U.S. Department of Transportation

Federal Railroad Administration

Preliminary Development of a Railroad Dispatcher Taskload Assessment Tool: Identification of Dispatcher Tasks and Data Collection Methods

Office of Research
and Development
Washington, DC 20590

DOT/FRA/ORD-07/13

Final Report
April 2007

This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161.

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY U.S.E ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	April 2007	Final Report, 12/99-01/04

4. TITLE AND SUBTITLE

Preliminary Development of a Railroad Dispatcher Taskload Assessment Tool: Identification of Dispatcher Tasks and Data Collection Methods

5. FUNDING NUMBERS

6. AUTHOR(S)

Stephen Reinach

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Foster-Miller, Inc.
350 Second Avenue
Waltham, MA 02451-1196

8. PERFORMING ORGANIZATION REPORT NUMBER

DFRA.010350

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Department of Transportation
Federal Railroad Administration
Office of Research and Development
Washington, DC 20590

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

DOT/FRA/ORD-07/13

11. SUPPLEMENTARY NOTES

COTR: Dr. Thomas Raslear

12a. DISTRIBUTION/AVAILABILITY STATEMENT

This document is available to the public through the National Technical Information Service, Springfield, VA 22161 and at www.fra.dot.gov.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This report summarizes research conducted to identify and document dispatcher tasks and activities and determine how data on these tasks are currently collected. The researcher generated an initial set of dispatcher tasks based on past research and literature and subject matter expertise. The researcher developed two questionnaires to expand the list, identify other factors that affect dispatcher taskload, and determine how challenging it is to collect data on these tasks. Representatives from all eight Federal Railroad Administration regional offices, railroad officers, and railroad dispatchers received questionnaires. The researcher identified 67 dispatcher tasks and organized them into 6 top-level task categories. Non-task factors that either affect a dispatcher's taskload or can be used to describe the circumstances in which taskload is measured were also identified. Respondents also identified how taskload data can be collected based on eight different data collection methods. One single, efficient mechanism to collect all of these data does not currently exist. In addition, taskload data collection would take time, involve effort, and would be obtrusive. Lastly, the researcher explored cognitive aspects of dispatching. Based on results from the taskload questionnaires, and an understanding of the cognitive aspect of dispatching, a model of railroad dispatching is generated.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Railroad dispatching, train dispatching, taskload, workload, railroad safety	69
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18
298-102

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	=	2.5 centimeters (cm)
1 foot (ft)	=	30 centimeters (cm)
1 yard (yd)	=	0.9 meter (m)
1 mile (mi)	=	1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz)	=	28 grams (gm)
1 pound (lb)	=	0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	=	5 milliliters (ml)
1 tablespoon (tbsp)	=	15 milliliters (ml)
1 fluid ounce (fl oz)	=	30 milliliters (ml)
1 cup (c)	=	0.24 liter (l)
1 pint (pt)	=	0.47 liter (l)
1 quart (qt)	=	0.96 liter (l)
1 gallon (gal)	=	3.8 liters (l)
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	=	0.04 inch (in)
1 centimeter (cm)	=	0.4 inch (in)
1 meter (m)	=	3.3 feet (ft)
1 meter (m)	=	1.1 yards (yd)
1 kilometer (km)	=	0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm)	=	0.036 ounce (oz)
1 kilogram (kg)	=	2.2 pounds (lb)
1 tonne (t)	=	1,000 kilograms (kg)
	=	1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 liter (l)	=	2.1 pints (pt)
1 liter (l)	=	1.06 quarts (qt)
1 liter (l)	=	0.26 gallon (gal)
1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

QUICK INCH - CENTIMETER LENGTH CONVERSION

Inches	0		1			2			3		4			5
Centimeters	0	1	2	3	4	5	6	7	8	9	10	11	12	13

QUICK FAHRENHEIT - CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50 SD Catalog No. C13 10286

Updated 6/17/98

Contents

Illustrations

Tables

Acknowledgements

This report presents research into the identification of a comprehensive set of railroad dispatcher tasks and activities, and how data on these tasks and activities might be collected and used in the assessment of railroad dispatcher taskload. The researcher performed this work under contract DTFR53-95-C-00049 for the Federal Railroad Administration (FRA) Office of Research and Development. Dr. Thomas Raslear, Senior Program Manager of FRA's Office of Research and Development Human Factors Program, was the Contracting Officer's Technical Representative. The researcher would like to thank both Dr. Raslear and Mr. Michael Coplen, also of the FRA Office of Research and Development Human Factors Program, for their guidance and support throughout this research effort.

Special thanks to Mr. Thomas Keane, formerly of the Office of Safety, FRA, and his support staff, for the initial groundwork in identifying dispatcher activities, and for providing answers to technical questions while conducting the early stages of the research.

The researcher could not have collected such a breadth of information without the help of the following FRA regional Operating Practice supervisors, specialists and safety inspectors around the country: Ms. Janet Lee, Mr. Richard Rusnak, Mr. Clyde Gilliland, Mr. Victor Sanocki, Mr. Ray Cicchino, Mr. Greg Perez, Mr. Frank Marino, Mr. Richard Shultz, and Mr. Keith Loveday. Thanks to each for taking time to complete the questionnaires and for providing a rich source of technical information on dispatching. Thanks are also due to two dispatchers, Mr. Tom Coughlan, Jr., and Mr. Russ Marcoux, for taking an interest in the study, completing the questionnaires, and expanding the list of dispatcher tasks. A special thank you is extended to the staff at Amtrak's Centralized and Electrified Traffic Control center in Boston, MA for allowing the researcher to come and observe their work from time to time. The researcher owes a great deal of his dispatching knowledge to these men and women.

The researcher wishes to thank Ms. Susan Madigan, a former railroad dispatcher and FRA field inspector, for her subject matter expertise and time in helping to develop the initial set of dispatcher tasks. Ms. Madigan was also instrumental in organizing the dispatching tasks into higher level categories. The researcher would also like to thank Ms. Susan McDonough, Ms. Judy Gertler, and Mr. Alex Viale, Foster-Miller, for reviewing drafts of the report and providing valuable feedback. Lastly, thanks to Dr. Stephen Popkin of the Volpe National Transportation Systems Center, for acting as a sounding board throughout the project and discussing the theoretical issues involved in defining and measuring taskload.

Executive Summary

Railroad dispatchers today shoulder more responsibilities than ever before due to changes in technology, operating practices, and the economy. In their capacity as rail traffic controllers, dispatchers play an integral role in rail safety. In the late 1980s and early 1990s, the Federal Railroad Administration (FRA) conducted two safety audits of railroad dispatching operations. One area of concern that the audits identified was railroad dispatcher workload. The systemwide audits found repeated evidence of periodic work overloads that had potential safety consequences.

No method currently exists to reliably and quickly measure a dispatcher's activity during the course of a work shift. The FRA Office of Research and Development is interested in increasing the generalizability and reliability of a taskload calculation method originally developed by the FRA Office of Safety to apply to all railroads, regardless of the dispatching technologies used or the nature (passenger or freight) or size of the operation. Taskload is defined as the average time demanded of a dispatcher in carrying out all job-related tasks at a particular dispatching desk, over a specified period of time (e.g., one shift). FRA also seeks to package this approach into a portable, software-based tool that could be used by railroads, researchers, and FRA to collect dispatcher task-based activity data. A major consideration in collecting dispatcher taskload data is that the tasks must be observable and quantifiable and that taskload data must be quick and unobtrusive to collect, since the ultimate goal of this effort is to produce a tool that FRA field inspectors, railroad officers, and researchers can use to reliably and quickly obtain taskload data.

A dispatcher taskload assessment tool has many potential uses, such as improving dispatcher training, helping to determine appropriate dispatcher staffing levels, and studying the effects of changes in technology on the job of dispatching. A first step in developing this taskload assessment tool is to identify the tasks and activities involved in railroad dispatching. This report summarizes research that identified and documented dispatcher tasks and activities, as well as determining how data on these tasks are currently collected. A more complete picture and understanding of these tasks is the foundation for the development of a taskload calculation methodology and an assessment tool.

First, the researcher produced an initial set of dispatcher tasks based on past research and literature, as well as input from a subject matter expert (SME). Next, the researcher developed a questionnaire to expand the list and identify factors that can affect dispatcher taskload. Representatives from all eight FRA regional offices, railroad officers at two railroads, and active railroad dispatchers received the questionnaire. Individuals from these three populations are representative of most, if not all, of the dispatching operations across the United States; are among the most knowledgeable on current dispatching tasks, technologies, and operations, as well as means of collecting task-related information; and will be among the users of a dispatcher taskload assessment tool.

Based on the results of the first questionnaire, the researcher developed a second questionnaire to determine how data on these tasks can be collected from different railroad dispatching operations and how easy, time-consuming, and obtrusive it would be to collect these data. Respondents to the first questionnaire received the second one.

Eleven individuals completed the first questionnaire. Nine of the 11 respondents were FRA regional safety inspectors or Operating Practice (OP) specialists, representing 6 of the 8 FRA regions. The two remaining completed questionnaires came from active railroad dispatchers—one from a passenger operation and one from a freight railroad. Of the 11 individuals who completed the first questionnaire, all but 1 completed the second questionnaire.

The researcher identified a total of 67 dispatcher tasks and organized them into the following 6 top-level task categories:

1. Actuation of signals, switches, blocking devices, and bridge controls via centralized traffic control (CTC) or computer-aided dispatching (CAD) systems
2. Issuance and cancellation of dispatcher-authorized mandatory directives
3. Granting of other track-related permissions, protections, and clearances (non-mandatory directives)
4. Carrying out non-movement authority or non-permission/protection/clearance communications
5. Performance of general recordkeeping tasks
6. Review of reference materials

While not all dispatchers carry out the same exact set of tasks, most if not all dispatchers probably do carry out one or more tasks in each of the six task categories.

A number of non-task factors either affect a dispatcher's taskload or can be used to describe the circumstances in which taskload is measured. Some factors are internal to the dispatcher, while other factors are external. The researcher also collected and documented data on these factors. Some of these factors will be used in the taskload calculation formula, while others are more descriptive, enabling inspectors and others to make fair comparisons between taskloads collected at two different desks or at two different times. The researcher collected data in the following areas:

1. Track-related factors
2. Railroad operation-related factors
3. Dispatcher-related factors
4. Other factors

Some questions addressed how taskload data for a 7-day (d) consecutive period could be collected and how time consuming, how much effort, and how obtrusive it would be to collect these data for a 7-d period. Results indicate that CAD reports are most advantageous in collecting signal and switch actuation information, mandatory directive data, and general recordkeeping tasks. Audiotapes of dispatcher conversations appear to be most useful in collecting data on track-related permissions, protections, and clearances. Direct observation appears to be most advantageous in collecting information on non-movement authority, or non-permission, non-protection, or non-clearance communications, and the amount of time dispatchers spend reviewing reference materials.

For each of the six task categories, the researcher asked questionnaire respondents to provide an indication of how much time, how much effort, and how obtrusive it would be to collect data on the number of tasks carried out over a 7-d consecutive period. Results indicate that while data on some observable dispatcher activities may be collected efficiently with the aid of automated computer-generated reports, collection of data on many other dispatcher activities still requires a significant amount of time through direct observation and monitoring of activity. A single, efficient mechanism to collect these data does not currently exist. Overall, it appears that collecting taskload data for all six task categories would take slightly more than some time, involve slightly more than moderate effort, and would be somewhat obtrusive.

Lastly, to gain an appreciation for how much time a dispatcher spends performing activities within each of the six task categories, the researcher asked questionnaire respondents to estimate how much of a dispatcher's time they felt that a dispatcher typically spends on each task category in a typical 8-hour (h) shift. Over half of a dispatcher's work-related time was reported to be spent actuating signals and switches via a CAD system and issuing and canceling mandatory directives to track occupants. The activities are indicative of a dispatcher's central role as rail traffic controller.

The dispatcher tasks identified through this research are valuable in contributing to a greater understanding of the demands of railroad dispatching. As can be seen, railroad dispatchers perform a wide array of physical activities in carrying out their job duties as rail traffic controllers. These activities clearly require both meticulous attention to detail (e.g., when routing a train via a CAD system or issuing a mandatory directive) and an understanding of the big picture (e.g., when communicating to crews regarding the amount of time a crew has remaining before the crew must give back control of a segment of track to the dispatcher to allow a train to pass without delay or harm).

