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TRANSPORTATION DIVISION

Minimum Train Crew Size Facts

- **Minnesota's Class One freight trains currently operate with 2 crew members**

- Railroads transport goods of all kinds including hazardous materials. The second crew member is essential to HazMat response when train derailments occur in our state. This person communicates with first responders when they reach the site, opens blocked road crossings to provide access for emergency and clean up vehicles, de-couples the rest of the train, moves it to a safe distance mitigating the damage and potential for additional release or explosion, and maintains accurate train placement lists and waybills identifying the cargo involved.

- **The second crew member can open blocked crossings allowing school busses, fire trucks, ambulances, police, and the general public to reach the other side of the tracks. Railroad workers are Minnesotans first and we live in the communities we operate through. We care about the impact the equipment we operate has on the public.**

- In the tragic event of a collision at a public grade crossing, **emergency responders must not be expected to climb on, under, or about railroad equipment without protection.** With the current staffing of two people, a radio equipped crew member is the first person on scene and immediately in control of train movements, allowing the emergency response teams safe access to the injured. A two-person crew also allows one member to offer Samaritan response and first aid to injured persons in the event of a collision or accident.

- **The use of modern technology in railroad operations has increased the number of duties on the existing two-person train crews. Positive train control, trip optimizer, and handheld electronic reporting devices are all extra tasks and distractions on top of the previously existing responsibilities.**

- Minnesota and the communities within are not experimental proving grounds for the railroads to implement trial and error practices. The stakes are too high and a minimum standard for public and worker safety must be set.

- **While the issue of crew size has been debated at the federal level, there is no existing regulation or law that would preempt Minnesota from passing this bill into law. If enacted this legislation is quite simply a minimum standard public and worker safety bill that mirrors what other states have done.**

- It has been proffered by some that minimum crew size is a collective bargaining issue. This is a false statement. Minimum crew size is a worker safety and public safety issue. Railroad safety is not collectively bargained for, and is separate from that process. The public has a right to weigh in when railroads operating massive trains carrying hazardous materials through their communities make changes that affect their safety. **The public is not afforded a seat at any collective bargaining table and this bill would set a basic safety standard that <u>is the current normal operating practice.</u>**

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Minimum Train Crew Size FAQ's

Q: **How many crew members currently operate most freight trains in Minnesota?**

A: Two.

Q: **Is there a federal law or regulation that addresses minimum crew staffing on trains?**

A: No.

Q: **With the implementation of Positive Train Control, is it still necessary to have two people on a train?**

A: Yes. Positive Train Control has added more duties and tasks to a train crew, not reduced them.

Q: **Why is train crew size being brought to the legislature?**

A: Minimum train crew size is a **public safety** and worker safety issue. Public safety is not collectively bargained for. **The public does not have a seat at the collective bargaining table.**

Q: **How has technology affected the operation of a modern freight train?**

A: As trains have become longer and added extra locomotives to the middle and rear, they have become more complicated and labor intensive to operate. New hand-held mobile devices have added more duties to crew members while on the train as well.

Q: **When a train is stopped and blocking crossings in my town, who is responsible for opening them up and letting traffic or emergency responders through?**

A: It takes two crew members to accomplish this; one in the locomotive operating the equipment and the other on the ground at the crossing physically manipulating the equipment and directing the separation.

Q: **Who coordinates with emergency responders in the event of a derailment?**

A: The train crew. One crew member meets with the emergency responders, shares all hazardous material paperwork, and ensures their safety while the other crew member maintains control of the locomotive and train.

Q: **How many people does it take to perform required safety inspections on a train?**

A: Two. One person operating the controls of the locomotive and the other in the field performing the inspection.

Q: **Is train crew size a partisan or labor only issue?**

A: No. Surveys have indicated this issue is beyond political party with overwhelming support from the public, 85% saying pass a law.

Q: **Is it physically possible for one person to perform all the duties required to safely operate a freight train in Minnesota?**

A: <u>No</u>

Ask us about Minimum Train Crew Size!

