities. Overall, the summer 2023 program continued the success from 2022. Feedback from students and parents was very good, even for the hybrid home-study portions. However, several lessons were learned along the way.

5.1 Marketing, Coordination and Registrations

With the increased number of host universities and participating students, coordinating the marketing, registrations, and other student arrangements across six university locations was somewhat of a challenge, although clear improvements were seen over Year 1. The team made the following recommendations:

- **Clear deadlines.** Each university has their own target dates and specifics when organizing summer programs. These dates should be clearly identified in advance and coordinated as much as possible. A single master schedule should guide the various steps in the project.
- **Centralized registration process with individual university responsibilities.** A single registration form worked well for creating and communicating cohorts, but there were challenges when transferring responsibilities to individual universities.
- **Pre/post-survey process.** The team made great progress in getting students to complete the pre-program survey for the program. However, using an online post-program survey returned a very poor completion percentage.
- **Student travel support.** The rail industry was very generous with their support, but the reimbursement process continues to be a challenge.
- **Invoicing limitations.** Researchers learned that some universities can only invoice certain expenses internally, which made it difficult to pay for them using Michigan Tech University accounts.

5.2 Curriculum

Only limited modifications were made to the hybrid curriculum. The team again received positive comments from several parents who noted that they were amazed how engaged their students were with the online material, as several of them had traditionally struggled with remote education activities. Nevertheless, the team made the following observations and recommendations for improvements:

- **Content aligned with time available.** The team reduced the amount of material, which made teaching in the available time slots more manageable.
- **Google Docs instead of downloads.** All interactive work was done through Google Docs. This worked well and allowed instructors to monitor student group progress during the assignments.
- **Instructors' breaks.** The instructor workload increased with the number of cohorts. On particularly heavy instruction days, there should be a break between sessions.

- **Zoom use.** There were numerous questions about Zoom use logistics from the students during the hybrid sessions, but at times there was no one from the host university to respond to the questions. For Phase III, the team should identify a logistics/questions session and ensure the host university coordinator is present at that time.

6. Conclusion

Phase II of the *Tracks to the Future, Railroad Transportation and Engineering* summer program successfully expanded from Phase I to over 100 students and 6 host universities. The program received wide interest across the nation, and was considered a success. The team hosted 105 students from 18 different states, most rising eleventh and twelfth graders.

All cohorts used a hybrid format where students first spent two days participating in live remote sessions via Zoom and completing hands-on activities mailed to them prior to program start. Students then traveled to one of the host campuses for two days of on-campus activities and field visits. FRA funded the course development, the program fees for the students (including meals and housing), and field visit expenses at the host site. Rail industry companies provided limited travel support for students in need to reach the host site.

Phase II built on the experiences from Phase I and expanded the number of students and host universities. Overall, the Phase II program continued the success of Phase I. Students and parents provided positive feedback f for both the remote and in person activities. However, improvements can still be made in the registration process, program logistics, and travel expense reimbursement.

7. References

Federal Railroad Administration (2011). Railroad Industry Modal Profile, An Outline of the Railroad Industry Workforce Trends, Challenges, and Opportunities.

Federal Railroad Administration (2016). Railroad Industry Modal Profile, An Outline of the Railroad Industry Workforce Trends, Challenges, and Opportunities — Update, 2016.

Lautala, P., Nelson, D., Tyler Dick, C., Schlake, B., & Ghoshani, F. (2024). Expanding Summer Youth Programs in Rail through Virtual Learning and a National Campus Network – Phase I Report. Washington, DC: U.S. Department of Transportation.

Appendix A.
Registration Forms and Documents

Tracks to the Future 2023 - Registration

Thank you for your interest for the 2023 Tracks to the Future Program!
The program is currently overbooked, and we are putting some students on a waiting list. If you would like us to add you to the list, please provide the contact information, as well as your preferred location information as accurately as possible. However, there are no guarantees you will be included this year. We will use our waiting list to give students preferential booking for next summer.
We're looking forward to meeting all the 2023 cohorts this summer!
If you need more detailed information on the program, please visit http://rail.mtu.edu/event/tracks-future-session-1.

* Indicates required question

1. Email *

2. Student First Name *

3. Student Last Name *

4. Student E-mail Address *

5. Parent First Name *

6. Parent Last Name *

7. Parent E-mail *

8. Parent Phone Number

9. Student Mailing Address *

10. Student Home City *

11. Student Home State

12. Student Zip Code *

13. Student Grade, Fall 2023 *

Mark only one oval.

- 9
- 10
- 11
- 12

14. Student Gender *

Mark only one oval.

- Male
- Female
- Other: _____

15. Student Preferred Pronouns

_____

16. Ethnic Background *

Mark only one oval.

- Caucasian
- African American
- Native American
- Latino
- Other
- Prefer not to say

17. If Other, describe your ethnic background

18. Student's School Name *

19. School Address *

20. Please provide a short narrative (a few sentences or a paragraph) describing why you would like to attend this railway education program *

21. Please rank the Sessions and Cohorts (sites) you would like to participate in (you have to rank all six). Remember, Mon-Tue of the week are remote via Zoom, Wed. is travel day to host site, and Thu-Fri are at the host site. If the session you choose as first is oversubscribed we will try to assign your second choice. Use the next question to indicate if there are any cohorts you can't, or won't attend. *

Mark only one oval per row.

	First	Second	Third	Fourth	Fifth	Sixth
Session 1, June 19-23, Michigan Technological University, Houghton MI	◯	◯	◯	◯	◯	◯
Session 1, June 19-23, Fresno State University, Fresno CA	◯	◯	◯	◯	◯	◯
Session 1, June 19-23, University of South Carolina, Columbia SC	◯	◯	◯	◯	◯	◯
Session 2, July 17-21, Penn State University, Altoona PA	◯	◯	◯	◯	◯	◯
Session 2, July 17-21, University of Illinois, Champaign/Urbana IL	◯	◯	◯	◯	◯	◯
Session 2, July 17-21, University of New Mexico, Albuquerque NM	◯	◯	◯	◯	◯	◯

22. The previous question required you to rank all the session options and locations. Are there any locations you would not, or could not attend?
Remember Session 1 is **June 19 - July 23**, and Session 2 is **July 17 - July 21**

Check all that apply.