The development of a railroad dispatcher taskload assessment tool based exclusively on observable task activity may not be the most appropriate approach to characterizing the job of a railroad dispatcher because it is highly cognitive in nature. A tool limited to observable activities may not tell the whole story. Observable activities make up only a fraction of a dispatcher's true activity. Much of what a dispatcher does, in fact, take place inside the dispatcher's head. Thus, one sees only the dispatcher's physical activity, not the cognitive activity that goes on but that is not visually discernable.

Taskload has often been examined because of the ease and convenience with which these data can be collected. Assessment of cognitive demands of tasks is more difficult and intrusive to capture. The heavily cognitive nature of railroad dispatching must be taken into account in order to most accurately measure the demands of railroad dispatching. Limiting any type of assessment of dispatcher activity to only observable tasks (taskload or physical workload) will be incomplete and may be misleading.

Data that the researcher gathered are still valuable in better understanding the job of a railroad dispatcher, further documenting the physical activities involved in dispatching, and adding to the growing body of research on the job of a railroad dispatcher. The data provide information on the number and diversity of activities that are involved in railroad dispatching and can serve as the building blocks to a preliminary model of dispatcher workload and safety that would include physical activities, as well as cognitive elements.

Results from the taskload questionnaires, and an understanding of the cognitive aspect of dispatching, led to the development of such a model of railroad dispatching. The preliminary model incorporates a railroad dispatcher's job functions, cognitive aspects, individual-based workload factors, and taskload components. When developed more fully, the model would be a valuable tool for FRA, researchers, and railroads. Such a model could ultimately be used to support future railroad dispatcher research, improve dispatcher training, reduce dispatcher stress, maintain safe workloads across dispatching desks, determine appropriate staffing levels, support FRA inspector audits of dispatching centers, and monitor the effects of changes in technology on the job of dispatching.

Future research activities might include the following:

- Conduct a literature review of Air Traffic Control Specialist (ATCS) cognitive workload and performance
- Conduct simulator studies to determine the relationship between dispatcher taskload and workload
- Develop a model of railroad dispatching
- Conduct a human reliability assessment of railroad dispatching operations
- Examine the effect(s) of Positive Train Control (PTC) on railroad dispatching

1. Introduction

1.1 Background

Railroad dispatchers today shoulder more responsibilities than ever before due to changes in technology, operating practices, and the economy. In the late 1980s and early 1990s, FRA conducted two safety audits of railroad dispatching operations (FRA, 1990; 1995). One area of concern that the audits identified was railroad dispatcher workload. The systemwide audits found repeated evidence of periodic work overloads that had potential safety consequences.

Means to improve and maintain railroad safety are of interest to FRA and the railroads. Due to their central role in railroad operations as rail traffic controllers, railroad dispatchers are often viewed as the lynch pin of railroad operations. Thus, dispatchers must perform optimally under all circumstances to ensure safe operations. A breakdown in dispatcher performance can lead to delays or, worse, fatalities. For example, dispatcher performance was cited as a contributing factor in a fatal collision between two trains in 1997 (NTSB, 1998).

Subsequent to the two FRA systemwide safety audits, the FRA Office of Research and Development initiated a broad research program to explore and better understand the nature and job of railroad dispatching in order to improve railroad safety. To date, FRA has studied and developed dispatcher training objectives, syllabi, and test designs (Reinach, Gertler, & Kuehn, 1998); performed a field study to examine dispatcher workload, stress, and fatigue (Popkin, Gertler, & Reinach, 2001); conducted a cognitive task analysis on a dispatcher's job (Roth, Malsch, & Multer, 2001); examined dispatcher selection practices (Gertler, 2003); developed communications training materials (Gertler & Acton, 2003); and explored dispatching center staffing and scheduling practices (Gertler & Nash, 2004). These efforts have led to a number of tools to aid the railroad industry and a greater understanding of the job demands of railroad dispatching.

No method currently exists, however, to reliably and quickly measure a dispatcher's activity during the course of a work shift. Railroads have their own methods—researchers have a variety of generic workload measurement techniques that may be applied to the railroad environment—and the FRA enforcement manual[1] provides some general guidelines about what kinds of data FRA Office of Safety field inspectors should collect when auditing a railroad dispatching center. For example, in the two systemwide safety audits conducted in the late 1980s and early 1990s, FRA collected data on a number of dispatcher activities. They felt, however, that their method was imprecise since it did not take into account the varied tasks that a dispatcher must perform to move a train across a territory.

A few years later, an FRA safety audit of a Class I railroad included an assessment of dispatcher taskload. Although effective at identifying overburdened dispatching desks at the railroad under study, the examined tasks and the method of calculating dispatcher taskload were specific to the audited railroad only. Further, the method was time consuming and required a number of individuals to collect the data.

---

[1] FRA enforcement manuals provide guidance to FRA inspectors and specialists regarding methods to enforce railroad compliance with Federal regulations.

An FRA-sponsored research study (Popkin, Gertler, & Reinach, 2001) that examined dispatcher workload, among other issues, involved the collection of data for a number of dispatcher tasks. The method, however, was found to be very time consuming, requiring two individuals to switch off sitting with the observed dispatcher and recording everything that the dispatcher did over the course of an 8-h shift. Such a method is not practical on a large scale for use by railroad officers, FRA field inspectors, or researchers.

The FRA Office of Research and Development is interested in increasing the generalizability and reliability of the taskload calculation method originally developed by the FRA Office of Safety, to apply to all railroads, regardless of the dispatching technologies used or the nature (passenger or freight) or size of the operation. FRA also seeks to package this approach into a portable, software-based tool that could be used by railroads, researchers, and FRA to collect dispatcher task-based activity data. A portable software-based tool would enable railroad officers, researchers, and FRA field inspectors to collect railroad dispatcher taskload data in a systematic and convenient manner. A computer-based data collection system would also enable these users to immediately analyze the data, including comparisons with past taskload data. A computer-based tool would also reduce the time and effort it takes to collect and analyze dispatcher taskload data.

A major consideration in collecting dispatcher taskload data is that the tasks must be observable and quantifiable and that taskload data must be quick and unobtrusive to collect, since the ultimate goal of this effort is to produce a tool that FRA field inspectors, railroad officers, and researchers can use to reliably and quickly obtain taskload data. Currently, dispatcher activity data collection is often slow and burdensome, requiring an individual to manually review records, such as Hours of Service (HOS) logs and track warrant books, or requiring the individual to observe the dispatcher and take notes. The intent of a dispatcher taskload assessment tool is to make data collection uniform, easier, and quicker to perform.

A reliable, valid, and easy-to-use computer-based tool for collecting dispatcher activity data would benefit FRA, researchers, and railroad officials by enabling each to conveniently and objectively determine whether or not a dispatching desk is overburdened (or underburdened) with activity, potentially jeopardizing the safety of rail users. Collection of quantitative task-based activity data would, for example, enable FRA inspectors and railroad personnel to compare the taskload of a dispatching desk to a previously defined acceptable limit and would enable comparisons to be made across dispatching desks, across railroads, and over time. Such a tool would enable railroads to monitor and track taskload at their own dispatching centers, FRA would have a consistent tool to use in safety audits, and researchers would have a valid measurement tool to use in assessing the demands of railroad dispatching. Further, such a tool would enable all three users to speak a common language when assessing railroad dispatcher taskload.

Ultimately, a dispatcher taskload assessment tool could be used to support future railroad dispatcher research, improve dispatcher training, reduce dispatcher stress, maintain safe workloads across dispatching desks, help determine appropriate staffing levels, support FRA inspector audits of dispatching centers, and monitor the effects of changes in technology (e.g., PTC) on the job of dispatching.

A first step in developing a railroad dispatcher taskload assessment tool is to identify the tasks and activities involved in railroad dispatching. This report summarizes research conducted to identify and document dispatcher tasks and activities, as well as determine how data on these tasks are currently collected. A more complete picture and understanding of these tasks is the foundation for the development of a taskload calculation methodology and an assessment tool.

1.2 Railroad Dispatcher Taskload: An Operational Definition

Hadley, Guttman, and Stringer (1999) define taskload for an ATCS, a job very similar to that of railroad dispatcher. They define ATCS taskload as "All of the system demands placed on the [air traffic] controller by the current situation; air traffic volume, mix, complexity of routings, weather, etc. The number of tasks or frequency of task occurrence associated with a specific job description" (p. 8). In the context of railroad dispatching, taskload could be defined as the number and types of tasks that a dispatcher carries out as part of his or her job. A task is an observable activity that a dispatcher performs to reach a job-related goal or objective. An example of a dispatching-related goal is to move a freight train through the dispatcher's territory. A task related to this goal might be to issue a main track movement authority, such as a track warrant, or actuate signals and control points via a CAD system to route the train through the territory.

This definition of taskload, however, is insufficient since it is not possible to compare taskloads across desks that require dispatchers to perform different sets of tasks. Given that it is unlikely that many dispatching desks involve the same exact set of tasks, comparisons across dispatching desks require a definition of taskload that is independent of operating practices and technologies used. That is, the definition of taskload requires a common denominator. Since a logical extension of the number of tasks that a dispatcher must complete is the total time it takes to complete these tasks, total time spent carrying out dispatcher tasks was selected as the common denominator. This new definition of taskload produces a number of total minutes that a dispatcher is busy working during a shift and is independent of the specific task set at a particular dispatching desk. Comparisons can be made across desks with different task sets since it is the total time that the tasks consume that is important. This new definition takes into account both the frequency of dispatcher tasks and the time it takes a dispatcher to perform the tasks.

This definition of taskload is similar to the definition of workload. Workload is defined as the interaction between the demands of a given task (or set of tasks) and the ability of the individual operator (the dispatcher) to meet those demands. Workload takes into account the ability of the individual operator to meet these demands and may depend on dispatching experience, training, familiarity with the specific territory, stress, fatigue, and a whole host of other factors which affect a dispatcher's ability to meet these task demands. Whereas workload takes into account individual abilities, taskload focuses on average dispatcher ability, thereby lending more weight to the number of tasks than the ability of any one dispatcher to manage those tasks. Taskload, therefore, is operationally defined as the average time demanded of a dispatcher in carrying out all job-related tasks at a particular dispatching desk over a specified period of time (e.g., one shift).

1.3 Objectives

The goal of the overall research program is to develop a valid, reliable, computer-based railroad dispatcher taskload assessment tool. The first part of this research involved the identification of a comprehensive set of dispatcher observable tasks and factors that affect these tasks and a determination of the current methods of collecting task data. An appreciation of the tasks involved in dispatching and an understanding of how data on these tasks can be collected will provide a basis for the future development of a dispatcher taskload assessment tool. The objectives of the research described in this report included the following:

- Identify the nature and types of dispatcher tasks and activities
- Determine how to collect dispatcher taskload data
- Discern factors that affect railroad dispatcher taskload

1.4 Technical Approach

The overall technical approach used in this research involved two distinct activities. First, the researcher identified a set of candidate dispatcher tasks. This set included, to the extent it is possible to identify, all possible dispatcher tasks and activities carried out in dispatching operations across the United States. Then, the researcher identified methods of collecting data for each type of dispatching task. The researcher expected that a wide variety of tasks and a number of different means of collecting task-related data would occur, depending on the technologies used at various railroad dispatching centers; the different means of collecting task data among railroad officers, FRA inspectors, and researchers; and the different dispatching centers across the country.

First, the researcher produced an initial set of dispatcher tasks based on past research and literature, and input from an SME. Next, a questionnaire was developed to expand the list and to identify factors that can affect dispatcher taskload. The researcher sent the questionnaire to representatives from all eight FRA regional offices around the country, two railroads, and the American Train Dispatchers Association (ATDA). ATDA represents a large number of railroad dispatchers in the United States.

Representatives from these three populations received the questionnaire because they provided an efficient approach to tapping into most, if not all, of the dispatching operations across the United States; are among the most knowledgeable on current dispatching tasks, technologies, and operations, as well as the means of collecting task-related information; and would be among the users of a dispatcher taskload assessment tool. Based on the results of the first questionnaire, the researcher developed a second questionnaire to determine how data on these tasks can be collected from different railroad dispatching operations and how easy, time consuming, and obtrusive it would be to collect these data. This questionnaire was sent to those who responded to the first questionnaire. Figure 1 summarizes this approach.

