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Guidebook for Railway-themed K-12 STEM Outreach Activities

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Introduction

Welcome to the *Guidebook for Railway-themed K-12 STEM Outreach Activities*! Inside, you will find descriptions of educational activities designed to introduce students to the railroad transportation mode through the lens of STEM (Science, Technology, Engineering, and Mathematics) concepts.

Railroads have been a critical part of the global economy since the 1830s. Today, railroads haul more ton-miles of intercity freight (one ton of freight moved one mile) than any other mode of transportation in the United States. While the railroad industry is the leader in long-haul freight transportation, recruiting students to leadership roles in the industry is challenging. With many railroad employees approaching retirement age, the need to raise student awareness of railway industry career opportunities has never been greater.

The activities in this guidebook cover a wide variety of railroad topics. The activities are intended to be hands-on to provide students with knowledge through experiential learning that also increases their awareness of railway transportation technology. Although the following chapters provide a step-by-step guide to each activity, we encourage you to experiment with modifications to each activity and to create your own activities on other facets of the railroad industry and STEM topics.

We hope you find the activities in this guidebook to be informative and entertaining!

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Railroad Safety, and Potential Collaborators, Educational Opportunities and Resources for Additional Learning

We hope that you find the activities described in this guidebook informative and entertaining. While we presented the methods and materials we used to conduct these activities, we strongly encourage you to experiment with different materials and methods to develop these activities into a learning experience that fits your group. The possibilities for new activities to teach railroad transportation, engineering and STEM concepts are endless, and we hope these activities serve as inspiration for your own activities.

Although this subject is not detailed in any of the activity guides presented earlier, we strongly encourage instructors of any railroad-related activities to discuss railroad safety. Approximately 95% of railroad fatalities are due to pedestrians trespassing on railroad property or highway grade crossing collisions, and the best way to lower these numbers is to educate. Here are some key points to teach:

- An average freight train travelling at 55 MPH can take over a mile to stop. Do not expect a train to stop if there is something on the tracks.
- Railroad tracks and right-of-way is private property and unauthorized access is trespassing, which can result in a fine. Never use railroad tracks as a short cut while walking. Only cross railroad tracks at designated public crossings.
- With modern distractions such as texting or listening to music, it can be hard to hear an oncoming train, so always remember to stay alert near railroad tracks. Expect a train on any track, from any direction, at any time.
- Never try to race a train at a railroad crossing. A train hitting an automobile is about the same as an automobile running over a soda can.

Figure 1: Highway grade crossing with Emergency Notification Sign and crossing number

- If your vehicle becomes stuck, stalled or disabled on a railroad crossing, find the blue and white Emergency Notification System (ENS) sign and call the phone number to let the railroad know the crossing is blocked. Be sure to tell them the crossing number printed on the ENS sign. In Figure 1, the crossing number is 759668R.
- If a train is approaching and your vehicle is stuck on the tracks, leave the vehicle and get clear of the tracks. If you see a train approaching, it is best to walk or run at a 45˚ angle away from the crossing but towards the oncoming train to avoid being hit by debris.