- [ ] Session 1, Michigan Tech, Houghton, MI
- [ ] Session 1, Fresno State University, Fresno, CA
- [ ] Session 1, University of South Carolina, Columbia, SC
- [ ] Session 2, Penn State, Altoona, PA
- [ ] Session 2, University of Illinois, Champaign, IL
- [ ] Session 2, University of New Mexico, Albuquerque, NM

23. In 2022 we had some industry companies that provided financial support to student families who could not afford to send a student. If financial support for the travel to your location where available would you need that support to be able to attend this year's program?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

24. Let us know, if you have any other questions

Tracks To The Future: Railroad Transportation and Engineering

For: All students grades 8-11

Dates: June 26-July 1, 2022 (On-Campus)

Applications are now closed. Please check back in Winter 2022 for information about the 2023 cohort.

Railroads, the high tech and environmentally sensitive transportation mode! Don't believe us? Come and learn why railroads remain the most energy-efficient mode of transportation and what forms modern railroad track, equipment, and communications/control systems might take. Learn how rail compares with other modes and leads the charge in reducing transportation greenhouse gas emissions! Find out ow it all works through classroom sessions, hands-on activities and field visits to railroad facilities.

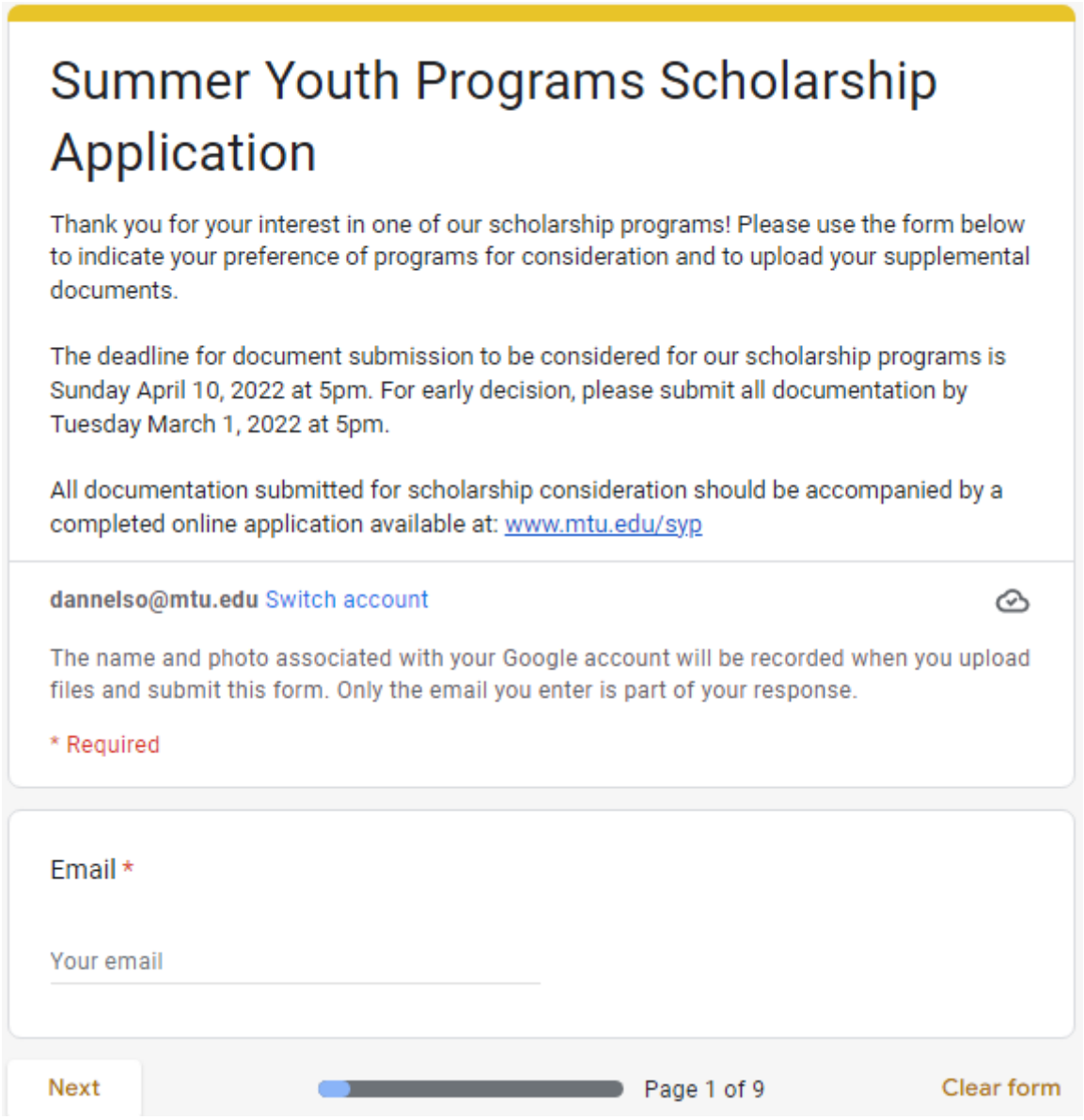
Note: Live-in participants only. This exploration will travel to various locations throughout Michigan's Upper Peninsula during the week, and may include an overnight stay in Escanaba, MI.