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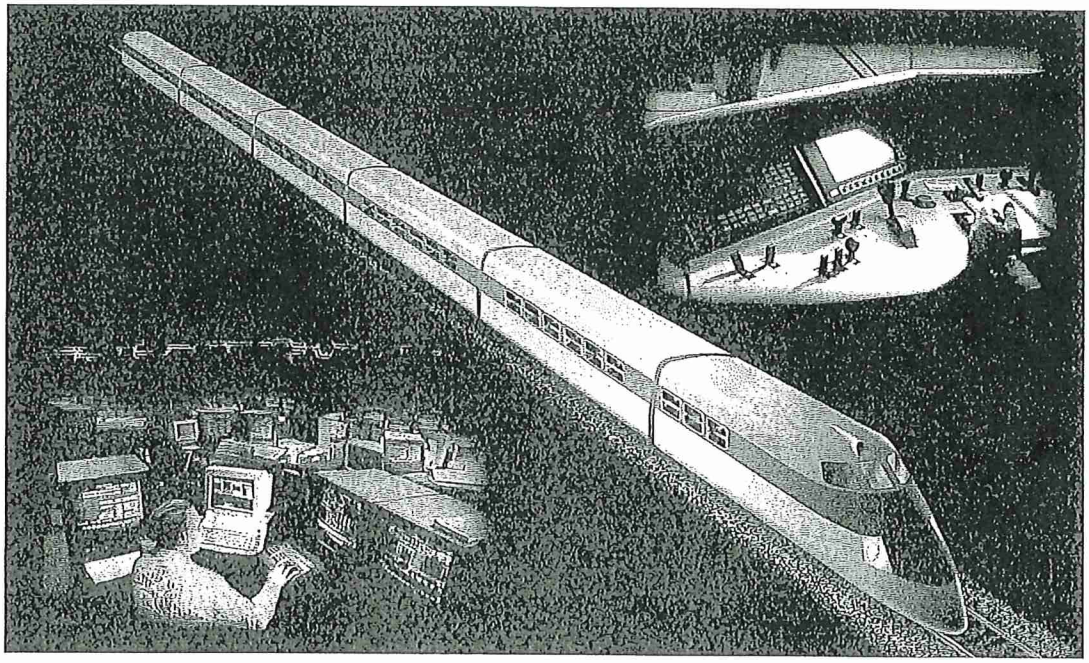
U.S. Department of Transportation

Federal Railroad Administration

Cognitive and Collaborative Demands of Freight Conductor Activities: Results and Implications of a Cognitive Task Analysis

Office of Railroad
Policy and Development
Washington, DC 20590



Human Factors in Railroad Operations

DOT/FRA/ORD-12/13

Final Report
July 2012

Executive Summary

Railroad operations in the United States are undergoing rapid changes. These changes are due in part to the Rail Safety Improvement Act of 2008 (RSIA), which calls for, among other things, enhancements in railroad conductor certification programs and the implementation of positive train control (PTC) on applicable freight and passenger rail lines. As part of its ongoing efforts to investigate the safety implications of emerging technologies on railroad operations, the Federal Railroad Administration's (FRA) Office of Research and Development sponsored a series of cognitive task analyses (CTA) to examine the cognitive and collaborative demands associated with different railroad operations. The first CTA focused on railroad dispatchers (Roth, Malsch, and Multer, 2001). A second CTA addressed roadway worker activities (Roth and Multer, 2007). The third CTA focused on locomotive engineers (Roth and Multer, 2009). The present report documents the results of a CTA that was conducted to examine the cognitive and collaborative activities of the freight train conductor.

Study Objectives and Method

The purpose of the freight train conductor CTA was to gain an understanding of the role of conductors in today's freight rail operations. To do this, researchers sought to understand the cognitive and collaborative activities associated with the role of the conductor, the situational factors that arise to complicate performance, and the knowledge and skills that experienced freight train conductors have developed to cope with performance demands so as to maintain a safe and efficient operation. A related aim was to understand the implications of RSIA on the role of the conductor, specifically the mandate for conductor certification and implementation of PTC. The goal was to understand current conductor training programs, to provide insight to FRA for the conductor certification effort, and, to the extent possible, to understand and anticipate potential impacts of PTC implementation on the conductor's work and future training trends.