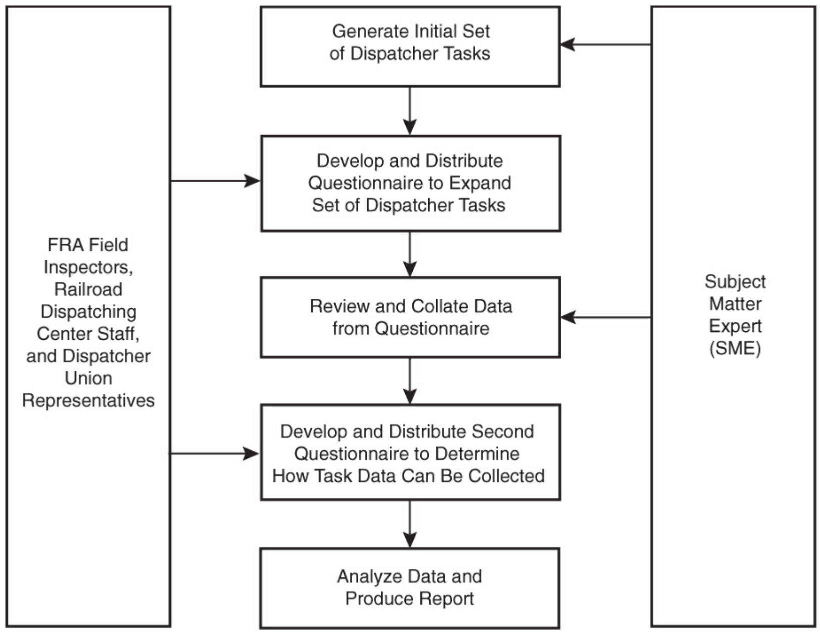

Figure 1. Technical approach used to identify railroad dispatcher tasks and determine how data can be collected on these tasks

1.5 Scope

The scope of this study focuses on the identification of railroad dispatcher (a.k.a. a trick dispatcher) tasks, those factors that affect dispatcher taskload, and a determination of how data on these tasks are currently collected. This study does not address other development stages of a taskload assessment tool.

Further, the research addresses only the job of railroad dispatching. It does not address any other jobs within a dispatching center environment, including Chief Train Dispatcher (CTD), Assistant Chief Train Dispatcher (ACTD), superintendents/supervisors, crew callers, and power managers. Furthermore, the research does not address any other railroad jobs, since the nature of each of these other jobs is fundamentally different from the job of a railroad dispatcher, and therefore the tasks are different as well.

1.6 Organization of the Report

To provide some background, Section 2 describes modern railroad dispatching. Section 3 presents the methods used to collect data on dispatcher tasks and information on how data on these tasks can be collected at dispatching centers around the country. The researcher developed two questionnaires for this purpose. Section 4 presents the results of the two questionnaires. Section 5 provides a discussion of the findings, while Section 6 presents some future recommendations. Section 7 includes a list of references used in the research. An Appendix contains copies of both questionnaires used in the study. Lastly, a list of abbreviations and acronyms used in the report is presented.

2. Modern Railroad Dispatching

Railroad dispatchers are responsible for controlling and authorizing track use over a given territory. Track users include different types of trains, maintenance of way crews, signal maintainers, and track inspectors, among others. In addition to controlling track use, a dispatcher must respond to unplanned events that occur on the dispatcher's territory, such as a malfunctioning locomotive or derailment, and he or she must also be prepared to manage emergency events that occur, however infrequently.

A variety of technologies, communications systems, and recordkeeping methods help the dispatcher perform his or her job. Dispatching methods range from issuance of manual train orders and other written or verbal authorities to occupy track, to CAD systems, through which the dispatcher can direct trains by affecting changes to railroad signals and switches remotely located over 1000 miles (mi) away. Dispatchers also perform a variety of recordkeeping functions as part of their job. Recordkeeping may be done manually, such as completing a paper train sheet; it may be automated through a computer; or some combination of manual and computer-aided recordkeeping might be used.

Railroad dispatchers work in climate-controlled office environments. Typically, a dispatcher works at a desk that contains multiple computer screens; audio equipment (multi-channel radio, telephone); and a number of paper records, logs, and forms. Each dispatching desk covers a certain amount of territory on the railroad's network, for which the dispatcher is responsible for the safe and efficient movement of all track occupants in that territory. As track users enter and leave dispatching territories, they are handed off to other dispatchers.

The introduction of CAD and communications systems late in the 20th century has made it possible for dispatchers to control more trains over more miles of track. Facilitated by these CAD systems, large centralized dispatching centers began to evolve in the late 1980s due in part to railroad mergers and consolidations. Today, dispatchers for some of the largest Class I railroads work in shifts around the clock in large centralized operations along with as many as 45 other dispatchers in 1 room, and they may control territories that span hundreds of miles that are located over 1000 mi away from the dispatching center.

Changes in signal technology, combined with an increase in computerized systems, have also led to a reduction in the use of field operations personnel, such as tower operators, bridge tenders, and clerks, who traditionally supported the dispatcher in carrying out his or her duties and responsibilities. This reduction in staff has resulted in more direct dispatcher control over train movements, an increase in responsibilities, and an increase in the number of individual tasks involved in carrying out those responsibilities. The reduction in field operations personnel has also, in effect, eliminated a source of redundant safety checks, since train orders used to be handed down from a dispatcher to a tower operator, then from the tower operator to the train and engine crew. With the elimination of tower operators, dispatchers now communicate directly with the train and engine crews and other track users. Furthermore, tasks that used to be completed by clerks are now being performed by the dispatcher in addition to his/her other responsibilities.

The combination of increased traffic volume, increased reliance on computers, larger territories, greater dispatcher responsibilities, and more tasks results in a greater amount of work for the dispatcher. Furthermore, due to the elimination of the redundancy that tower operators once provided, the increased amount of work has greater potential of resulting in compromised safety.

3. Methods

This section describes the methods used to identify a comprehensive set of dispatcher tasks and delineate the means in which data on these tasks can be collected. The primary methods included review of past research; input from SMEs; and the development and distribution of two questionnaires designed to tap the knowledge and experience of FRA field inspectors, railroad officers, and experienced railroad dispatchers. Individuals from these three populations are representative of most, if not all, of the dispatching operations across the United States and are among the most knowledgeable on current dispatching tasks, technologies, and operations, as well as means of collecting task-related information, and will be among the users of a dispatcher taskload assessment tool.

First, the researcher identified an initial set of dispatcher tasks based on past research and the expertise of an SME. Data sources used to compile the initial set of dispatcher tasks include the following:

- *Training requirements for railroad dispatchers: objectives, syllabi, and test designs* (Reinach, Gertler, & Kuehn, 1998)
- *An analysis of the job of railroad train dispatcher* (Devoe, 1974)
- *Understanding how train dispatchers manage and control trains: results of a cognitive task analysis* (Roth, Malsch, & Multer, 2001)
- *A preliminary examination of railroad dispatcher workload, stress and fatigue* (Popkin, Gertler, & Reinach, 2001)
- Naturalistic observation
- Subject matter expertise
- FRA *Operating practices enforcement manual*[2] (FRA, 1998)

The researcher then developed a questionnaire to verify and expand upon the set of dispatcher tasks. The Appendix contains a copy of this questionnaire. In addition to being asked to verify and add to the list of tasks, questionnaire respondents were asked if they currently collect data on any of the tasks listed as part of their job responsibilities.

The questionnaire also asked respondents to list circumstantial variables they felt may affect a dispatcher's ability to complete a particular task. These circumstantial variables are factors external to the dispatcher (e.g., the number of trains) that focused on track-related issues and railroad operations, as well as any other factors (e.g., weather, month) that may affect a dispatcher's ability to carry out his or her tasks (and thus taskload). Respondents were also asked to identify dispatcher-related factors that they felt may affect a dispatcher's ability to complete a task, such as dispatching experience and dispatcher familiarity with a particular territory. Lastly, the questionnaire asked respondents to evaluate the relative speed of routing different types of trains through a territory using a CAD system.

---

[2] The Enforcement Manual includes a Train Dispatchers Assessment Checklist and Train Dispatchers Desk Audit guidelines.

The researcher developed three different versions of the questionnaire, based on whether the questionnaire was intended for railroad officers, FRA inspectors, or active dispatchers. Copies of the questionnaire were then sent to representatives from each of these three stakeholder groups. OP supervisors at each of the eight FRA regions across the country received several copies of the questionnaire to distribute to as many of their safety inspectors and OP specialists as possible. The only requirement was that the inspectors and OP specialists had to be familiar with dispatching operations and practices. The goal was to have at least one safety inspector or OP specialist from each region complete a questionnaire. Safety inspectors and OP specialists from FRA regional offices offer efficient exposure to a large number of railroad dispatching operations around the country. Railroad officers at two railroads, one commuter and one freight, also received the questionnaire. Lastly, the researcher sent several copies of the questionnaire to a representative of ATDA, who was asked to distribute the questionnaire to both passenger and freight railroad dispatchers.

A second questionnaire was developed based upon the results of the first questionnaire. The Appendix also contains a copy of this questionnaire. The second questionnaire aimed to determine the feasibility of collecting data on the dispatcher tasks that the researcher had identified. Before the distribution of the second questionnaire, the researcher re-organized the tasks identified in the first questionnaire into a more logical structure containing six high-level task categories. The second questionnaire asked, for each of these six high-level task categories, how data can be collected (e.g., via computer, computer-generated report, paper train sheet, other paper record, direct observation, review of audiotape), how much time and effort it would take, and how obtrusive it would be to collect these data. Respondents used a Likert-type scale (1-7) with anchor points and clear definitions. A final question asked respondents to estimate how much of a dispatcher's time they felt is spent carrying out each task category in a given 8-h shift (as a percentage between 0 and 100). The second questionnaire was distributed to those who completed the first questionnaire. The next section presents the results of both questionnaires.

4. Results

Results are organized into several sections. Section 4.1 presents demographic information about questionnaire respondents. Section 4.2 discusses the content of the dispatcher tasks based on data compiled from the first questionnaire. Section 4.3 presents other factors, such as dispatcher experience, based on results from the first questionnaire. Although these factors are not activities that dispatchers carry out, they affect how dispatcher activities are carried out. Lastly, Section 4.4 presents information on how to collect data on these tasks, as well as how much time and effort, and how obtrusive it is to collect these data, based on the results of the second questionnaire.

4.1 Questionnaire Respondents

Eleven respondents completed the first questionnaire. Nine of the 11 respondents were FRA regional safety inspectors or OP specialists, representing 6 of the 8 FRA regions around the country. The two remaining completed questionnaires came from active railroad dispatchers—one from a passenger operation and one from a freight railroad. t reviewing reference materials

Table 1 shows the railroads and dispatching center locations represented by the FRA safety inspectors and OP specialists who completed questionnaires. Of the 11 individuals who completed the first questionnaire, 10 completed the second questionnaire.[3]

Five of the nine FRA safety inspectors/specialists had prior experience as dispatchers, and a sixth individual had experience as a block tower operator. The 9 inspectors/specialists had an average of 7.1 years (yr) of experience (median of 6 yr) at their present inspector/specialist position. The dispatchers had an average of 21 yr of dispatching experience each.

4.2 Railroad Dispatcher Tasks

The researcher initially identified a total of 87 dispatcher tasks and organized them into 8 categories:

1. CTC or CAD activity[4]
2. Dispatcher-authorized mandatory directives[5]
3. Other directives
4. Phone/radio calls
5. Internal conversations

---

[3] The 11th individual left his job sometime between the distribution of the first and second questionnaires and therefore was unavailable to complete the second questionnaire.

[4] Although some operational differences occur between CTC and CAD systems, to simplify matters the two are considered interchangeable since both serve a similar function—to remotely actuate signals and switches along a territory.

[5] Mandatory directives are movement authorities issued by a dispatcher that govern track occupancy and speed and/or operation over a specific segment of track, possibly for a specific duration of time.