How to Apply

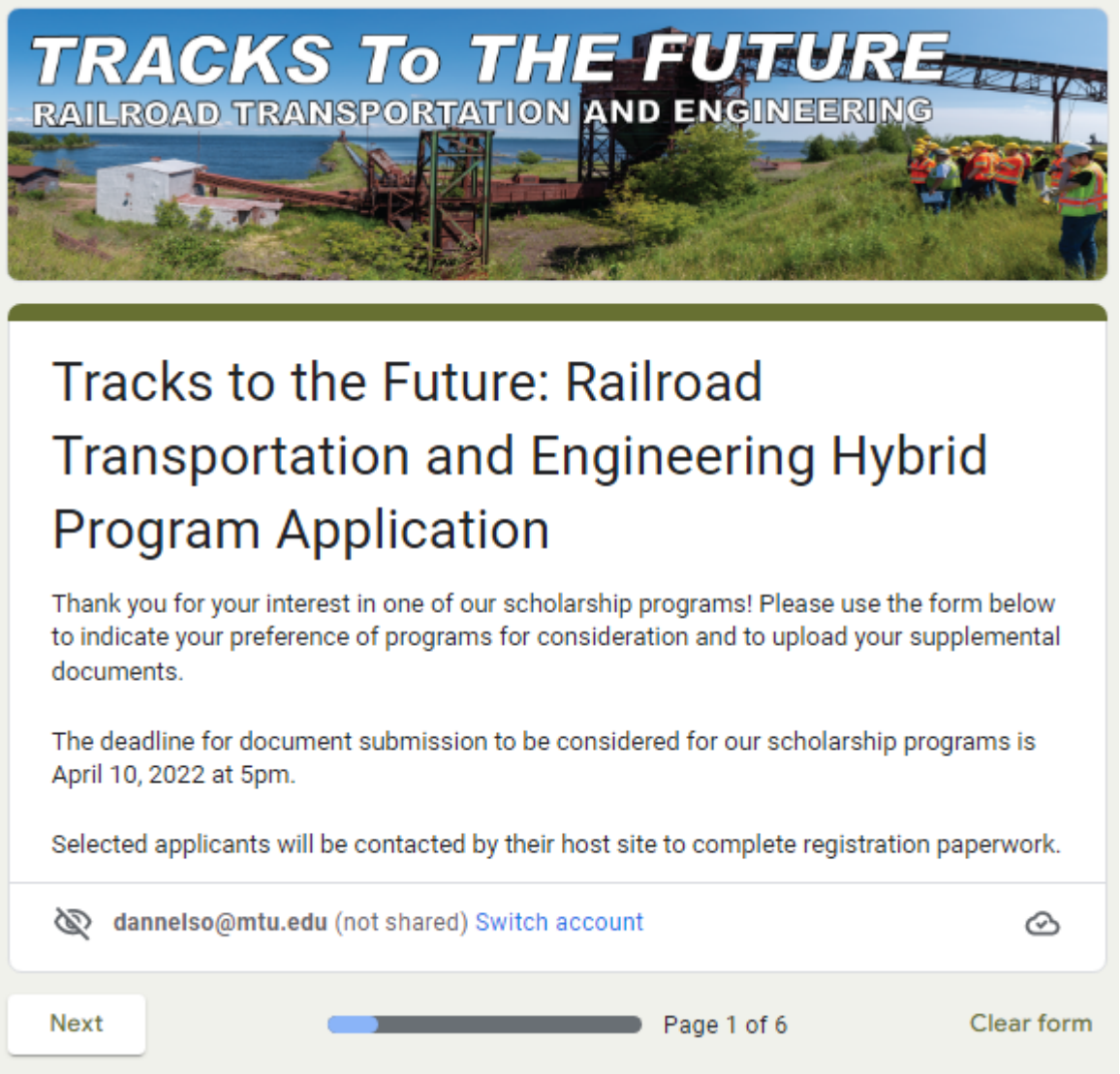
1. Complete the online SYP application here selecting "Tracks to the Future: Railroad Transportation and Engineering" (CRN 51204) as your program of choice.
   a. When prompted for deposit, click "Mail-In Deposit". Program fees will not be applied until selection decisions are made (within 3 weeks of the deadlines).

2. Provide supplemental documents *either* through our Summer Youth Programs Scholarship Application or by emailing documents to syp@mtu.edu.

Drop down box from Michigan Tech SYP



Michigan Tech SYP Application, Opening Page



Tracks to the Future Hybrid Opening Page of the Application

Appendix B.
Norfolk Southern Story on UIUC Visit

Developing the next generation of railroaders

We're developing the next generation of railroad talent, and Norfolk Southern recently hosted 21 students at our Decatur Terminal for a behind the scenes tour. They came from high schools from throughout the nation and were part of a summer program called *Tracks to the Future: Railroad Transportation and Engineering*.

The program was hosted by the University of Illinois Urbana-Champaign's Rail Transportation and Engineering Center (RailTEC) program. This program is possible thanks to funding by the Federal Railroad Administration (FRA). Students participate at no cost.

"It is important that we provide opportunities for students to see how our operations work by working in partnership with institutions such as the University of Illinois," said **Tim Crouch,** Manager of Dispatch Compliance and Training at the Network Operations Center. "These types of activities help to inspire the next generation of rail talent we need to fill positions in the future."

Students participated in a five-day program that included two days of at-home instruction, followed by a two-day visit to the University of Illinois Urbana-Champaign campus. The visit included a comprehensive overview of the railroad, facilities, equipment, and technology.

"For many of the students the field trip to NS' Decatur Terminal was their first opportunity to see rail operations up close and meet rail industry employees," said **Riley Edwards,** Assistant Professor and Manager of RailTEC's Infrastructure Research Program. "A visit like this creates a memory that we hope will point them toward the rail industry in their future education and career decisions. I am grateful to NS for their willingness to host these students and impact the next generation."

Click **here** to learn more about the University of Illinois RailTEC program.

Click here to learn more about the University of Illinois RailTEC program.

Appendix C.
Pre- and Post-Knowledge Assessments

Let's see what you already know about rail …. Name _____

Instructions: Answer the following questions to the best of your ability, however, please do not guess at an answer. If you really don't know, answer I Don't Know (IDK). If you think you have an answer, but aren't positive, go ahead and give it your best shot! Some of the multiple-choice questions have more than one correct answer, in those cases choose all the correct ones.

1. Where was the final spike for the transcontinental railroad driven?

A) Promontory, UT	B) San Francisco, CA
C) Omaha, NB	D) New York, NY
E) I Don't Know	

2. List as many large (Class 1) freight railroads in the US as you can? _____
3. List as many passenger rail/transit systems in the US as you can (up to 10)? _____
4. What is the most common freight car in the US today?

A) tank car	B) covered hopper
C) box car	D) flat car
E) I Don't Know	

5. How is a typical modern freight locomotive powered in the US?

A) Nuclear power turns an alternator to create electricity	B) Coal burns to heat water to steam
C) A diesel engine turns an alternator to create electricity	D) A gasoline engine drives a mechanical transmission
E) I Don't Know	

6. Railroad wheels are shaped like:

A) Flat cylinders	B) Cones
C) I Don't Know	

7. How is a typical bogie set held together?

A) Welding	B) Gravity
C) High strength bolts	D) Super glue
E) I Don't Know	

8. The average freight rail shipment in the US moves _____ miles.
9. The typical US Class 1 railroad freight train is _____ cars long
10. Most freight cars move directly from origin to destination on a single freight train. T/F/IDK
11. Amtrak owns all the rail lines it operates on. T/F/IDK
12. Most passenger trains in the North America operate at speeds over 100 mph T/F/IDK
13. Rubber truck tires have more resistance than steel train wheels. T/F/IDK
14. What does the ballast do in a track system?

A) Holds the track down to the ground	B) Keeps the ties from moving longitudinally
C) Provides vertical support underneath the sleepers	D) Provides drainage through the system
E) I Don't Know	

15. Diesel engines drive the wheels that make the maglev move forward. T/F/IDK
16. If you have a freight car with a nominal capacity of 110,000 pounds what is the maximum gross rail load?

