U.S. Department of Transportation

Federal Railroad Administration

Research Results

RR 09-02
January 2009

Tool for Planning and Monitoring Railroad Traffic Supports Visualization of Railroad Operations

SUMMARY

The *Railroad Traffic Planner* application is a visualization tool with stringline diagrams that show train positions over time, as shown in Figure 1 (see the Stringline Diagrams section for more information on interpreting this display). In addition to supporting scheduling, the *Railroad Traffic Planner* provides near-real time traffic position information when associated global positioning system (GPS) tracking devices have been installed. The Federal Railroad Administration (FRA) Human Factors Research and Development Program sponsored the development of the *Railroad Traffic Planner* to evaluate the potential for this type of visualization tool to improve safety and productivity in the railroad industry. FRA also sponsored technology transfer efforts to bring this prototype tool to additional railroads and other interested parties in the railroad industry.

Many potential benefits of stringline tools were identified. For example, this type of display can be helpful for defining, evaluating, and communicating potential schedule changes. It can also enhance training for planners and dispatchers. Additionally, the GPS tracking information can help railroads better monitor locomotive speeds and the movement of hazardous materials, improve arrival time estimates for customers, and predict crew change and equipment arrival times.

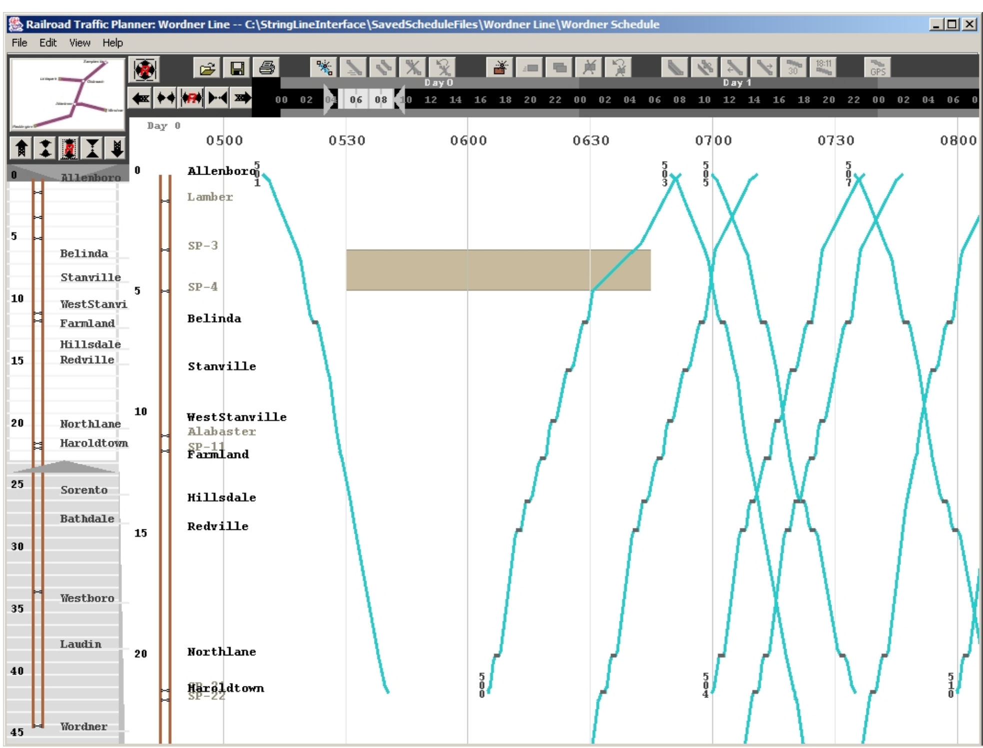

Figure 1. Sample Stringline Diagram in the Railroad Traffic Planner

BACKGROUND

Effective railroad traffic planning is crucial to safe and efficient railroad operations. If trains are positioned too close together, an increased risk of collision occurs, especially if the operations are not monitored properly. Also, the efficiency of the entire railroad system can be disrupted if a poorly scheduled train blocks the path of other trains creating congestion. Potential financial implications result from bad schedules as well. Railroads can be less profitable when customer expectations are not met or extra crew dollars are needed due to schedule deficiencies.

Traditional methods for creating railroad schedules can be very time consuming and mentally challenging. Planners must estimate how long it will take the trains to get from one location to another accounting for factors such as the different train types, speed limits along various stretches of track, speed restrictions, and the rate of acceleration and deceleration as the trains change speed.

Not only do planners need to determine how long it will take the trains to arrive at the destinations, they must also ensure that no two trains (or other vehicles on the tracks) are going to be at the exact same location at the same time. All passing traffic must be on separate tracks and/or sidings—trains cannot swerve to avoid oncoming traffic and they cannot stop very quickly.