The report focuses primarily on freight train conductors operating on the mainline. Mainline freight train crews operating in the United States generally include a locomotive engineer and a conductor. Our findings indicate that the conductor and the locomotive engineer function as an integrated team that often operate as a single unit with a common goal. As such, the cognitive and collaborative challenges and skills documented in the locomotive engineer CTA largely apply to conductors. Similarly, the results documented here will also generally apply to the locomotive engineer.

The CTA was based on several sets of interviews and site visits conducted between January 2009 and April 2010. Interviews and focus groups were conducted with stakeholders and railroad practitioners, experienced conductors, and conductor trainers and training managers, including representatives from FRA, American Association of Railroads (AAR), United Transportation Union (UTU), Transportation Technology Center, Inc. (TTCI), National Academy of Railroad Sciences (NARS), BNSF Railway (BNSF), and Union Pacific Railroad (UP). Site visits included a trip to the NARS facility in the UP Beaumont Yard and the UP Houston Yard.

Results

Cognitive Tasks and Associated Challenges

A conductor is defined as the crewmember in charge of a train or yard crew. Freight conductors supervise pre-trip activities, over-the-road operation, and post-trip activities to ensure overall safe and efficient train movement.

To better understand the cognitive tasks and challenges associated with the freight conductor's job, we broke the job duties down into five categories:

- Managing the train consist
- Coordinating with the locomotive engineer for safe and efficient en route operation
- Interacting with dispatchers/roadway workers and others outside the locomotive cab
- Dealing with exceptional situations (e.g., diagnosing and responding to train problems)
- Managing paperwork

The conductor's role in managing the train consist means that he or she must understand train makeup rules and apply them both in the yard and on the mainline. Experienced conductors understand the implications of car placement, car consist, and car weight and shape when building trains. Conductors on the mainline must look over the train consist and car list prior to departing the yard to ensure proper train makeup. Conductors must understand how the train's consist will affect train handling, which is important to ensure locomotive engineer compliance when operating the train.

En route, one of the conductor's main tasks is supervising overall operation and administration of the train to ensure safe and efficient operation. This involves communicating and coordinating closely with the locomotive engineer, monitoring locomotive engineer performance, and providing backup as needed. Conductors handle all radio communication and take care of paperwork when the train is in motion so that the locomotive engineer can concentrate on operating the train. The conductor also serves to remind the engineer about upcoming signals and slow orders and provides "look ahead" information to alert the engineer to hills, curves, grade crossings, etc. If the locomotive engineer is not in compliance with the railroad's operating rules, it is the conductor's job to bring it to the locomotive engineer's attention or pull the emergency brake to bring the train to an emergency stop if he or she feels the train, its crew, or others outside the train are in danger. Finally, the conductor's presence in the cab may help to keep the locomotive engineer awake and alert, and vice versa (Frings, 2011).

The conductor is also in charge of all radio communications in the cab. Radio communications come in spurts, meaning there can be lulls in communication and times of heavy interaction that require conductors to multitask. For example, a conductor may need to communicate with the dispatcher (or a roadway worker), copy the information back to the dispatcher and write it down, make sure the engineer received the information, and also maintain awareness of conditions outside the cab, which includes calling out signals and speed restrictions. This can be especially challenging when the dispatcher is speaking quickly and using railroad jargon.

Unexpected situations include anything from train equipment issues (e.g., mechanical performance, operability, etc.), to collisions and derailments. Although these unanticipated events run the gamut, train equipment issues are perhaps the most common unanticipated events

that arise en route, and in these cases, it is the conductor who is responsible for troubleshooting and, when possible, repairing the problem.

Finally, conductors are required to fill out and maintain all paperwork for the train, including track warrants, work orders, train consist, etc. At the start of a shift, the conductor's duty is to gather all the paperwork and make two copies, one for him/herself and one for the engineer, look it over, and check for errors. In addition to maintaining paperwork relating to the trip, the conductor must also be vigilant about keeping the railroad's rulebook up to date, which can be challenging because of the frequency with which operating rules are updated. Finally, while en route, the conductor is responsible for documenting the trip in a log. This includes writing down slow orders and authorizations from the dispatcher and recording signal indications as they are passed as well as filling out other forms as necessary.