A) 220,000 pounds	B) 263,000 pounds
C) 286,000 pounds	D) 315,000 pounds
E) I Don't Know	

17. Trains are very efficient, so it doesn't take a lot of accelerating force or braking effort to start and stop them. T/F/IDK
18. The number of trains per day that can travel across a single-track corridor is primarily dependent on siding length and location. T/F/IDK
19. Trucks are more effective for long-haul and high-volume transportation than rail T/F/IDK

Let's see what you learned about rail …. Name _____

Instructions: Answer the following questions to the best of your ability, however, please do not guess at an answer. If you really don't know, answer I Don't Know (IDK). If you think you have an answer, but aren't positive, go ahead and give it your best shot! Some of the multiple-choice questions have more than one correct answer, in those cases choose all the correct ones.

1. Where was the final spike for the transcontinental railroad driven?

A) Promontory, UT	B) San Francisco, CA
C) Omaha, NB	D) New York, NY
E) I Don't Know	

2. List as many large (Class 1) freight railroads in the US as you can? _____
3. List as many passenger rail/transit systems in the US as you can (up to 10)? _____
4. What is the most common freight car in the US today?

A) tank car	B) covered hopper
C) box car	D) flat car
E) I Don't Know	

5. How is a typical modern freight locomotive powered in the US?

A) Nuclear power turns an alternator to create electricity	B) Coal burns to heat water to steam
C) A diesel engine turns an alternator to create electricity	D) A gasoline engine drives a mechanical transmission
E) I Don't Know	

6. Railroad wheels are shaped like:

A) Flat cylinders	B) Cones
C) I Don't Know	

7. How is a typical bogie set held together?

A) Welding	B) Gravity
C) High strength bolts	D) Super glue
E) I Don't Know	

8. The average freight rail shipment in the US moves _____ miles.
9. The typical US Class 1 railroad freight train is _____ cars long
10. Most freight cars move directly from origin to destination on a single freight train. T/F/IDK
11. Amtrak owns all the rail lines it operates on. T/F/IDK

Appendix D.
Pre- and Post-Survey Engineering Belongingness

Belongingness & Identity Pre Survey

The following survey consists of 16 multiple choice questions. Circle the best answer for each.

1. A career in rail transportation/engineering will give me the kind of lifestyle I want.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

2. A degree related to rail transportation/engineering will allow me to get a job where I can use my talents and creativity.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

3. A degree in rail transportation/engineering will allow me to obtain a job that I like.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

4. I can relate to people around me in this summer program.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

5. I have a lot in common with the other students in this summer program.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

6. The other students in this summer program share my personal interests.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

7. My parents see me as a rail transportation engineer.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

8. My instructors see me as a rail transportation engineer.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

9. My peers see me as a rail transportation engineer.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

10. I am interested in learning more about rail transportation/engineering.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

11. I enjoy learning about rail transportation/engineering.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

12. I find fulfillment doing rail transportation/engineering.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

13. I am confident that I can understand rail transportation/engineering in this program.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

14. I am confident that I can understand rail transportation/engineering outside of this program.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

15. I understand concepts I have studied in rail transportation/engineering.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

16. Others ask me for help in rail transportation/engineering.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

Belongingness & Identity Post Survey

The following survey consists of 16 multiple choice questions. Circle the best answer for each.

1. A career in rail transportation/engineering will give me the kind of lifestyle I want.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

2. A degree related to rail transportation/engineering will allow me to get a job where I can use my talents and creativity.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

3. A degree in rail transportation/engineering will allow me to obtain a job that I like.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

4. I can relate to people around me in this summer program.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

5. I have a lot in common with the other students in this summer program.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

6. The other students in this summer program share my personal interests.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

7. My parents see me as a rail transportation engineer.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

8. My instructors see me as a rail transportation engineer.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

9. My peers see me as a rail transportation engineer.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

10. I am interested in learning more about rail transportation/engineering.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

11. I enjoy learning about rail transportation/engineering.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

12. I find fulfillment doing rail transportation/engineering.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

13. I am confident that I can understand rail transportation/engineering in this program.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

14. I am confident that I can understand rail transportation/engineering outside of this program.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

15. I understand concepts I have studied in rail transportation/engineering.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

16. Others ask me for help in rail transportation/engineering.

1–Strongly Disagree 2–Disagree 3–Somewhat Disagree 4–Neutral 5–Somewhat Agree 6–Agree 7–Strongly Agree

Appendix E.
Program Feedback Survey and Student Comments (Michigan Tech)

SYP 2023
Student/Parent Feedback

Tracks to the Future: Railroad Transportation & Engineering

Overall Exploration

100% Participants say their exploration was different than the classroom experience at home — avg. 93%

100% Participants say they would recommend this exploration to others — avg. 96%

91% Participants rated the experiments/hands-on activities during the course as Excellent (9% rated Good) — avg. 53%

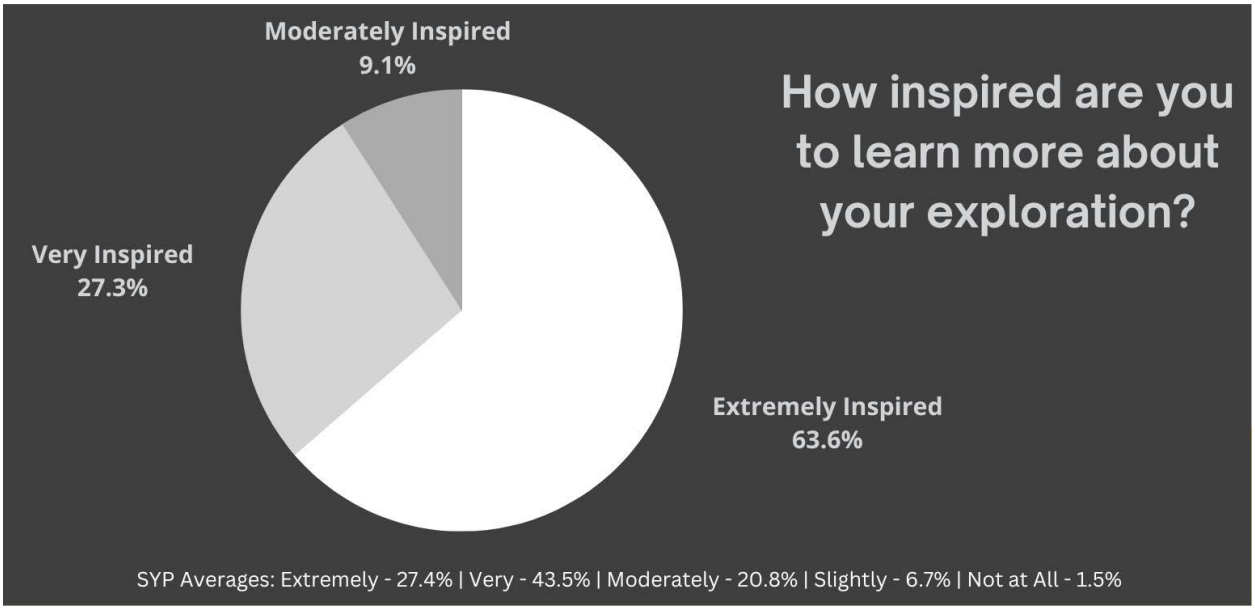
88% Eligible participants said they would return next summer if possible (27% said they will be too old) — avg. 88%