STRINGLINE DIAGRAMS

One planning tool that has been used for more than a century in the railroad industry is the stringline diagram. This tool shows train positions over time. Figure 2 shows a sample stringline diagram with two trains going in opposite directions. In Figure 2, the train going from Oxfield to Oakville will stop in Anderson for 1 hr before continuing. The two trains will "meet" near Tinella, meaning they will pass each other on separate tracks going in opposite directions. The stringline diagram also shows that the train from Oxfield will go slower for about 10 mi near Greenly where the slope of the string is less steep (the train will take more time to travel along that stretch of track than the same length of track in other areas).

Some large railroads have benefited greatly from elaborate scheduling software products that incorporate stringline displays with a large array of associated tools, such as train performance calculators and schedule optimization features. Many of the existing software scheduling tools were designed to address the complexities of large-scale operations, so considerable time is needed to effectively learn and work with them. Planners from some smaller railroads have expressed concern that many existing systems are too expensive and/or unwieldy for their needs.

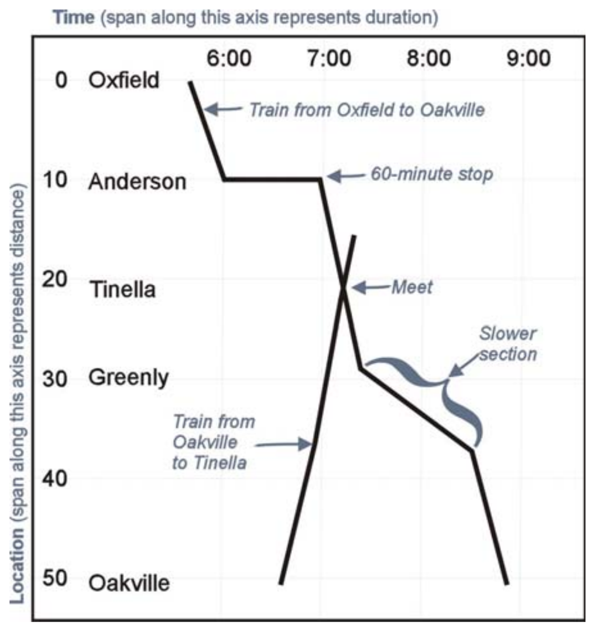

Figure 2. Stringline Diagram with Explanations

OBJECTIVES

The objectives of this project were to develop and evaluate the effectiveness of a stringline visualization tool designed to support traffic planning and monitoring at smaller railroads that do not have software for these activities or the resources to procure it. Technology transfer of the system was also undertaken to disseminate the results of this work.

DEVELOPMENT PROCESS

The John A. Volpe National Transportation Systems Center (Volpe Center), the Massachusetts Institute of Technology (MIT), and Fulcrum Corporation developed the *Railroad Traffic Planner* with input from four railroads. The development team used an iterative user-centered design process in which team members met periodically with railroad personnel to determine their needs and how well the prototype system was meeting them. When development team members met with potential users, they asked them to demonstrate how they would use the tool to perform actual work-related activities. This helped reveal the primary concerns of the users and barriers to effective usage.

RAILROAD TRAFFIC PLANNER FEATURES

The *Railroad Traffic Planner* shows the position of trains at various points in time with stringline diagrams. Users can enter schedule-related information in a dialog box (such as the one in Figure 3), and then the *Railroad Traffic Planner* automatically calculates the times and speeds and draws the strings.

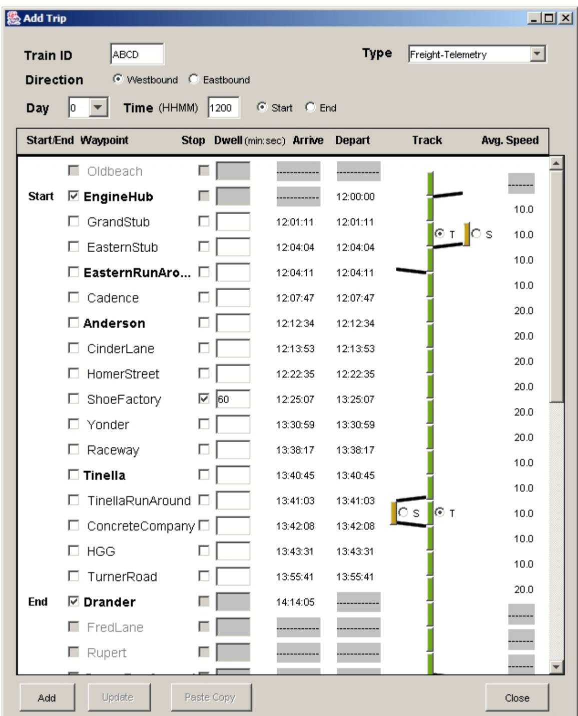

Figure 3. Dialog Box for Adding a String

The *Railroad Traffic Planner* allows users to move the strings around to see the impact of changes to the schedule. Users can also add temporary speed restrictions to the schedules, which slow down the speeds of the strings during a particular period of time. Additional information, such as the locations of tracks, sidings, stations, interlockings, and grade crossings, are displayed with the strings to provide users with the context necessary to make good decisions. Users can view schedules in a tabular format as well as the stringline display.