Challenges Associated with Mountain Grade Territory

A significant finding of the CTA was that operating territory can affect the complexity of the conductor's job to a great degree. Specifically, operating in mountain grade territory adds complexity to the job and introduces additional cognitive demands on both the conductor and the locomotive engineer.

Overarching Cognitive Challenges

Interviews with conductors and trainers indicate that it can take up to 5 years to gain sufficient experience to become a confident, expert conductor. We sought to understand the type of knowledge and cognitive skills that conductors develop over time, largely acquired through on-the-job experience, that enable them to function safely and efficiently. The following points summarize our findings of the characteristics that differentiate expert conductors from less experienced ones.

- Knowledge of the Territory - Knowledge of the territory, including a detailed mental model of the physical landscape in which they operate, is critical to enabling train crews to operate efficiently as well as to anticipate and mitigate risks to themselves and others.
- Ability to Maintain Situation Awareness of Surroundings - Conductors need to be continuously aware of their physical surroundings, whether they are in the locomotive, switching cars on the ground, or walking to and from the train. They need to maintain awareness of the location of other trains and machines on adjacent tracks, the location of cars and whether they are properly secured, and the location of people working on or about the track.
- Ability to Project Effect of Consist on Train Dynamics - The ability to successfully estimate the impact of consist characteristics (e.g., number of cars, length, and weight) on train dynamics is another characteristic conductors develop over time. Although operating the train is the responsibility of the locomotive engineer, the conductor also needs to develop an understanding of the impact of consist characteristics on train dynamics to function in his or her general role of supervising train operations. An understanding of how the consist can impact train dynamics is needed to enable conductors to effectively monitor the performance of the locomotive engineer and provide backup support as needed.
- Ability to Problem Solve - Conductors are routinely confronted with novel situations for which they have to perform mental simulations to identify a correct solution. Building trains

and car placement issues, for example, often require problem solving and mental simulation, as do unanticipated, emergency situations.

- Ability to Plan Ahead - Conductors need to project into the future to anticipate and prepare for what is coming up next on the road (e.g., signals, curves, grade crossings, and train meets). It is also important to think ahead about various tasks they will need to accomplish over the shift so as to plan the most efficient way to accomplish them.
- Ability to Multitask - Another skill that differentiates more experienced from less experienced conductors is the ability to manage multiple demands on their attention. Experienced conductors have learned strategies for managing and prioritizing these competing demands.
- Ability to Exploit External Memory Aids - Mainline operations place heavy demands on memory. Experienced conductors have developed a variety of strategies that rely on external aids to support memory, including strategies to support prospective memory that allow themselves to focus their attention on the task at hand.
- Ability to Foster Shared Situation Awareness through Active Communication - Conductors need to be able to communicate effectively with the locomotive engineer as well as other members of the train crew to maintain shared situational awareness, facilitate efficient work, and enhance safety. This communication needs to be an active, ongoing process, beginning with an initial job briefing and continuing en route through active communication such as calling out signals and confirming that the locomotive engineer acknowledged them.

In addition to learning about the types of knowledge and skills that enable experienced conductors to perform more effectively, the CTA also uncovered effects of lack of experience on conductor performance. Less experienced conductors, we found, are less able to handle situations that require balancing multiple demands on attention, and they are less able to effectively problem-solve, plan ahead, or identify and avoid potential hazards. Because they have had less "first-hand" experience on the job, they are typically less confident in their knowledge and ability.