82% Participants gained confidence in their ability to be successful in a college atmosphere — avg. 91%

Student Feedback

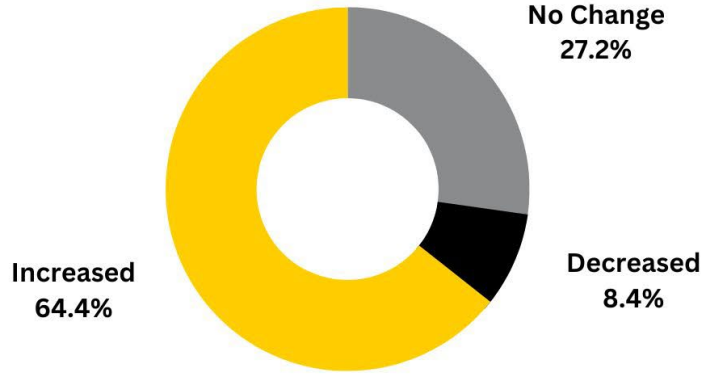
What improvements would you like to see in this course?

- More engaging Online sessions
- More time on campus
- Consolidated email communications
- More time on passenger rail/public rail transit
- More focus on history of rail.
- More hands-on learning



Parent Perceptions

How did attending SYP affect your students interest in attending Michigan Tech?



91.3% Felt the program offered an academic experience not available in their students school

57.5% Feel SYP is of Higher Quality or Much Higher Quality compared to other campus-based pre-college academic programs

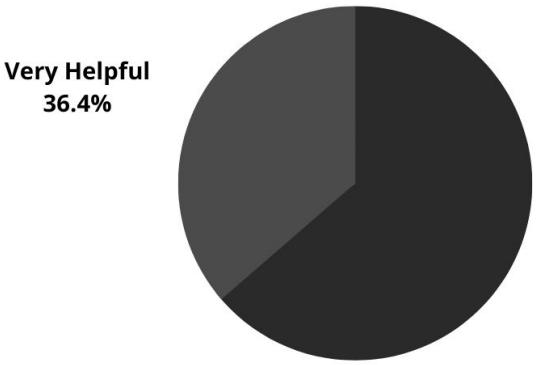
63% Parents indicated that SYP Greatly or Highly impacted their students knowledge of future career options

84.3% Ranked their students perceived quality of SYP Instructors as High or Extremely High quality.

64.2% Indicated attending SYP increased their student's interest in a career pathway

Instructor Performance

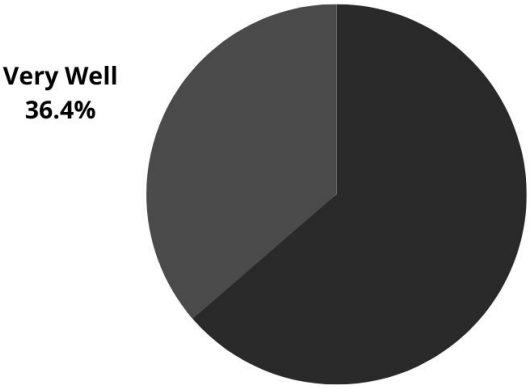
How helpful was your instructor at explaining material?



SYP Average

Extremely	43.7%
Very	43.5%
Moderately	11.6%
Slightly	1.2%
Not at All	0%

How well did your instructor allocate time to complete tasks?

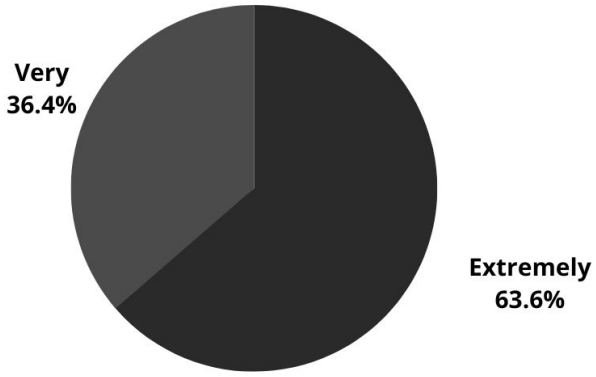


SYP Average

Extremely	48.6%
Very	42.5%
Moderately	7.4%
Slightly	1.2%
Not at All	0.3%

Instructor Performance

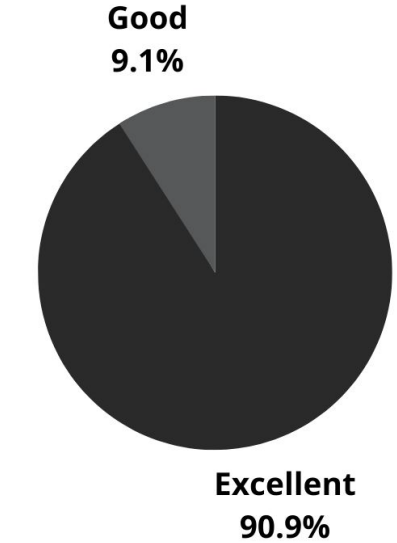
Did your instructor keep class interesting?



SYP Average

Extremely	43.5%
Very	39.7%
Moderately	13.6%
Slightly	3.1%
Not at All	0.2%

How would you rate your instructor(s) overall?