6. Miscellaneous activity
7. Recordkeeping tasks
8. Time spent reviewing reference materials

Table 1. Railroads and dispatching center locations represented by inspectors who completed questionnaires

Railroad Name	Dispatching Center Location
Alaska Railroad	Anchorage, AK
Amtrak	Boston, MA; New York, NY; Somerville, MA
Atlantic & Gulf Railroad	Albany, GA
Burlington Northern Santa Fe	Ft. Worth, TX; San Bernardino, CA
Burlington Northern Santa Fe/Union Pacific Railroad	Spring, TX
CSX Transportation, Inc.	Jacksonville, FL; Selkirk, NY
Dakota, Minnesota and Eastern Railroad	Brookings, SD
Florida East Coast Railway Co.	St. Augustine, FL
Fort Worth & Western Railroad	Fort Worth, TX
Georgia Central Railroad	Vidalia, GA
Georgia-Florida Railnet	Albany, GA
Kansas City Southern Railroad	Shreveport, LA
Long Island Railroad	Jamaica, NY
Metro-North Railroad	New York, NY
New England Central Railroad	Saint Albans, VT
New Jersey Transit	Hoboken, NJ
Norfolk Southern	Bluefield, WV; Roanoke, VA; Pittsburgh, PA; Harrisburg, PA; Atlanta, GA; Birmingham, AL; Greenville, SC; Summerset, KY; Knoxville, TN
New York, Susquehanna and Western Railway	Cooperstown, NY
Port Authority Trans-Hudson	Jersey City, NJ
Providence and Worcester Railroad	Worcester, MA
Seminole Gulf Railroad	Ft. Myers, FL
Southeastern Pennsylvania Transportation Authority	Philadelphia, PA
Springfield Terminal Railroad	North Billerica, MA
Union Pacific Railroad	Spring, TX; Fort Worth, TX; Omaha, NE; San Bernardino, CA
Vermont Railways	Rutland, VT

A preliminary review of the tasks found several duplicates among the 87 tasks. The researcher eliminated these duplicates and re-organized the resulting 67 tasks into 6 new task categories to represent a more logical structure. The following lists the six new task categories:

1. Actuation of signals, switches, blocking devices, and bridge controls via CTC/CAD system
2. Issuance and cancellation of dispatcher-authorized mandatory directives

3. Granting of other track-related permissions, protections, and clearances (non-mandatory directives)
4. Carrying out non-movement authority or non-permission/protection/clearance communications[6]
5. Performance of general recordkeeping tasks
6. Review of reference materials

Table 2 presents a final set of 67 tasks.

Table 2. Final set of railroad dispatcher tasks

General Task Category	Task
1. Actuate signals, switches, blocking devices, and bridge controls via CAD system	1. Route passenger/commuter trains 2. Route local freight trains 3. Route through freight trains 4. Route work trains 5. Route hi-rail vehicles 6. Route other moving track vehicles 7. Open/close railroad bridges
2. Issue/void dispatcher-authorized mandatory directives	8. Issue (or cancel) Form Ds 9. Issue track warrants 10. Issue Direct Traffic Control (DTC) block authorities 11. Issue track bulletins (e.g., Form B) 12. Issue track permits 13. Issue track and times 14. Issue work and times 15. Issue joint track and times 16. Issue joint work and times
3. Grant other track-related permissions, protections, and clearances	17. Grant permission to pass a red signal 18. Grant permission to open up a switch onto main line 19. Grant permission to close a main track switch 20. Grant permission to make a reverse move 21. Grant permission to leave a passenger station/terminal 22. Grant other permissions, clearances, and protections 23. Protect for other-than-normal switch operations 24. Protect passengers crossing main tracks between platform and station (station cut-outs) 25. Provide blue flag protection 26. Provide roadway worker protection/foul time 27. Issue plate orders (catenary out of service) and other electrified territory maintenance protections 28. Issue yard protection 29. Issue stop and protect orders (to protect highway users at grade crossings with reported activation failures) 30. Follow cab signal failure procedures 31. Issue heat orders for welded rail/catenary territories

[6] This entails the communications that the dispatcher carries out that are not part of issuing an authority (task category #2) or a permission, clearance, or protection (task category #3). They generally involve advisories, coordinating activities, and the exchange of work-related information.

Table 2. Final set of railroad dispatcher tasks (continued)

General Task Category	Task
4. Carry out non-authority or non-permission/protection/clearance communications	32. Issue traffic advisories 33. Issue weather advisories 34. Issue track condition advisories 35. Issue speed restrictions, slow orders, bulletins, etc. 36. Issue line-ups 37. Coordinate between parties 38. Communicate with train crews (e.g., time train crew goes on duty, outlaw-related information, initial terminal Form D check) 39. Communicate with dispatchers at other centers and with other departments: yardmasters, crew callers, police department 40. Communicate with other railroads (e.g., dispatcher, CTD) 41. Call for taxis/crew transportation for outlawed/incoming crews 42. Communicate and coordinate incident-related matters 43. Conduct conference calls with freight agents and clerks 44. Field incoming wrong number calls 45. Field passenger complaints 46. Field requests from emergency responders to intrude into right-of-way to handle emergencies 47. Communicate with power manager (electric traction territory) 48. Communicate with those inside the dispatching center, such as another dispatcher, an ACTD or CTD, or other supervisor in the same center
5. Perform general recordkeeping tasks	49. Enter train sheet data (e.g., train times, crew duty times, unusual events, and/or equipment defects, such as signal failures) 50. Complete train delay reports 51. Enter train ID data 52. Prepare train consist reports 53. Complete incident logs 54. Set up train sheet 55. Prepare daily Bulletin Order 56. Keep payroll records 57. Check automatic equipment inspection (AEI) readers and record car numbers 58. Transfer on/off duty 59. Maintain block register territory record 60. Complete various other FRA- and railroad-required reports (e.g., grade-crossing malfunction, signal failure)
6. Review reference materials *Time spent reviewing…* →	61. Rulebook(s) 62. Special bulletins, speed restrictions, general orders 63. Dispatcher notes 64. Dispatcher manual of instructions 65. Bridge maps, track charts 66. Train consist reports 67. Rule-of-the-day and other daily postings

Questionnaire respondents were asked whether they routinely collected any of these data. Most respondents (FRA inspectors/specialists) indicated that they did not routinely collect these performance-related data, instead focusing on compliance and regulatory-based issues, such as adherence to HOS requirements, correct recordkeeping, proper (formal) communications with other parties, and satisfactory transfer process at the turnover of a shift. Further, most of this information is collected via direct observation of the dispatcher, as well as some monitoring of audiotaped conversations.

The first questionnaire also asked about the relative time and effort required to route different track vehicles across a dispatching territory. This has implications for the calculation of dispatcher taskload, since it is not clear if it takes a dispatcher the same amount of time and effort, or different amounts of time and effort, to route different trains across a territory using a CAD system (see general task category # 1). The researcher asked respondents to consider a through freight train, a local freight train, a passenger/commuter train, and a work train, each separately moving down the exact same stretch of territory, with no other traffic around. The respondents were further instructed to assume that all things other than the type of train or track vehicle were equal, such as the weather, current traffic (none), the distance that the dispatcher is routing the train, and the type of CTC or CAD system that the dispatcher is using. The researcher then asked respondents to provide a relative judgment regarding whether it typically takes a railroad dispatcher less time (or effort), the same time (effort), or more time (effort) to route a passenger/commuter train, a local freight train, a work train, and a hi-rail vehicle than a through freight train.

Table 3 and Table 4 summarize data provided by 9 of 11 respondents. The values in each table correspond to the number of questionnaire respondents who indicated less, equal, or more time (effort) to route each type of track vehicle relative to a through freight train. Numbers in bold correspond to the greatest number of responses indicating less, equal, or more time (or effort) required to route each type of track vehicle relative to a through freight train.

A slight majority of respondents judged that passenger/commuter trains and local freight trains take about the same time to route as a through freight train, while work trains and hi-rail vehicles take more time to route. In addition, passenger/commuter trains involve about the same effort to route as through freight trains, while local freight trains, work trains, and hi-rail vehicles were all judged to take more effort to route than a through freight train. Although caution should be exercised when analyzing these results due to the very small sample size, different track vehicles appear to require different amounts of time and effort to be routed through a territory. One possible explanation for this finding is that hi-rail vehicles and work trains often make frequent stops in order to inspect or repair track and thus require extra care in routing and protecting these vehicles and track occupants.

Table 3. Relative judgment of the time required to route different track vehicles

	Passenger/ Commuter Train	Local Freight Train	Work Train	Hi-Rail Vehicle
Less time than routing a through freight train	2 (18%)	0 (0%)	0 (0%)	0 (0%)
Equal time than routing a through freight train	**6 (55%)**	**5 (45%)**	3 (27%)	2 (18%)
More time than routing a through freight train	1 (9%)	4 (36%)	**6 (55%)**	**7 (64%)**

Table 4. Relative judgment of the effort required to route different track vehicles

	Passenger/ Commuter Train	Local Freight Train	Work Train	Hi-Rail Vehicle
Less effort than routing a through freight train	2 (18%)	0 (0%)	0 (0%)	0 (0%)
Equal effort than routing a through freight train	**5 (45%)**	4 (36%)	2 (18%)	0 (0%)
More effort than routing a through freight train	2 (18%)	**5 (45%)**	**7 (64%)**	**9 (82%)**

4.3 Other Dispatcher Factors That Affect Railroad Dispatcher Taskload

A number of non-task factors either affect a dispatcher's taskload or can be used to describe the circumstances in which taskload is measured. Some factors are internal to the dispatcher, while other factors are external. Data for these factors should also be collected and documented. The researcher can use some of these factors in a taskload calculation formula (e.g., the number of control points can be used with data on CTC/CAD[7] activity, since the amount of CTC/CAD actuation is expected to be affected by the number of control points), while others are more descriptive, enabling inspectors and others to make fair comparisons between taskloads collected at two different desks or at two different times. The descriptive factors can be used to match two different taskload assessments to ensure that the results of one or both are not unduly influenced by, for example, a particular month of the year.

Data were collected in the following areas:

- Track-related factors
- Railroad operation-related factors
- Dispatcher-related factors
- Other factors

Table 5 presents a set of track-related factors expected to affect a dispatcher's ability to carry out job-related tasks. Table 6 presents factors related to the day-to-day operation of the railroad that affect the number and types of tasks to be carried out at a particular dispatching desk. Table 7 presents a set of factors related to the dispatcher that affect his/her ability (and thus time) to complete job-related tasks. Table 8 presents a set of other factors that affect the number and type of dispatching tasks that are performed on any particular day.

Table 5. Track-related factors

General Measure	Example
1. Number of limitations/restrictions/changes in track characteristics (i.e., number of bulletins and general orders in effect)	• High-wide clearances • Speed restrictions (e.g., slow order) • Signal system changes (e.g., for duration of project or time period using Form D or Bulletin)
2. Number of passenger station cut-outs	
3. Number of track miles	
4. Number of route miles	
5. Number of control points/interlockings	
6. Number and type of grade crossings	• Active grade crossing warnings • Passive grade crossing warnings
7. Number of abutting territories	• Number of adjoining territories • Number of own railroad dispatchers with whom a dispatcher must interact • Number of foreign railroads/ dispatchers with whom dispatcher must interact

[7] Although operational differences exist between CTC and CAD, the researcher combined the two into one category since both serve a similar function—to remotely actuate signals and switches along a territory.