At some participating railroads a global positioning system (GPS) tracking device was installed on locomotives (Figure 4) and other vehicles (e.g., highrailers) that use the tracks. With the GPS system, users can view actual train and vehicle positions on the stringline display and on a Web-based geographical map display. Because the tracking system uses GPS-enabled cellular telephones, the communication channel can also be used for other purposes, such as transmitting information from sensors in the locomotives.

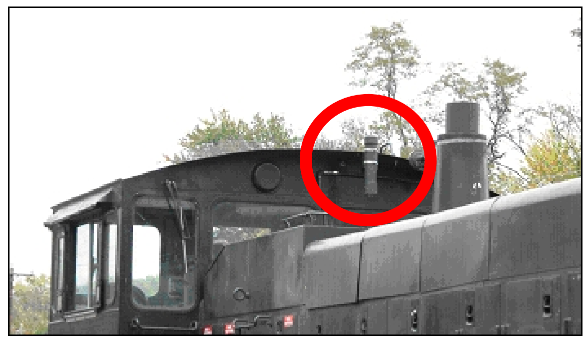

Figure 4. GPS Tracking System

TECHNOLOGY TRANSFER

In addition to installing the *Railroad Traffic Planner* at the four participating railroads, the project team has distributed more than 60 software copies to transportation professionals who expressed interest in trying it and providing feedback. To share the *Railroad Traffic Planner* concepts more widely, development team members have also demonstrated it at several conferences and created a Web site about it (http://www.volpe.dot.gov/hf/railroad/rtp.html).

Additionally, Fulcrum Corporation has used some of the GPS tracking capabilities developed during this project for other projects, including a hazardous tank car security program sponsored by FRA and a container security program for the Office of Naval Research.

CHALLENGES

One significant challenge encountered during this project was determining how to make the planning system powerful enough to effectively support the process without making it too cumbersome for the users. Another challenge was determining how to mount the GPS equipment on the locomotives in a way that the battery would remain charged and the components would be protected from shock, weather, and vandalism.

POTENTIAL BENEFITS

Several potential benefits of tools like the *Railroad Traffic Planner* were identified during this project. Planners demonstrated that they needed less time (sometimes hours less) for calculations, drawing strings, making modifications, and evaluating schedules when they were using the software compared to when they did these activities with traditional paper-based planning techniques. Two of the railroads involved in this project suggested that the visual evidence provided by the stringline display could help them better communicate with other railroads about proposed schedule changes. Many individuals indicated that the *Railroad Traffic Planner* could be useful for training planners and dispatchers. In fact, several professors of transportation courses who received the demonstration software expressed interest in using it in their classes.

Individuals who tried the tracking system component also found it useful. They noted that the real-time train location information can help them better monitor locomotive speeds and the movement of hazardous materials, improve arrival time estimates for customers, and predict crew change and equipment arrival times.

CONCLUSIONS

This project was a successful demonstration that a computerized stringline diagram tool can effectively support railroad traffic planning and monitoring activities. It also showed that the value of a technology can increase if the development team interacts closely with a variety of potential users and makes revisions based on their needs. The iterative user-centered design process and technology transfer efforts applied in this project led to the implementation at the four participating railroads as well as applications in other settings both in an out of the railroad industry.

WANT MORE INFORMATION?

More details about this project are located at http://www.volpe.dot.gov/hf/railroad/rtp.html.

ACKNOWLEDGMENTS

Many people deserve thanks for their support of this project, particularly those who contributed from FRA, Volpe Center, MIT, Fulcrum Corporation, Massachusetts Bay Transportation Authority, Guilford Rail System, North Shore Railroad, and Paducah and Louisville Railway. Throughout the development process, the application has been presented at industry meetings and shared with others interested in trying it and providing feedback. We would like to thank everyone from industry, academia, and government who reviewed our demonstrations throughout the project and provided support and ideas.

CONTACT

Dr. Thomas Raslear
Human Factors Program Manager
Federal Railroad Administration
Office of Research and Development
1120 Vermont Avenue NW - Mail Stop 20
Washington, DC 20590
(202) 493-6356
thomas.raslear@dot.gov

Dr. Jordan Multer
Manager, Rail Human Factors Program
Human Factors Division
Research and Innovative Technology Administration
Volpe National Transportation Systems Center
55 Broadway, RTV-4G
Cambridge, MA 02142
(617) 494-2573
multer@volpe.dot.gov

KEYWORDS: Stringline diagrams, planning software, railroad operations, user-centered design, technology transfer, human factors