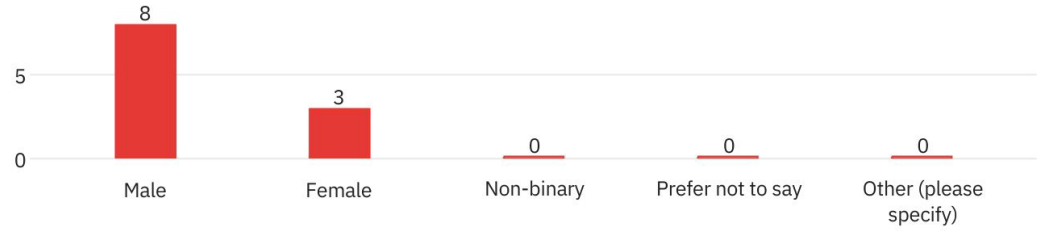
SYP Average

Excellent	67.1%
Good	25.9%
Average	5.7%
Fair	1.2%
Poor	0%

Tracks to the Future (Hybrid) 1

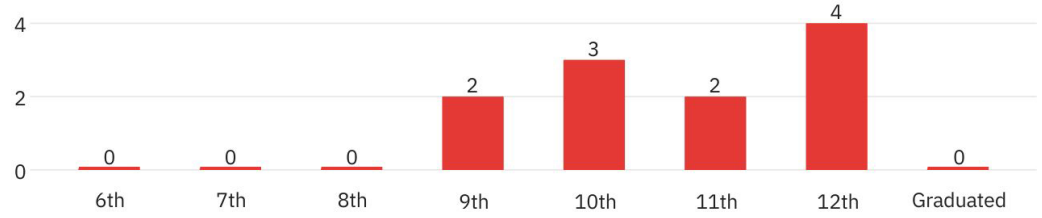
What is your gender?

11 Responses



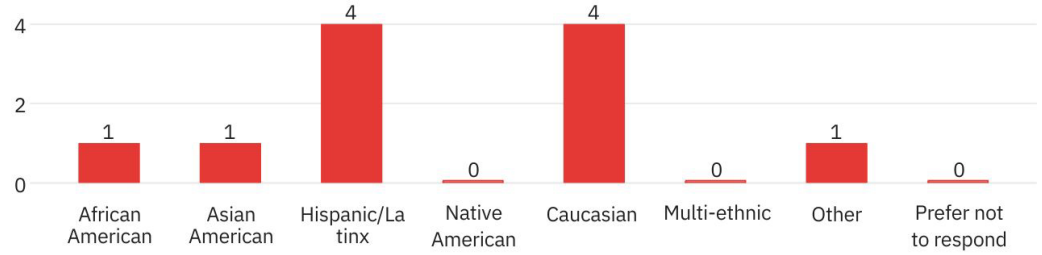
What grade will you be in this fall?

11 Responses



What is your ethnicity?

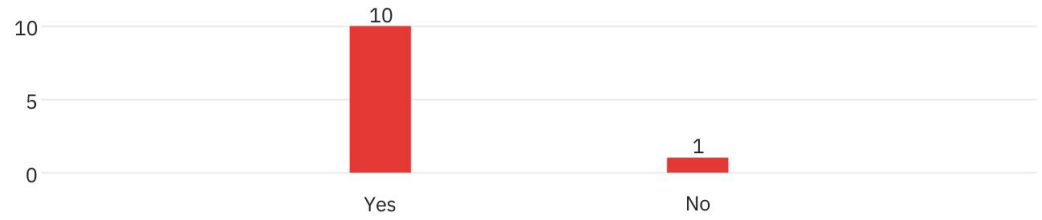
11 Responses



Tracks to the Future (Hybrid) 2

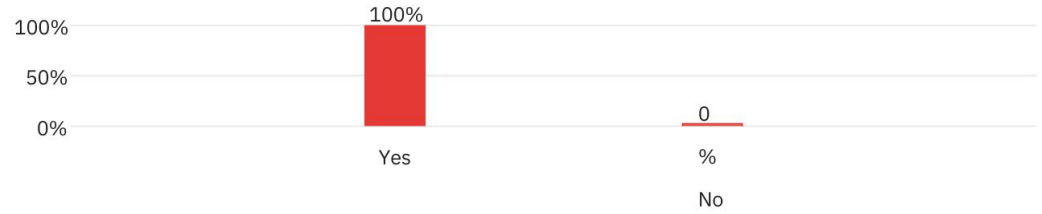
Was this your first summer at SYP?

11 Responses



Was your course experience different from your classroom experiences at home?

11 Responses



How so?

11 Responses

How so?
This was a more engaging learning environment and I really did enjoy it
I was an industry I never knew about until I took tracks to the furture
there where more interactible learning materials and they brought people that work in the industry
None of my courses at home are related to rail. There was also a higher concentration of hands on activities
It was hybrid, more hands on, and had more field trips.
Very important to me because I am hands on and only learn in person. I can't focus online
We had a lot more hands on activities
It was different
It was more hands on and very indulging and interesting

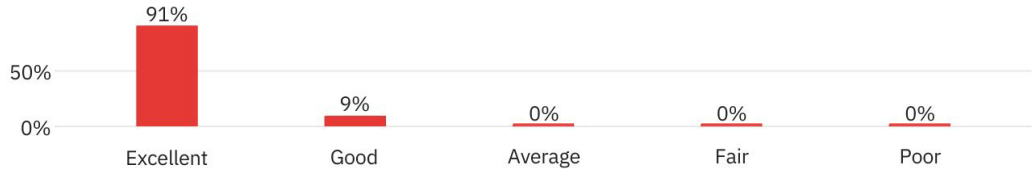
Tracks to the Future (Hybrid) 3

There was more hands on learning and fewer students and was more fun

I was there

How would you rate the experiments/hands-on activities during your course?

11 Responses



Q13 - What was your favorite class activity/experiment and why?

10 Responses

What was your favorite class activity/experiment and why?
The train race where we had to make the most money by running trains
I enjoyed comparing moving crates with trucks compared with trains.
oTour of the Rialrods and car facilities, the reason why liked this activity the most is because I finally got to see real car shops and Maintenace and repairs of equipment and how everything works in the industry and the tour of the mines also for the same reason as previus
I liked the railroad operation simulation with toy PlanCity trains, especially the dispatch job.
I really liked the operation activity with the toy trains.
Going to explore the site at the ELS, it was a beautiful place where I learned so much about repairs and cars
The Maglev experiment because we were able to design our own trains.
My favorite activities were the Maglev demonstration and activity and all of the activities that had to do with the operating of the lines and constructing a shipment
I liked the rail management activity because of the unique teamwork and collaboration
Train simulator

Tracks to the Future (Hybrid) 4

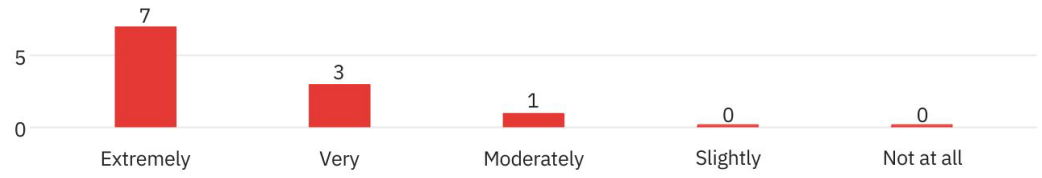
Would you recommend this course to others? Why or why not?