Table 5. Track-related factors (continued)

General Measure	Example
8. Capacity	• Single track with passing sidings • Single track without passing sidings • Double track • Multiple track
9. Method of operation	• Dark territory • CTC • Absolute block system • Yard limits • Voice control

Table 6. Railroad operation-related factors

General Measure	Example
1. Type of operation	• Passenger • Freight • Mixed operation
2. Method(s) of operation (check all that apply)	• Verbal and written directives (e.g., train orders) • CTC • Tower/block operator-assisted • Non-signaled track warrant control (TWC) • Signaled TWC/absolute block system • DTC
3. Number of passenger trains	
4. Number of commuter trains	• Local commuter trains • Express commuter trains
5. Number of local freight trains	
6. Number of through freight trains	
7. Number of work trains	• This is related to the number of maintenance of way and communication-and-signal projects
8. Number of other track users	• Hi-rail vehicles • Moving track equipment • Stationary track equipment
9. Train priorities	• Passenger train incentives • High priority freight traffic • Train connections • HOS considerations • Need for locomotives to make trains elsewhere • Other considerations • Consistency of priorities: Are train priorities generally consistent, or do they change frequently?
10. Number of defect detectors monitored	• Hot box detector • High/wide detector
11. Mix of traffic speeds (i.e., traffic complexity)	
12. Traffic density	
13. (Train) Running times	
14. Major maintenance projects	• Ballast dumping operation • Tie replacement • Track installation

Table 7. Dispatcher-related factors

General Measure	Example
1. Age	
2. Generation differences	
3. Gender	
4. Dispatching experience	
5. Familiarity with territory/desk	
6. Familiarity with track equipment	• Track equipment performance characteristics
7. Familiarity with train crews	
8. Personality	• Ability to work cooperatively with dispatchers responsible for adjoining territories • Ability to work cooperatively with dispatchers in own center
9. Time on duty	
10. Work schedule	• Number of consecutive d worked • Regular schedule • Extra board schedule
11. Quality of transfer	• Range from detailed written and verbal transfer to terse verbal (e.g., "it's all there in front of you on the sheet—you figure it out!")
12. Personal issues	• Family problems
13. Illness	• Loss of voice
14. Articulation	• Ability to formulate and communicate clear instructions
15. Ability to hear and listen	
16. Ability to march and chew gum at same time	
17. Railroad background/experience	
18. Ability to tolerate noise/stress/conflict	

4.4 Railroad Dispatcher Task Data Collection

Section 4.4 presents the results from the second questionnaire and is divided into two parts. The first part presents aggregate data on how taskload data for a 7-d consecutive period could be collected. The second part presents the results of questions that addressed how time consuming, how much effort, and how obtrusive it would be to collect these data for a 7-d period. A continuous 1-week (wk) data period was selected because this represents a realistic amount of time for which a researcher, an FRA safety inspector or specialist, or a railroad officer might want to collect dispatcher taskload data at any one time. One d of data may not sufficiently represent the variety and scope of dispatcher activity, and 1 month (mo) of data, although perhaps preferable, is likely to require too many resources from those collecting the data and thus will likely be unacceptable (and thus data will not be collected at all). One wk is an optimum period of data collection since a railroad officer, researcher, or FRA safety inspector or specialist could collect 1 wk of data during a 1-2 d visit, and this amount of data is expected to be accessible from the dispatching center without undue burden to the railroad. Ideally, a researcher, an FRA inspector or specialist, or a railroad officer would collect several non-consecutive weeks of data over a given period of time (e.g., 1 wk of data collected per month for 4 mo) to increase the amount of data collected, enabling more reliable data analyses and a more robust dispatcher taskload assessment.

Table 8. Other factors

General Measure	Example
1. Number of decision/planning aids available	
2. Weather	• Monitor known trouble spots (e.g., tendency to get high water or washouts, power lines down) • Provide weather and track advisories to train crews
3. Season/month	
4. Work climate	
5. Quality of workspace	
6. Acts of God	
7. Pace of work	• Surges in workload • Long periods of low workload
8. Unanticipated problems[8]	• Mechanical (equipment) failure
9. Technology-related problems	• Dead spots in radio • CTC or power outages that affect segments of a territory • Inability to conference call
10. Communication problems	• Awaiting response from a CTD or other official to act • Radio congestion • Cross-talk in radio
11. Type of equipment	• CTC/CAD versus paper forms
12. Quality of transfer	
13. Conflicting expectations	• Commuter versus intercity trains
14. Muddled chain-of-command	• Exacerbates problems/delays

Questions addressed the 6 higher level task categories (see Table 2) rather than each of the 67 specific tasks, since it was unreasonable to ask respondents to complete a lengthy questionnaire covering the details of data collection on 67 different tasks. The researcher sent the second questionnaire to 10 of the 11 respondents who completed the first questionnaire (the 11th respondent had left his job before the distribution of the second questionnaire). All 10 respondents completed the second questionnaire.

4.4.1 Dispatcher Task Data Collection Methods

For each of the six task categories, respondents indicated how data can be collected on the number of tasks for a 7-d consecutive period (i.e., 1 wk), at the dispatching centers for which the respondent either worked or was responsible. The questionnaire presented eight data collection methods—review of a CAD report, review of some other computer-generated report, review of a paper train sheet, review of some other paper record, review of an audiotape, direct observation of the dispatcher, some other method not previously listed, or cannot be collected—and asked the respondents to identify all data collection methods that applied to the particular task category. Table 9 presents the results. The values in Table 9 correspond to the number of respondents who indicated that, for a particular task category, data could be collected using one of the methods

[8] An unanticipated problem may cause the dispatcher to completely reformulate his or her operating plan or strategy, including train movements and meets/passes.

shown in the left-hand column. The values highlighted in bold correspond to the data collection method most frequently identified by respondents as capable of collecting data for each task.

Table 9. Dispatcher task data collection methods

Data Collection Method	Task Category					
	Actuate signals and switches via a CAD system	Issue/cancel mandatory directives	Grant track-related permissions, protections, and clearances	Carry out non-movement authority or non-permission/ protection/clearance communications	Perform general recordkeeping tasks	Review reference materials
CAD report	**10**	**8**	3	5	**8**	4
Other computer report	3	2	1	5	4	3
Paper train sheet	3	3	3	3	5	2
Other paper record	4	3	4	4	6	3
Audiotape	5	7	**9**	8	6	0
Observation	8	7	7	**9**	**8**	**6**
Other	2	3	1	0	1	3
Cannot be collected	0	0	1	1	0	1

According to the results, CAD reports are most advantageous in collecting signal and switch actuation information, mandatory directive data, and general recordkeeping tasks (although direct observation appears to be equally as effective for general recordkeeping tasks). Audiotapes of dispatcher conversations are most useful in collecting data on track-related permissions, protections, and clearances. Direct observation appears to be most advantageous in collecting information on non-movement authority, or non-permission, non-protection, or non-clearance communications, general recordkeeping tasks (although CAD reports appear to be equally as effective as a data collection method for this latter task), and amount of time dispatchers spend reviewing reference materials.

4.4.2 Amounts of Time, Effort, and Obtrusiveness in Collecting Dispatcher Task Data

For each of the six task categories, the questionnaire requested respondents to provide an indication of how much time, how much effort, and how obtrusive it would be to collect data on the number of tasks carried out over a 7-d consecutive period to begin to gauge resource requirements for a taskload assessment tool. Respondents used a seven-point Likert-type scale corresponding to a non-specific range of time, effort, and obtrusiveness to provide an indication of how much time, how much effort, or how obtrusive it would be to collect data by circling a value between one and seven. Each scale contained descriptors for the anchors and the mid-point. For example, with respect to the level of time, a seven-point scale was produced where one represented very little time, four represented some time, and seven represented a lot of time.

Where a respondent circled two different values for a given scale or omitted a response, data were eliminated from analysis since it was unclear which response was intended. This occurred a total of 16 times out of 180 possible data points (each of 10 respondents could provide 3 scores for 6 tasks, thus 10 x 3 x 6 = 180).

Table 10 presents respondents' ratings of the amount of time, effort, and obtrusiveness in the form of median values, which provide an indication of how much time, how much effort, and how obtrusive it would be to collect data for each task category. A value of one corresponds to very little time, minimal effort, and not at all obtrusive. A value of seven corresponds to a lot of time, maximum effort, and very obtrusive. Thus, generally, the higher the number, the more time, more effort, and more obtrusive it would be to collect data on the particular task category.

Table 10. Median levels of time, effort, and obtrusiveness required to collect dispatcher task data

	Task Category						Median value across all task categories
	Actuate signals and switches via a CAD system	Issue/ cancel mandatory directives	Grant track-related permissions, protections, and clearances	Carry out non-movement authority or non-permission/ protection/clearance communications	Perform general recordkeeping tasks	Review reference materials	
Time	4	4	7	7	6	4	5
Effort	4	4	6.5	7	5.5	3	4.75
Obtrusiveness	3	3	4.5	6	4	4	4
Composite score of median values for each dispatcher task	11	11	18	20	15.5	11	

Overall, it appears that collecting taskload data for all six task categories would take slightly more than some time, involve slightly more than moderate effort, and would be somewhat obtrusive. Based on composite scores for how much time, how much effort, and how obtrusive it would be to collect data for each individual task category, it appears that collecting data on track-related permissions, protections, and clearances; non-movement authorities and non-permission, non-protection, and non-clearance communications; and general recordkeeping tasks will take the most time, most effort, and be the most obtrusive to the dispatching operation. Conversely, respondents felt that collecting data on switch and signal actuation, mandatory directives, and time spent reviewing reference materials would take the least amount of time or effort, and be the least obtrusive.

Lastly, to gain an appreciation for how much time a dispatcher spends performing activities within each of the 6 task categories, the questionnaire asked respondents to estimate, from 0-100 percent, how much of a dispatcher's time they felt a dispatcher typically spends on each task category in a typical 8-h shift. Data from two of the respondents included unsolicited non-task activities (planning and free time), so their data were excluded from the results since the percentages attributed to each of the 6 task categories no longer totaled 100. Table 11 presents the results, based on data from 8 of the 10 respondents. The table presents average percentage of time instead of the median percentage, since median values did not total 100 percent.

Table 11. Average percentage of time dispatchers spend on each task category during a typical 8-h shift

	Task	Percentage of Time
1.	CAD actuation of switches, signals, blocking devices, and bridge controls	29.3 percent
2.	Issuing and canceling mandatory directives	28.5 percent
3.	Granting track-related permissions, protections, and clearances	17.4 percent
4.	Carrying out non-authority, permission, protection, or clearance-related communications	10.0 percent
5.	Performing general recordkeeping tasks	10.9 percent
6.	Reviewing reference materials	3.9 percent
	TOTAL	100 percent

Similar to any other job, railroad dispatchers conduct some non-work related activities beyond those described by the six work-related task categories during a typical shift (e.g., toileting, eating meals, informally talking with colleagues about non-work issues). Consequently, the data in Table 11 indicate the relative percentage of time that a dispatcher spends performing each of the six work-related activities; it does not necessarily represent the total amount of time a dispatcher spends at work. The results show that respondents feel that over half of a dispatcher's work-related time is spent actuating signals and switches via a CAD system and issuing/canceling mandatory directives.

5. Discussion

Section 5 is organized into several subsections. Section 5.1 discusses the results of the two questionnaires. Section 5.2 discusses the cognitive nature of railroad dispatching. Lastly, Section 5.3 discusses the value of these data in better understanding the nature of railroad dispatching, which can aid researchers, FRA inspectors, OP specialists, and railroads in further measuring the demands of railroad dispatching and improving railroad safety.

5.1 Dispatcher Tasks

Based on the results from the two questionnaires, the demands of a railroad dispatcher's job can be classified into six different types of activities. The following lists them:

1. Actuation of signals, switches, blocking devices, and bridge controls via CAD/CTC system
2. Issuance and cancellation of mandatory directives—authority to occupy track
3. Granting of other track-related permissions, protections, and clearances (non-mandatory directives)
4. Carrying out non-movement authority or non-permission/protection/clearance communications
5. Performance of general recordkeeping tasks
6. Review of reference materials

The researcher identified a total of 67 dispatcher-related activities. While not all dispatchers carry out the same exact set of tasks, most, if not all, dispatchers probably perform one or more tasks in each of the six task categories identified.

While data on some observable dispatcher activities (e.g., CAD switch and signal actuation) may be collected efficiently with the aid of automated computer-generated reports, collection of data on many other dispatcher activities still requires a significant amount of time through direct observation and monitoring of activity. Thus, a single, efficient mechanism to collect these data does not appear to exist. Interestingly, over half of a dispatcher's work-related time appears to be spent actuating signals and switches via a CAD system, as well as issuing and canceling mandatory directives to track occupants. These activities are indicative of a dispatcher's central role as rail traffic controller.

The dispatcher tasks identified through this research are valuable in contributing to a greater understanding of the demands of railroad dispatching. As can be seen, railroad dispatchers perform a wide array of physical activities in carrying out their job duties as rail traffic controllers. These activities clearly require both meticulous attention to detail (e.g., when routing a train via a CAD system or issuing a mandatory directive) and an understanding of the big picture (e.g., when communicating to crews regarding the amount of time a crew has remaining before the crew must give back control of a segment of track to the dispatcher to allow a train to pass without delay or harm).

5.2 The Cognitive Nature of Railroad Dispatching

The goal of this research was to begin to develop a computer-based dispatcher taskload assessment tool that could be used by railroads, FRA, and researchers to reliably measure observable dispatcher activity at each desk within a dispatching center. The tool would be based on a methodology developed by the FRA Office of Safety, where taskload is equal to the accumulation of time spent completing all relevant, observable dispatcher tasks.