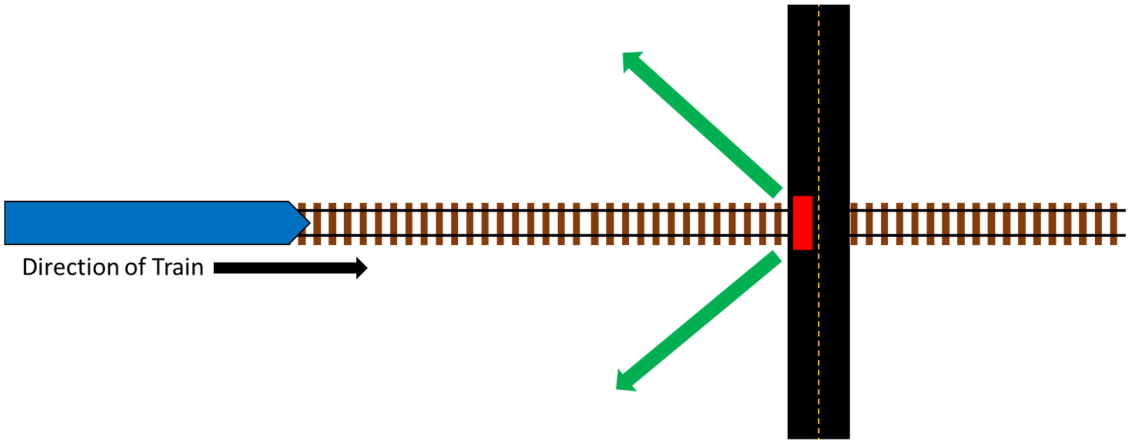

Figure 2: If your vehicle is stuck on a crossing and a train is approaching, move away at a 45˚ angle to avoid being hit by debris as shown by the green arrows.

If you would like to learn more about railroad safety, visit the official website of Operation Lifesaver (https://oli.org/safety-near-trains). Operation Lifesaver is a national organization created by the railroad industry in 1972 to educate the public about railroad safety. Through trained local representatives in communities across the country, Operation Lifesaver offers free youth-oriented railroad safety educational materials and presentations that can be requested for local events and community groups.

Potential Partner Organizations

For railroad safety, an excellent organization to partner with is Operation Lifesaver. However, there are other railroad-related organizations that may be willing to partner with you to educate students about the railroad industry. A few of these groups are listed here.

Railroad Museums:

There are hundreds of railroad museums and tourist railroads across the United States and Canada. Many of these organizations have an educational mission and would likely be willing to assist you in introducing railroad topics to students. For example, at the University of Illinois, students enrolled in railroad engineering classes participate in a work day each year held at the Monticello Railway Museum (Figure 3). These work days provide students an opportunity to learn about track maintenance and tools in a hands-on environment. Many museums and tourist railroads in North America are members of the Heritage Rail Alliance (https://heritagerail.org/). If you are unsure of the nearest railway museum, the Heritage Rail Alliance may be able to assist you in locating an organization nearby.

Figure 3: University of Illinois students replacing crossties at the Monticello Railway Museum.

Model Railroad Clubs:

While it is unlikely that any model railroad clubs in your area have a display or other setup dedicated to education, they may be able to help with recommendations for materials and suppliers for activities involving model railroad products. In some instances, there may be opportunities to use existing model railroad layouts to teach "big-picture" concepts such as rail line capacity, signaling systems, traffic control systems, and train dispatching. These types of opportunities will vary depending on the facilities of each club and the availability of the club membership to support such activities. Many clubs and model railroaders are members of the National Model Railroad Association (https://www.nmra.org/). If you are unsure if there are any clubs or model railroaders in your area, the NMRA may be able to put you in contact with a local club representative or member.

Railway Engineering Firms and Contractors:

There are many engineering firms of various sizes that participate in railway design. These firms may be willing to provide a presentation to your students on the work they perform and about the railroad industry in general. Additionally, many engineers that work for these firms are members of the American Railway Engineering and Maintenance-of-Way Association (AREMA, https://www.arema.org/). AREMA has a committee dedicated to Education and Training (Committee 24) that may be able to put you in contact with a railway engineering professional interested in serving as a classroom speaker.

AREMA also supports a number of student chapters at universities across North America. These student chapters frequently participate in educational events. For a current list of AREMA Student Chapters, please visit: https://www.arema.org/AREMA_MBRR/Students/Student_Chapters_List.aspx

Many railway engineering firms and contractors that construct track, bridges and other railroad infrastructure projects are members of the National Railroad Construction and Maintenance Association (https://www.nrcma.org/) which is another resource for making contacts with local professionals.

Railroad Supply Companies:

In addition to engineering firms, there are many companies that supply the railroad industry with components, systems, and services. You may be able to get a representative from one of these companies to present their work and information about the railroad industry. Many of these companies are members of the Railway Supply Institute (https://www.rsiweb.org/), which may be able to assist you in contacting a local railroad supply company.