10 Responses

Would you recommend this course to others? Why or why not?
Yes I would recommend this course to others because I feel like it is a great learning opportunity for people who may not like trains
Definitely, they covered a lot of material with a short amount of time.
yes,the reason why is because i think the program in general the summer youth program has something for everyone and you get to meet very friendly people
Yes if they are interested in rail. It is a one of a kind course and it gives you an idea as how to proceed to college and careers in that field
Yes, if I knew someone interested in rail.
Yes, even though I was not really interested in railroads, it was very beautiful and I loved it. I learned so much about engineering and it has helped me to navigate the process
Yes, it's very informative.
Yes. It is very engaging, indulging, and interesting.
Yes; It was a great experience for those with interest in a particular field or topic
Yes because it's fun

How inspired are you to learn more about your exploration after attending SYP?

11 Responses



What are your top 3 career choices right now?

10 Responses

What are your top 3 career choices right now?
Railroad engineer, transportation engineer, travel agent

Tracks to the Future (Hybrid)

5

Construction Management
Railroad Engineering, Civil Engenieering, Architecture
Railroad design civil engineer, urban planner, architect
City planner, civil engineer, and railroad engineer
Mechanical Engineering, Poly Sci, Music
Transportation planning, city planning, transportation design
Civil Engineer (Planning railroads and cities), A different mode of engineering or something similar(like mechanical or architecture), or mathematics
Railroad Engineer, Naval Architect/Engineer, Maglev Designer
Train driver,Lawyer,Selling homes

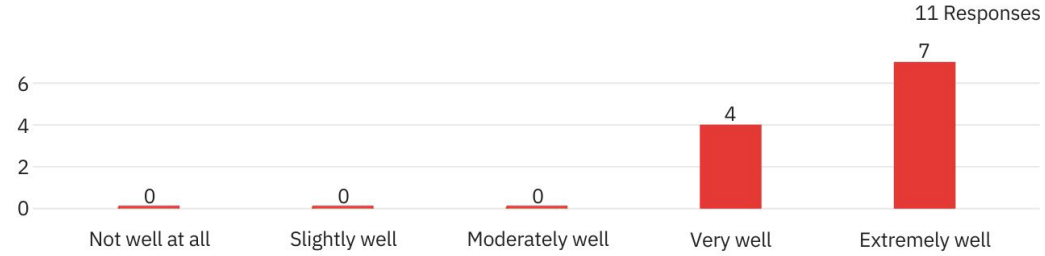
Tracks to the Future (Hybrid) 6

How helpful was your instructor in explaining the material?

11 Responses

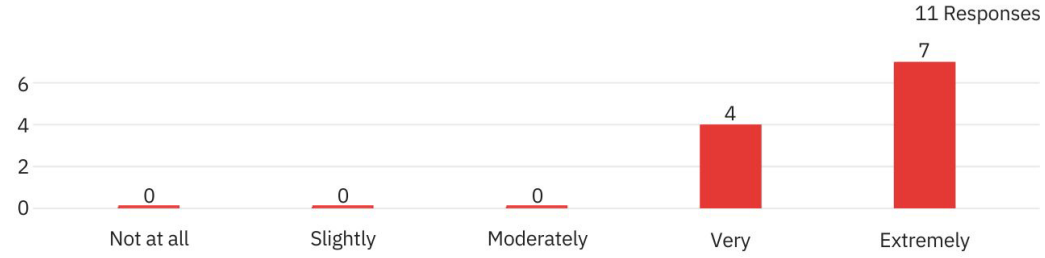
How well did your instructor allocate time to complete tasks?

11 Responses



Did your instructor keep class interesting?

11 Responses



What improvements would you like to see in this course?

10 Responses

What improvements would you like to see in this course?
The only improvements I would like to see would be more engaging online lessons
No improvements necessary.
it was all good

Tracks to the Future (Hybrid) 7

Pre-camp communication was confusing. I got multiple emails a day, so when I needed to find a particular one, I couldn't even with in email search. I did not know we were staying in a hotel in Escanaba for our field trip until the day before. I also didn't know linens were being provided at the dorm either, or what time we needed to be there until the day before

I would have liked to arrive later on Wednesday or have the whole week in person.

Integrate the presentations into the activities because it keeps our attention more

If possible I think more time should be spent on passenger rail or other rail based public transit. Also, while the course is titled tracks to the future I do think a little more focus should be allowed for the history.

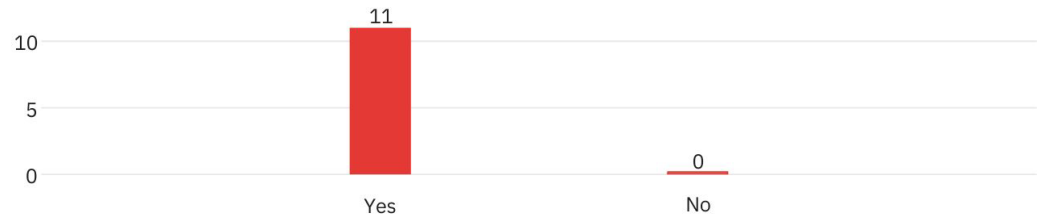
I didn't see anything that necessarily needed to be changed

Less lectures, more hands-on learning and no Zoom hybrid

More free water

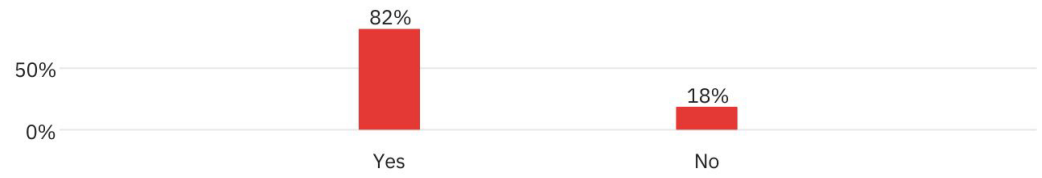
Before coming to SYP, did you plan to attend college?

11 Responses



Since attending SYP, have you gained confidence in your ability to be successful in a college atmosphere?