The development of a railroad dispatcher taskload assessment tool based exclusively on observable task activity, however, may not be the most appropriate approach to assessing the demands of railroad dispatching. This is because railroad dispatching is highly cognitive in nature. As such, a tool limited to observable activities may not tell the whole story. Observable activities likely make up only a fraction of a dispatcher's true activity. Much of what a dispatcher does, in fact, takes place inside the dispatcher's head.

As far back as 1948, researchers observed the cognitive aspects of railroad dispatching. McCord (1948), a medical doctor who conducted naturalistic observations of railroad dispatchers, noted, "The train dispatcher carries a greater minute-by-minute mental load than that for any known occupation save a general in battle" (p. 377). More recently, Tom White (1992) in his monograph on the job of a railroad dispatcher, succinctly explains, "Train dispatching is a science of strategy and tactics" (p. 4). Gertler (2001) evaluated the job of a railroad dispatcher while studying railroad dispatcher selection practices. Using the Position Analysis Questionnaire, she identified a number of cognitive abilities associated with the job of a railroad dispatcher, leading her to conclude, "The relatively large number of cognitive abilities…is proof of the cognitive nature of this job" (p. 34). Finally, Roth et al. (2001) studied the cognitive strategies that railroad dispatchers use to safely and efficiently route trains and other track users, leading the authors to conclude that "dispatching is a cognitively demanding task" (p. 55).

5.3 The Relationship Between Physical Taskload and Cognitive Workload

One can think of the job of railroad dispatching as analogous to an iceberg (see Figure 2). With an iceberg, one sees only its tip, while the rest remains submersed under water. Even though one knows an iceberg is present by seeing its tip, it is difficult to determine the actual size of the iceberg, particularly the parts under water. This is quite similar to a dispatcher's work, where one sees only the physical activity of a dispatcher (the tip), not the cognitive activity that goes on that is beyond visual discernment. That is, much of what a dispatcher does is inside his/her head. It is quite possible, too, that the cognitive work that occurs beyond the eye may not be easily measured using only the physical work, just as an iceberg is not easily measured using only its tip.

The precise relationship between the directly observable taskload and the unobservable cognitive workload is unclear. To further understand the complicated relationship between physical taskload and cognitive workload, research on ATCS can be examined since dispatchers and ATCS share many of the same job responsibilities and work demands, and numerous research studies have examined ATCS workload. Railroad dispatching and air traffic control both involve the command and control of multiple vehicles in a fixed space (a dispatching territory or air sector), are susceptible to work surges and extended periods of high or low workload, and are safety-critical jobs involving decisions with potentially fatal consequences.

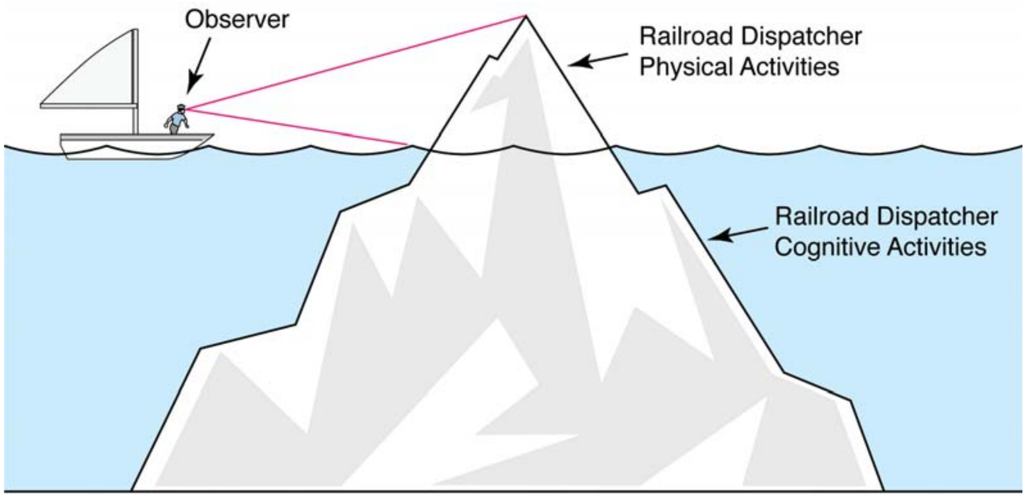

Figure 2. Railroad dispatching iceberg analogy

Pawlak, Brinton, Crouch, and Lancaster (1996), in their framework for evaluating air traffic control complexity, distinguish physical workload from mental workload. They define physical workload as “measurable external actions of the controller, used to implement a plan of action that has been previously determined” (p. 4), while they define cognitive workload as “the amount of cognitive activity spent performing such tasks as the evaluating, planning, and monitoring necessary for effective air traffic control” (p. 5). Pawlak et al.’s definition of physical workload is similar to Hadley et al.’s (1999) definition of taskload. Pawlak et al. suggest that physical workload (i.e., taskload) and cognitive workload are not necessarily correlated, and they provide several examples of high physical workload, low cognitive workload situations, and low physical workload, high cognitive workload situations. Separately, they note, “The task time and effort needed to issue a single clearance [physical workload or taskload] will not provide a meaningful measure of the amount of cognitive activity [cognitive workload] involved” (Pawlak et al., 1996; p. 5).

Pawlak et al. (1996) explain:

> Previous studies of ATC[S] complexity have based their measures on the amount of physical workload experienced by an Air Traffic Specialist …. It is our position, however, that the complexity of ATC[S] is better revealed through the analysis of controller strategies and decision making activities (cognitive tasks), and that this type of complexity may not be accurately reflected through measures of physical workload alone (p. 1).

Further, Pawlak et al. suggest that researchers have traditionally looked at physical workload because of the ease and convenience with which these data can be collected. They note:

> Measurements such as the number of communications and data entries, as well as the numerical counts of aircraft have been adopted primarily because this physical data is some of the only direct data that is readily available. Directly measuring the cognitive load that is being experienced is more difficult and, unfortunately, highly intrusive in a real-world, operational setting (Pawlak et al., 1996; p. 5).

Hadley et al. (1999) came to the same conclusion in stating that, “Since the tasks of …[ATCS] primarily involve cognitive activities, they are difficult to measure directly."

In fact, Salvendy (1997) suggests that, to the extent that a job becomes increasingly automated, and "…the role of the human operator becomes predominantly that of monitoring and supervising, the degree to which the operator is performing some observable functions is not an adequate index of cognitive workload" (Salvendy, 1997; p. 436). Such is the case for railroad dispatchers, since recent technologies, such as CAD systems, have begun to automate the dispatcher's job. For example, some CAD systems have decision aids built into them to help dispatchers route trains more efficiently and safely.

The cognitive nature of dispatching suggests that a taskload assessment tool based exclusively on observable taskload data may not be the most appropriate approach to measuring a dispatcher's work level or demands. Taskload is important to understanding a dispatcher's job, but it does not, in itself, convey an absolute burden or demand on the dispatcher. For example, 2 dispatchers, 1 with 3 mo on-the-job experience, and 1 with 25 yr of dispatching experience, may accomplish the same tasks but may experience very different completion times, stress levels, and efficiencies in carrying out the tasks, depending on their strategies and tactics in accomplishing the task. Thus, it is not just the task demands, but the dispatcher's ability to manage these task demands, that are important, and that must be considered when assessing the demands of railroad dispatching. Taskload measurement does not address this latter component to dispatching. Further, as Pawlak et al. (1996) note, taskload and workload are not always correlated.

Taskload has often been examined because of the ease and convenience with which these data can be collected. Assessment of cognitive demands of tasks is more difficult and intrusive to capture. Due to the heavily cognitive nature of railroad dispatching, however, the cognitive aspects of railroad dispatching must be taken into account in order to most accurately measure the demands of railroad dispatching. Limiting any type of assessment of dispatcher activity to only observable tasks (taskload or physical workload) will be incomplete and may be misleading.

Due to the heavy cognitive component of dispatching, assessment of dispatcher taskload may not be the best methodological approach to measuring the demands of railroad dispatching. Data gathered as part of this research, however, are still valuable in better understanding a railroad dispatcher's job, further documenting the physical activities involved in dispatching, and adding to the growing body of research on a railroad dispatcher's job. Data collected provide information on the number and diversity of activities that are involved in railroad dispatching and can, for example, serve as the building blocks to a model of railroad dispatching that would include both physical and cognitive elements.

5.4 Putting It All Together—A Preliminary Model of Railroad Dispatching

According to Pawlak et al. (1996) an ATCS's primary task is to maintain aircraft separation. To do this, an ATCS must use available information to control and predict potential conflicts between aircraft in order to maintain separation. This involves four main processes: planning, monitoring, implementing, and evaluating. These processes are similar to the four primary railroad dispatcher functions that describe the job of railroad dispatching, described by Reinach et al. (1998): planning, controlling (track use), managing unplanned and emergency events, and performing required recordkeeping. Pawlak et al. suggest that ATCS physical workload is related only to the one process of implementation. The three remaining processes, then, are not effectively measured using physical workload (i.e., taskload).

Using a similar approach to that of Pawlak et al., a dispatcher's taskload—the directly observable and quantifiable activities—is associated with two of the four dispatching functions described by Reinach et al. (1998): controlling track use and performing required recordkeeping. The other two functions, planning and managing unplanned and emergency events, although essential to the job of dispatching, may not be addressed (sufficiently or at all) by quantifying a dispatcher's taskload.

Figure 3 presents a preliminary model of railroad dispatching. The model incorporates the job functions of a railroad dispatcher (shown in the four rectangular boxes in the middle), the cognitive aspects (the innermost concentric circle), the individual-based workload factors (the outermost concentric circle), and the taskload components (shown at the top). The innermost concentric circle represents the cognitive elements of railroad dispatching, which are influenced by the primary functions of a railroad dispatcher. Two of the four functions—controlling track use and performing required recordkeeping—can be measured, at least in part, through their relationship to directly observable activities (i.e., taskload), as indicated in the model. The other two functions—planning and managing unplanned and emergency events—are not directly measured using taskload data. The model shown in Figure 3, when developed more fully, would be a valuable tool for FRA, researchers, and the railroads. Such a model could ultimately be used to:

- Support future railroad dispatcher research
- Improve dispatcher training
- Reduce dispatcher stress
- Maintain safe workloads across dispatching desks
- Determine appropriate staffing levels
- Support FRA inspector audits of dispatching centers
- Monitor the effects of changes in technology (e.g., PTC) on the job of dispatching

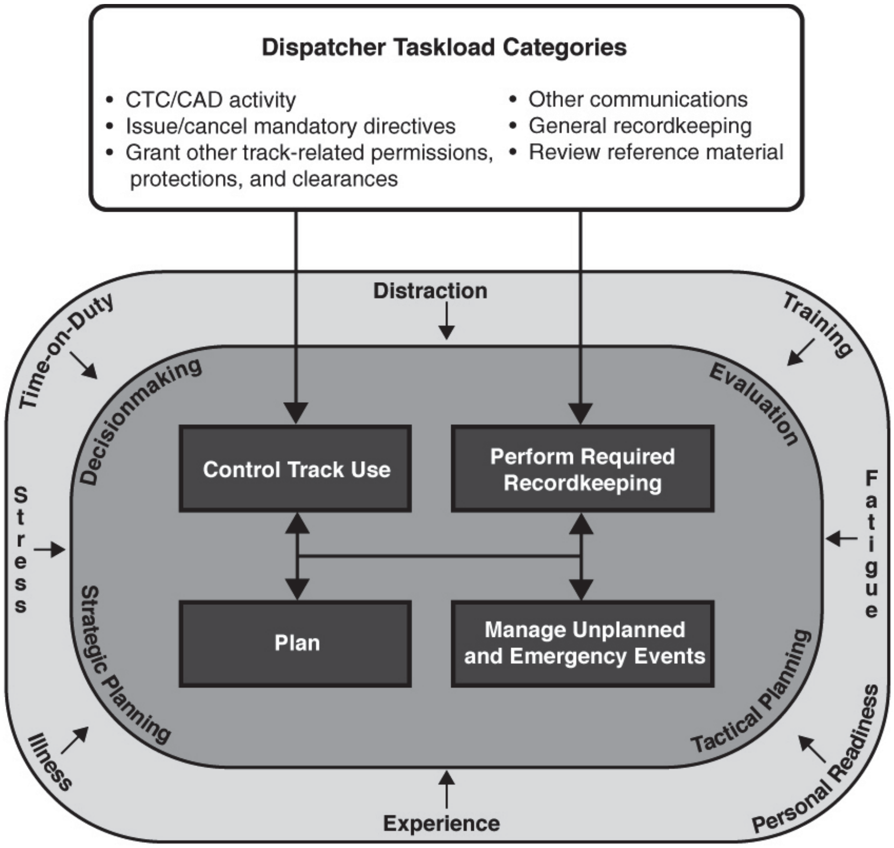

Figure 3. A preliminary model of railroad dispatching

6. Recommendations for Future Research

This report presents an inventory of observable activities required of dispatchers in carrying out their job duties. As such, it provides insight into the range and diversity of dispatching tasks. More research is needed, however, to understand the relationship between the observable dispatcher tasks and the cognitive elements of dispatching (e.g., decisionmaking strategies, information-processing heuristics). Future research might take several directions, including gathering more information about the job and processes of railroad dispatching and developing an appropriate model of railroad dispatching that shows the relationship between dispatcher taskload and workload. Based on the findings in this report, the researcher recommends the following research activities:

1. *Conduct a literature review of ATCS cognitive workload and performance*. The purpose of this effort would be to gain a further appreciation of the research performed on ATCS cognitive workload and performance, determine the state-of-the-art technology in measuring ATCS safety, and identify successful applications of ATCS research that can be adopted to railroad dispatching operations. Because air traffic control and railroad dispatching are similar to one another, and a significant amount of research has already been conducted on ATCS cognitive workload and performance, the proposed paper-based research review would use the previous research to leverage future research efforts in studying railroad dispatcher cognitive workload and performance, and it would aid in the eventual development of a valid model of railroad dispatching.