Training

The CTA sought to assess current training practices and trends to help identify future training needs. Currently, there is no conductor training standard or uniform syllabus among railroads and conductor training programs, though they generally include a mixture of classroom and on-the-job training (OJT). The length of each training program varies by railroad. We found that different railroads have different training models, and the industry is experiencing different training trends among the various railroads. For example, many railroads have been implementing crew resource management (CRM) training, which focuses on training the crew to function optimally as a team. Our findings point to a need for a more uniform standard of training. Many conductors expressed a desire to standardize OJT so that guidelines exist for situations and events all conductor trainees must experience in training. Conductors specifically indicated the need to train for rare but serious events and incidents, and stressed the importance of training so that tasks become intuitive and reflexive (perhaps more so in mountain grade territory). Finally, conductors mentioned the need to train new hires to anticipate and discuss risk, and noted that CRM training is especially important in giving new hires the confidence to speak candidly with experienced engineers about risks.

Key Findings

Locomotive Engineer and Conductor Function As a Joint Cognitive System

From interviews with conductors and locomotive engineers during the Conductor CTA and the earlier Locomotive Engineer CTA (Roth and Multer, 2007) it is clear that both employees function as a joint cognitive system (Woods and Hollnagel, 2006). They closely coordinate tasks with each other, adaptively share perceptual and cognitive load, and rely on each other to successfully accomplish the mission of the train. The conductor and locomotive engineer not only serve as an extension of "eyes" and "ears" for each other, catching and communicating information that the other may have missed, but they also extend each other cognitively—filling in knowledge gaps, providing reminders for upcoming tasks, and contributing jointly to problem-solving and decisionmaking situations that arise. This is especially true when a less experienced crewmember is paired with a more experienced crewmember.

The Role of Conductors in Handling Unanticipated Situations

Another important role that conductors play on the mainline is handling unanticipated situations. This includes a variety of situations where conductors need to troubleshoot the source of the problem and take appropriate action. These unanticipated situations impose cognitive as well as physical demands on the conductor. Experienced conductors have developed a variety of skills and strategies that enable them to handle these non-routine situations more safely and efficiently. This knowledge is primarily gained in the field through first-hand on-the-job experience as well as by working with more experienced conductors and engineers.

Implications of Results

The Role of Conductors and PTC Technology

One of the questions that motivated the cognitive task analysis was how new technologies, such as PTC, are likely to impact the role of conductors in the future. The cognitive task analysis addresses this issue by laying out the multiple ways in which conductors contribute to safe and efficient train operations and contrasts this with the anticipated features of PTC systems.

Findings from the CTA indicate that PTC will not account for all of the cognitive support functions the conductor currently provides. For example, conductors support locomotive engineers in monitoring conditions outside the cab for potential obstacles and hazards that are undetected by automated systems, filling knowledge gaps that locomotive engineers may have, and supporting decisionmaking (e.g., where to stop to avoid blocking a grade crossing). Conductors also serve an important role in handling unanticipated events as well as keeping the locomotive engineer alert, especially on long monotonous trips where there is a risk of falling asleep.

Potential to Accelerate Development of Expertise

The results of the CTA suggest an opportunity to potentially accelerate building conductor expertise by providing a broader set of carefully selected experiences as part of OJT. These would potentially enable new conductors to more quickly build up their knowledge of the territory and direct experience with a variety of situations.

The results also point to the importance of teaching conductors and locomotive engineers effective cab communication and job briefing skills. More focus on effective communication would enhance teamwork and encourage joint problem-solving and decisionmaking that

leverages the knowledge and skills of the entire train crew for safer and more efficient performance.

Finally the results of the cognitive task analysis point to the value of carefully pairing conductors and locomotive engineers so that less experienced individuals are paired with more experienced ones. This not only makes for a safer and more efficient train crew but also it provides opportunities for knowledge transfer between crewmembers, further accelerating development of expertise.

Future Research Needs

The cognitive task analysis uncovered several open questions relating to conductor expertise, conductor training, and conductor certification. Future research is needed to answer these questions. For example, although the CTA identified the knowledge and skills required of expert conductors at a high level, additional studies can be performed to examine the cognitive skills at a more detailed level of analysis. Other promising lines for future research relate to how skills expand with level of expertise, how CRM can contribute to safer and more effective teamwork, and the impact of PTC displays on crew cognitive and collaborative processes. Many of these open questions can be explored through the use of simulator studies.