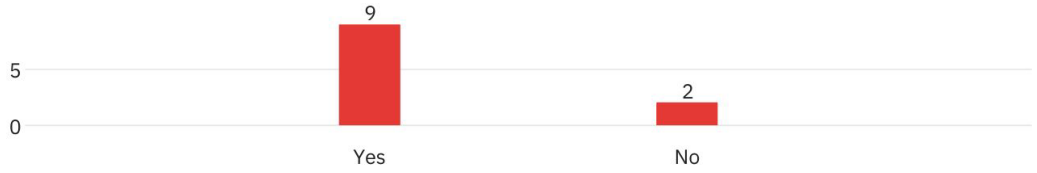
11 Responses



Tracks to the Future (Hybrid) 8

Has participating in this program positively influenced your thinking about attending Michigan Tech?

11 Responses



Appendix D.
Training Modules Detail

Module 0: Pre-Course Assignments

The opening module required student to complete two survey documents, the pre-skills knowledge assessment and the pre-belonginess survey. These documents were intended to allow researchers to assess whether the material and activities provided in the program produced any change in student knowledge or attitude. The survey documents are included in Appendix B.

Module 1: What is Rail Transportation

This module introduced the rail industry. This material was presented synchronously using Zoom, PowerPoint slides, and Kahoot! competitions.

Part 1 – Industry Panel Discussion, Welcome and Rail Industry Jobs

Program started with moderated industry panel discussion between representatives from Diamond level industry sponsors, followed by student and instructor introductions, and finished with a short PowerPoint slide presentation focusing on industry jobs and the railroad programs at each university.

Part 2 – Transportation Modes and Railroad History

The second part started with discussion of transportation in general and introduced the different modes for both freight and passenger operations. Instructors started a Kahoot! competition during the second presentation.

The second presentation covered the history of rail, from beginnings in the early 1800's, through the golden years in the late 1800's, the death spiral in the mid 1900's, and the Staggers Act of 1980. Instructors again used Kahoot! questions to maintain student interest and engagement.

Part 3 – Railroad System Components Freight and Passenger Rail Transportation Today

The first presentation provided a macro level overview of a railroad and what is required to operate one. The discussion included use of word clouds to brainstorm different components of the system, locomotives, railcars, crew, passengers, cargo, fuel, and all the paperwork required to keep track of the commodities moved. The slides used a passenger train example to focus the discussion.

Instructors concluded the introductory module with a final PowerPoint presentation with embedded Kahoot! competitions to look at how railroads have progressed since the Staggers Act. Topics covered included the rail consolidations that led to today's Class 1 railroads, the shortline railroads that support them, the commodities the railroads move, and the infrastructure involved. The morning sessions ended with an introduction to the different types of passenger rail operations, both in the US and around the world.

Module 2: Rolling Stock and Locomotives

Module 2 focused on the rail cars and locomotives used across the rail industry. The presentation centered on PowerPoint presentations in Zoom with embedded poll questions. It also featured two hands-on activities.

Part 1 – Locomotives

Instructors used a PowerPoint presentation to focus student discussion. This section also featured a Wheel Dynamics activity, using 3D printed "cylinders" with different profiles to illustrate the wheel shape used on modern railcars and locomotives. Students rolled the cylinders down a curved track they assembled at home, and noted which shapes managed to stay on track. The student cohort reconvened for a short discussion of their findings.

Part 2 – Railcars

This session again included a PowerPoint presentation, this time to discuss the parts of a typical car and the markings on its sides. Instructors presented an interactive quiz on car parts, used a Menti WordCloud to discover what kinds of cars students were already familiar with, and discussed the various types of cars and where they were used. The session ended with a discussion of railcar loading and a Kahoot! competition on railcar information.

Part 3 – Train Energy Management

This session opened with a Kahoot! on braking and train energy management. Instructors followed with a PowerPoint presentation covering the history of rail brakes and how they evolved to today's standards. A YouTube video of Wabtec's Trip Optimizer system was used to illustrate train handling concepts. This session ended with a presentation about alternative power systems for locomotives.

Module 3: Freight Operations

Instructors opened the second day of the home sessions with an introduction to Freight Operations. This session again used PowerPoint, with Kahoot! competitions interspersed throughout the presentation, as well as several videos and individual and group activities.

Part 1 – State to State Freight Movements

This group activity used Zoom breakout rooms. Students researched commodity flows between state pairs and reported back to the larger group at the end of the activity.

Part 2 – Network Operations, Trucks vs Trains

An individual guided activity introduced network operations using materials included in the lesson kit.

Part 3 – Freight Rail Terminals

The final part of the freight operations module included two activities. The first was a small group activity where students explored a variety of freight rail yards and then compared them with the rest of the students in the main classroom. Then students used a freight yard diagram and a set of paper cars and locomotives to "sort" rail cars using the Basic Sorting Process. The instructor also demonstrated Geometric and Triangular sorting using the same tools, allowing students to follow along on their own freight yards (provided as part of the student package).

Module 4: Passenger Operations

Module 4 was conducted in three parts: Passenger Operations, High Speed Rail, and Urban Rail Transit. Each part used a PowerPoint presentation with embedded Kahoot! competitions. Instructors also included a variety of student activities, as detailed below.

Part 1 – Intercity Rail

This session included a brief discussion of current Amtrak operations and the shared track concept. The session ended with a small group activity where students investigated the time and cost to complete a journey between a US city pair using four different passenger modes. Students returned to the large group to discuss their findings.

Part 2 – High Speed Rail (HSR)

This session introduced high speed rail with a discussion of systems in operation around the world, highlighting that the US is significantly behind in HSR development. Instructors also discussed the "sweet spot" for HSR operations distance, and how the distance between many US city pairs makes HSR more difficult to implement.

The session included two student activities. The first activity asked students to work in small groups and research the operating characteristics of five different rail corridors, each around 200 miles long. Characteristics included the number of daily service options, the time required to complete the route, and the cost to do so. As the students discovered various parts of the puzzle, they entered the values in a shared Google Docs sheet. The activity wrapped up with a guided discussion illustrating the differences.

The second activity required students to work in small groups to compare a potential highspeed corridor in the US with an existing one in China. The activity pointed out that the corridors have similar distance and population characteristics, illustrating the idea that there are some areas in the US where HSR might make sense.

Part 3 – Urban Rail Transit

The final virtual session illustrated the different types of urban rail systems currently operating in the US and where those systems are found. The session wrapped up with a final student activity where students used internet resources to research the characteristics of an assigned transit system. Students returned to the full group session to compare results.

Abbreviations and Acronyms

ACRONYM	DEFINITION
AREMA	American Railway Engineering and Maintenance of Way Association
FRA	Federal Railroad Administration
HSR	High Speed Rail
NRC	National Railroad Construction and Maintenance Association
NS	Norfolk Southern
PSU	Penn State University
SYP	Summer Youth Program
UIUC	University of Illinois, Urbana-Champaign