2. *Conduct simulator studies to determine the relationship between dispatcher taskload and workload.* A human-in-the-loop dispatching simulator offers researchers a controlled environment in which to define and measure dispatcher taskload, workload, and performance, and to relate these measures to safety outcomes. Simulator studies could be used, for example, to determine how increasing levels of dispatcher taskload and workload (e.g., periods of underload followed by a surge in taskload/workload) may affect a dispatcher's ability to carry out his or her job responsibilities and safety. The dispatching simulator located at the Volpe National Transportation Systems Center, or some other dispatching simulator, could be used in such an effort. Initially, dispatcher taskload, workload, and performance measures would need to be clearly defined and based on some type of theoretical underpinning that relates taskload, workload, and operator performance to human error and safety.

3. *Develop a model of railroad dispatching*. Based on the research results in the first two recommended studies, a model of railroad dispatching performance could be explored, then developed, and finally validated, using both empirical research, such as further simulator testing, and models of operator performance in other modes of transportation and other safety-critical industries.

4. *Conduct a human reliability assessment (HRA) of railroad dispatching operations*. Modern HRA techniques examine the cognitive aspects of operator performance, including errors of omission and commission. One or more HRA methods may be applied to study dispatching safety through prospective, predictive analyses of various dispatching scenarios (e.g., managing an unplanned or emergency event, such as a derailed train on a single-track main line).

5. *Examine the effect(s) of PTC on railroad dispatching.* The introduction of PTC will undoubtedly alter the nature of railroad dispatching, from controlling, communicating, and coordinating with track users to supervising their movements. That is, the job will probably involve some degree of transition from an active role in managing track occupancy and usage to a passive role of monitoring and supervising an automated system that will specify the actions of track users. Of particular concern is how PTC will affect a dispatcher's situation awareness, especially when time and safety-critical demands are made on the dispatcher in an emergency. The introduction of PTC has the potential to increase safety and efficiency in railroad operations but only if PTC systems take into account the human capabilities and limitations of those who interface with, or supervise, such systems, including railroad dispatchers.

7. References

Devoe, D. (1974). *An analysis of the job of railroad train dispatcher*. Springfield, VA: National Technical Information Service. Report No. FRA-ORD&D-74-37.

Federal Railroad Administration. (1990). *National train dispatcher safety assessment (1987-1988)*. Washington, DC: Author. Retrieved April 10, 2007, from http://www.fra.dot.gov/us/content/1716.

Federal Railroad Administration. (1995). *Train dispatchers follow-up review: report to Congress*. Washington, DC: Author. Retrieved April 10, 2007, from http://www.fra.dot.gov/us/content/1716

Federal Railroad Administration. (1998). *FRA operating practices enforcement manual*. Washington, DC: Author.

Gertler, J. & Acton, S. (2003). *Railroad dispatcher communications training materials*. Washington, DC: Federal Railroad Administration. Technical Report No. DOT/FRA/ORD-03/12.

Gertler, J. & Nash, D. (2004). *Optimizing staffing levels and schedules for railroad dispatching centers*. Washington, DC: Federal Railroad Administration. Technical Report No. DOT/FRA/ORD-04/01.

Gertler, J. (2003). *Selection of railroad dispatcher candidates*. Washington, DC: Federal Railroad Administration. Technical Report No. DOT/FRA/ORD-03/09.

Hadley, G., Guttman, J., & Stringer, P. (1999). *Air traffic control specialist performance measurement database*. Atlantic City International Airport: Federal Aviation Administration William J. Hughes Technical Center. Technical Report No. DOT/FAA/CT-TN99/17.

McCord, C. (1948). Life and death by the minute. *Industrial Medicine*, 17(10), 377-382.

National Transportation Safety Board. (1998). *Collision and derailment of Union Pacific Railroad freight trains 5981 North and 9186 South in Devine, Texas on June 22, 1997*. Railroad Accident Report No. NTSB/RAR-98/02. Washington, DC: Author.

Pawlak, W., Brinton, C., Crouch, K., & Lancaster, K. (1996). A framework for the evaluation of air traffic control complexity. In *Proceedings of the AIAA Guidance, Navigation and Control Conference*. Reston, VA: American Institute of Aeronautics and Astronautics.

Popkin, S., Gertler, J., & Reinach, S. (2001). *A preliminary examination of railroad dispatcher workload, stress, and fatigue*. Washington, DC: Federal Railroad Administration. Technical Report No. DOT/FRA/ORD-01/08.

Reinach, S., Gertler, J., & Kuehn, G. (1998). *Training requirements for railroad dispatchers: objectives, syllabi, and test designs*. Washington, DC: Federal Railroad Administration. Technical Report No. DOT/FRA/ORD-98/08.

Roth, E., Malsch, N., & Multer, J. (2001). *Understanding how train dispatchers manage and control trains: results of a cognitive task analysis*. Washington, DC: Federal Railroad Administration. Technical Report No. DOT/FRA/ORD-01/02.

White, T. (1992). *Just what is a train dispatcher*. Retrieved April 10, 2007, from http://www.halcyon.com/tawhite/just/justnx.htm.

Appendix.
Railroad Dispatcher Taskload Questionnaires

This Appendix contains copies of the two railroad dispatcher taskload questionnaires that were developed as part of the research described in this report. The first questionnaire focuses on identifying an extensive set of dispatcher tasks, while the second questionnaire focuses on how data related to these tasks can be collected. Copies of the first questionnaire were sent to all eight FRA regional offices, several railroad officers, and several active railroad dispatchers. The second questionnaire was sent to those who responded to the first questionnaire.

RAILROAD DISPATCHER TASKLOAD QUESTIONNAIRE # 1

Instructions:

Please read each question carefully. Feel free to write your responses directly on this questionnaire and/or use a separate sheet of paper. Some of the questions are conceptual in nature, so it may be necessary to read the question several times. If you have any questions, please do not hesitate to contact me and I will be happy to discuss the questions or your ideas. My phone number is (781) 684-4259, my fax number is (781) 890-3489, my email address is sreinach@foster-miller.com, and my mailing address is:

Mr. Stephen Reinach
Foster-Miller, Inc.
350 Second Avenue
Waltham, MA 02451

Overall project goal and background information to assist you in responding to the questionnaire:

The overall goal of this project is to develop a tool that FRA inspectors and OP specialists, as well as railroad officials, can use quickly and unobtrusively to assess railroad dispatcher taskload at a particular desk at a particular dispatching center. These tasks must be *observable* to someone like yourself, AND *quantifiable* either by hand or the railroad's computer system. For the tool to be highly successful and broadly used, it is important that the data collection take as little time as possible and not disrupt the railroad dispatching center staff and operation. For this reason, it is most desirable to be able to collect aggregate data using electronic (e.g., CAD system) or paper (e.g., Form D log) records, rather than through labor-intensive and potentially distracting observation of dispatchers. Furthermore, ideally data would be collected for a particular time period, for example, 1 week or 1 month, and could be collected retrospectively (in other words, an FRA inspector could go into a railroad dispatching center and examine taskload of a dispatching desk from a month ago).

Please complete the following information:

Your Name: ____

Title: ____

Phone No.: ___________________________

Pager No.: ___________________________

Region No.: ______________

Date: __________________________

Former dispatcher? (Please circle one) Yes No

Number of years of experience as field inspector/specialists: __________________

Questions:

1. Take a moment to review the list of *observable and quantifiable* tasks or activities on the next page (Table 1). Now think about the job of a dispatcher, and about observing dispatchers as part of your work. Can you think of any additional tasks or activities that are missing from the list? If so, please add them using the space provided on the next page. For example, are there any other verbal or written authorities issued by the dispatcher that are missing from the list? Again, these tasks must be observable to someone like yourself, AND quantifiable either by hand or by the particular railroad's computer system. Remember that the overall goal of the project is to develop a tool that you, as well as railroad officials, can use quickly and unobtrusively to assess dispatcher taskload at a particular desk at a particular dispatching center. When thinking about the tasks, therefore, it is important to remember that the goal is to take as little time as possible to collect the data, and to disrupt a railroad dispatching center and operation as little as possible.

Additional (observable) dispatcher tasks and activities not included in Table 1:

Table 1. Observable dispatcher tasks

Category	Data (tasks) to be collected
1. CTC/CAD activity	• Number of passenger/commuter trains • Number of local freight trains • Number of through freight trains • Number of work trains • Number of hi-rail vehicles • Number of other moving track vehicles • Number of pieces of stationary track equipment
2. Mandatory directives	• Number of Form Ds or TWCs issued/canceled • Number of Form Bs issued/canceled • Number of foul time permits issued/canceled • Number of blue flag protections issued/canceled • Number of other train orders/directives
3. Other directives	• Number of permissions to pass a red signal • Number of permissions to open up a switch onto main line • Number of permissions to make reverse move • Number of clearances to leave passenger station/terminal • Number of blocking devices applied/removed • Number of other clearances/directives
4. Phone/radio calls	• Number of traffic advisories • Number of weather advisories • Number of track condition advisories • Number of mandatory directives • Number of coordination b/w parties • Number of communications with another dispatcher/yardmaster • Number of line-ups issued • Number of re-crews • Number of required communications with train crews (e.g., when train crew goes on duty) • Number of miscellaneous other conversations
5. Internal conversations	• Number of conversations with the ACTD or CTD • Number of conversations with another dispatcher • Number of conversations with a superintendent/manager/supervisor
6. Miscellaneous Activity	• Number of line-ups issued • Number of re-crews issued
7. Recordkeeping tasks	• Number of train sheet entries • Number of train delay reports • Number of grade-crossing malfunction book entries • Time spent setting up a train sheet
8. Review of reference material *Time spent reviewing…* →	• Rulebook • Special bulletins • Dispatcher notes • Dispatcher manual of instructions • Bridge maps, track charts

2. Do you already collect any of this data on a regular or routine basis? If so, which data do you already collect and how do you collect it?

3. Are there any other types of dispatcher-related data that are not listed above that you already routinely collect? If so, what other data do you already collect, and how do you collect it?

4. What factors external to the dispatcher affect the time it takes a dispatcher to carry out various job-related tasks or activities? Consider the items in Tables 2-4 on this and the following page, as well as any others that you can think of. Consider the work environment, operational environment and physical characteristics of the territory that may somehow affect what a dispatcher must do to move or protect a track user or communicate with other railroad personnel. Please note that we are only interested in those factors that affect the dispatcher's time to complete his or her tasks. Please use the space provided on the Page 6 to provide your answers.