Freight Railroad Companies and Passenger Rail Operating Agencies:

While most railroad companies do not have railroad education programs, it is in their interest to recruit students to the rail industry, so they may be willing to participate in educational events if contacted through their public relations departments. There are also two trade associations that occasionally participate in educational events and may help you contact a local freight railroad representative:

- Association of American Railroads (https://www.aar.org/)
- American Short Line and Regional Railroad Association (https://www.aslrra.org/)

Agencies responsible for the management and operation of regional commuter rail and urban rail transit systems (such as light rail and subways) can also be contacted directly or through the American Public Transportation Association (https://www.apta.com/). With a focus on serving the transportation needs of the local travelling public, these organizations may be willing to support educational activities.

Figure 4: A student learns the basics of locomotive operation on the Norfolk Southern Railway locomotive simulator during Engineering Open House at the University of Illinois.

Other Educational Opportunities

If you have students who are interested in learning more about the railroad industry, there are several opportunities for further learning.

Boy Scouts of America Scouts BSA Railroading Merit Badge:

If the student is a member of the Boy Scouts of America, they may be able to obtain the Scouts BSA "Railroading" merit badge. Fulfilling the merit badge requirements will teach them the basics of the railroad industry and serve as a foundation for further education on railroad topics. For more information on the requirements of this merit badge, please visit: https://filestore.scouting.org/filestore/Merit_Badge_ReqandRes/Railroading.pdf

Summer Camps:

Several organizations offer railroad summer camps for youth. These camps typically expose the students to a variety of railroad topics and encourage hands-on learning. Some of these camps include:

- National Railway Historical Society RailCamp: https://nrhs.com/programs/railcamp/
- Michigan Technological University Summer Youth Program in Rail and Intermodal Transportation: http://www.rail.mtu.edu/youth-and-pre-university-programs
- Penn State Altoona Kids' College Railroad Camp: https://altoona.psu.edu/offices-divisions/continuing-education-training/kids-college
- Tennessee Valley Railroad Museum Summer Camp: https://www.tvrail.com/events-exhibits/rides/railroad-summer-camp

University Degree Programs and Courses:

If a student is interested in pursuing a career in the railroad industry, there are specific degree programs in railroad engineering programs at several universities in North America:

- University of Illinois at Urbana-Champaign: Civil Engineering BS/MS/PhD with Railroad Primary, and Master of Engineering in Railway Engineering Degree, https://railtec.illinois.edu/academics/
- Penn State Altoona: Rail Transportation Engineering Degree Program, https://altoona.psu.edu/academics/bachelors-degrees/rail-transportation-engineering
- Michigan Technological University: Minor in Rail Transportation, Rail Transportation Program, http://www.rail.mtu.edu/minor-rail-transportation
- University of South Carolina: Graduate Railway Engineering Certificate, https://sc.edu/study/colleges_schools/engineering_and_computing/academics/graduate_programs/railway_engineering_certificate/index.php

Additional universities may offer one or more specific courses on railway engineering topics but not have specific railroad degree programs. Many of these universities are the same institutions that host AREMA student chapters. A website link to a list of active AREMA student chapters can be found under *Engineering Firms* within the Potential Partner Organizations section of this chapter.

Resources for Additional Learning

If you would like to learn more about the railroad industry and various subjects related to the activities in this guidebook, some additional resources are suggested below:

- "The Railroad: What it is, what it does" (John H. Armstrong) ISBN: 978-0911382044
    - General information about railroading
- "All About Railroading" (William C. Vantuono) ISBN: 978-0911382259
    - General information about railroading
- https://www.csx.com/index.cfm/about-us/company-overview/railroad-dictionary/
    - Definitions of various railroad terms
- https://www.aar.org/aar_news/weekly-rail-traffic-data/
    - Weekly railroad traffic data for the United States
- https://www.bnsf.com/ship-with-bnsf/ways-of-shipping/equipment/
    - Pictures of various railcars and information on the commodities they carry
- http://woodenrailway.info/
    - Information on BRIO wooden railway products

Several television shows on railroad topics have been produced over the years. These shows are typically good sources of knowledge in addition to the other resources provided. Individual episodes may be available on DVD from your local library or available online. Suggested television series include:

- Extreme Trains
- Impossible Engineering: Extreme Railroads
- Rocky Mountain Railroad
- Tracks Ahead

Figure 5: Students from the Next Generation School in Champaign, Illinois attend a rail-focused summer day camp hosted by the University of Illinois Rail Transportation and Engineering Center