Table 2. Track-related characteristics

General measure	Specific examples
• Number of limitations/restrictions/changes in track characteristics (i.e., Number of bulletins and general orders in effect)	• High-wide clearances • Speed restrictions (e.g., slow order) • Signal system changes (e.g., for duration of project or time period using Form D or Bulletin)
• Number of passenger station cut-outs	
• Number of track mi	
• Number of route mi	
• Number of control points/interlockings	
• Number and type of grade crossings	• Active grade-crossing warnings • Passive grade-crossing warnings
• Number of abutting territories	• Number of adjoining territories • Number of own-railroad dispatchers with whom a dispatcher must interact • Number of foreign railroads/dispatchers with whom dispatcher must interact
• Capacity	• Single track with passing sidings • Single track without passing sidings • Double track • Multiple track
• Method of operation	• Dark territory • CTC • Absolute block system • Yard limits • Voice control

Table 3. Railroad operation-related factors

General measure	Specific examples
• Type of operation	• Passenger • Freight • Mixed operation
• Method(s) of operation (check all that apply)	• Verbal and written directives (e.g., train orders) • CTC/CAD • Tower/block operator-assisted
• Number of passenger trains	
• Number of commuter trains	• Local commuter trains • Express commuter trains
• Number of local freight trains	
• Number of through freight trains	
• Number of work trains	
• Number of other track users	• Hi-rail vehicles • Moving track equipment • Stationary track equipment
• Train priorities	• Passenger train incentives • High priority freight traffic • Train connections • HOS considerations • Need for locomotives to make trains elsewhere • Other considerations • Consistency of priorities: Are train priorities generally consistent, or do they change frequently?
• Number of defect detectors monitored	• Hot box detector • High/wide detector
• Mix of traffic speeds (i.e., traffic complexity)	
• Traffic density	

Table 4. Other factors

General measure	Specific examples
• Number of Decision/planning aids available	
• Weather	• Monitor known trouble spots e.g., tendency to get high water or washouts, power lines down • Provide weather and track advisories to train crews
• Season/mo	
• Work climate	
• Acts of God	
• Pace of work	• Brief surges in workload • Long periods of low workload

Additional factors <u>external to the dispatcher</u> that affect the time it takes a dispatcher to carry out his or her job-related tasks and activities:

5. We have identified a number of factors <u>related to the dispatcher</u> that affect the *time* it takes a dispatcher to complete the dispatcher activities/tasks provided in Table 1. These include the dispatcher's familiarity with the position and their experience, among others. Please take a few minutes to review the factors we have identified in Table 5. Can you think of any additional factors related to the dispatcher that affect the *time* it takes a dispatcher to complete the dispatcher activities/tasks provided in Table 1? If so, please list these factors in the space provided on the next page, and briefly describe how these factors affect a dispatcher's time to complete the tasks/variables.

Table 5. Dispatcher-related factors

General measure	Specific examples
• Age	
• Generation differences	
• Gender	
• Dispatching experience	
• Familiarity with territory/desk	
• Familiarity with track equipment	• Track equipment performance characteristics
• Personality	• Ability to work cooperatively with dispatchers responsible for adjoining territories • Ability to work cooperatively with dispatchers in own center
• Time on duty	
• Work schedule	• Number of Consecutive d worked • Regular schedule • Extraboard schedule
• Quality of transfer	• Range from detailed written and verbal transfer to terse verbal (e.g., "it's all there in front of you on the sheet—you figure it out!")

Additional dispatcher-related factors that affect the *time* it takes a dispatcher to complete the various dispatcher activities/tasks listed in Table 1:

____

____

____

____

____

6. I am interested in determining if different types of track vehicles (e.g., local freight train vs. through freight train) affect the *time* or *effort* it takes a dispatcher to effect signal or switch changes (i.e., CTC/CAD activity). Please take a moment and think about a through freight train, a local freight train, a passenger/commuter train, and a work train, each separately moving down the exact same stretch of territory, with no other traffic around. Assume that all things other than the type of train or track vehicle are equal, such as the weather, current traffic (none), the distance that the dispatcher is routing the train, and the type of CTC/CAD system that the dispatcher is using.

   Using the following table (Table 6), please indicate whether it typically takes a railroad dispatcher less time, the same time, or more time, to route each type of track vehicle listed in the left-hand column *relative to moving a through freight train*. Ties are allowed. So, for example, if it typically takes a dispatcher the same time to route a passenger/commuter train as it does a through freight train, than you would record a 2 in the box located in the second column and fourth row. If you need to add another track vehicle type, please use the space provided in the table. <u>Remember, we are interested in the time it takes a dispatcher to route a train, not how long it takes the actual train or track vehicle to move along the track</u>.

Table 6. Track vehicle types and CAD/CTC activity

Track vehicle type	**Time** 1-Less time than a through freight train 2- About the same time as a through freight train 3- More time than a through freight train	**Effort** 1-Less effort than a through freight train 2- About the same effort as a through freight train 3- More effort than a through freight train
Through freight train	**2**	**2**
Passenger/commuter train		
Local freight train		
Work train		
Hi-rail vehicle		
Please list any additional track vehicle types below, and follow instructions above		
Other1:		
Other2:		
Other3:		

7. Which dispatching centers does your region oversee? Please list them below, and include both the railroad name and the location (city, state) of the dispatching center. If you need more space to list additional dispatching centers, please feel free to add them at the bottom of this list or on the back of the questionnaire.

	Railroad Name:	Dispatching Center Location:
1.	______________________	______________________
2.	______________________	______________________
3.	______________________	______________________
4.	______________________	______________________
5.	______________________	______________________
6.	______________________	______________________
7.	______________________	______________________
8.	______________________	______________________
9.	______________________	______________________
10.	______________________	______________________

8. Do you have any additional comments or questions? If so, please use the space provided below to write them down.

____

____

____

____

____

____

____

Thank you for participating!

RAILROAD DISPATCHER TASKLOAD QUESTIONNAIRE # 2:

Overall project goal and background information:

The overall goal of this research project is to develop a tool that FRA inspectors and OP specialists, as well as railroad officials, can use quickly and unobtrusively to assess railroad dispatcher taskload at a particular desk at a particular dispatching center. These tasks must be *observable* AND *measurable* either by hand or a railroad's computer system. For the tool to be highly successful and broadly used, it is important that the data collection take as little time as possible and not disrupt the railroad dispatching center staff and operation. Ideally, data would be collected for a particular time period, for example, one week, and could be collected after-the-fact (in other words, an FRA inspector could go into a railroad dispatching center on December 1st and retrieve and examine taskload data for a dispatching desk for the last full week in September or October).

A questionnaire that was distributed last summer helped to identify six types of observable dispatcher tasks and over 80 examples of these tasks. Tasks range from verbal to written activities, and cover both NORAC and GCOR railroads.

This questionnaire has been designed to address several questions related to the dispatcher tasks identified in the earlier questionnaire. Specifically, using this questionnaire, I am interested in answers to the following questions:

1. Given the dispatching center(s) for which you are responsible, how can data on each dispatcher task be collected?
2. How much time, effort, and obtrusion (i.e., interference) are involved in collecting data on each dispatcher task?
3. What percentage of a dispatcher's time, on average, do you feel he/she spends engaged in each of the six tasks during a typical 8 hr shift?

This information will help determine the feasibility of developing the railroad dispatcher taskload tool described above.

Instructions:

For each observable dispatcher task, there are four questions. The first question addresses how data can be collected for the particular task. The second through fourth questions for each task address the level of *time*, *effort* and *obtrusiveness* expected to collect data on the particular dispatcher task. For these three questions, you will be asked to provide a rating from 1-7. Definitions and explanations on how to use each of the 7-point rating scales are provided below. At the conclusion of this questionnaire, there is one final question that asks for an estimate of the percentage of time you think a dispatcher spends on, or is involved with, each task during any given 8 hour shift. Percentages can range from 0 (a dispatcher spends none of his/her time on this task) to 100 (the entire d is spent exclusively on this task), and the values assigned should add up to 100 for the six tasks. Further instructions are provided with the question.

<u>The basic explanation of a 7-point scale</u>: Below is an example of a 7-point scale. The specific example is the one used to assess or estimate the *effort* involved in collecting data for a certain task. Similar 7-point scales will also be provided to estimate or assess the *time* and *obtrusiveness* related to collecting data on each task. You will be asked to provide a rating that describes your perception of how much *time*, *effort* or *obtrusiveness* it would take to collect data on a particular task. For example, one question asks, "How much *effort* would it take to collect the number of mandatory directives issued and canceled over seven consecutive days for a given dispatching desk?" Using definitions that are provided below, you will select and circle one of the seven numbers on the rating scale that best corresponds to your perception of the effort involved in collecting the particular data. Descriptive anchors are provided at both ends of the rating scale, along with a central anchor point, to help you use the rating scale. Using the example above, the rating scale will look like the following:

1---------------2---------------3---------------4---------------5---------------6---------------7

1	2	3	4	5	6	7
Minimal effort			Moderate effort			Maximum effort

You would then circle the number that best corresponds to your perception of how much effort would be involved to collect a week of mandatory directive data for a given dispatching desk at a railroad. If it required a lot of effort to collect this data, you might circle the "7"; if minimal effort were involved, you might circle the "1"; if it were somewhere in between, you would circle a number between 2-6, where "4" represents moderate effort.

Definitions of time, effort and obtrusiveness:

Time. How much time does it take to collect data for a particular task? This is likely going to be a function of whether data for the task is immediately available or can be produced relatively quickly. You will be provided with the following seven-point scale and will be asked to circle the number that best matches your perspective:

1---------------2---------------3---------------4---------------5---------------6---------------7

Very little time	Some time	A lot of time

Effort. By effort, we mean that level of mental and physical energy required or expended on collecting data for a particular task. Consider the effort expended by both the individual collecting the data and those at the railroad who assist in collecting the data. Data that require a simple push of a computer key to generate a report may involve minimal effort, while reviewing and coding an audio tape may take considerable effort. You will be provided with the following seven-point scale and will be asked to circle the number that best matches your perspective:

1---------------2---------------3---------------4---------------5---------------6---------------7

Minimal effort	Moderate effort	Maximum effort

Obtrusiveness. By obtrusive, we want to know how disruptive it would be to the railroad to collect data for a particular task. Obtrusiveness also relates to how conspicuous or noticeable an individual is when collecting the data. Some examples of what may be considered very obtrusive include asking a dispatcher many questions, sitting/standing nearby to the dispatcher so that they are aware of your presence, requiring a lot of assistance from the railroad to obtain the data, or causing a visible distraction to the workplace (e.g., if railroad employees approach you to ask you questions). By contrast, collecting data simply by requesting a computer-based report to be generated, and which could be reviewed away from the dispatching office, might be considered "not at all obtrusive." You will be provided with the following seven-point scale and will be asked to circle the number that best matches your perspective:

1---------------2---------------3---------------4---------------5---------------6---------------7

Not at all obtrusive	Somewhat obtrusive	Very obtrusive

***** If you are not familiar with a particular task, simply write "N/A" (not applicable) by the question and go to the next task.

If you have any questions, please do not hesitate to contact me and I will be happy to discuss the questions or your ideas. My contact information is as follows:

Mr. Stephen Reinach
Foster-Miller, Inc.
350 Second Avenue
Waltham, MA 02451
Phone: (781) 684-4259
Fax: (781) 890-3489
Email: sreinach@foster-miller.com

Please complete the following information:

Your Name: ____

Title/Position: ____

Years of experience as a dispatcher (if applicable): ________________________

Phone Number: ____

Date: ____

Please return the completed questionnaire by <u>Friday, February 16th, 2001</u>

TASK 1: ACTUATE SIGNALS, SWITCHES, BLOCKING DEVICES, AND BRIDGE CONTROLS VIA CAD SYSTEM

This task involves any CAD activity related to lining switches, routing signals, applying or removing blocking devices, locking/unlocking bridges, or opening and closing bridges, for the purposes of authorizing trains and other track users to occupy a segment (or segments) of track.

Some examples of this task include the following:

- Routing passenger/commuter trains
- Routing local freight trains
- Routing through freight trains
- Routing work trains
- Routing hi-rail vehicles
- Routing other moving track vehicles
- Locking/unlocking bridges
- Opening/closing railroad bridges

How can data on a dispatcher's signal, switch, blocking device and bridge control CAD activity for a consecutive seven-day period (i.e., one week) be collected? Please check all that apply:

___________ 1. From a computer-aided dispatching (CAD)-generated record/report
___________ 2. From some other computer-generated record/report (please specify):______________________
___________ 3. Review of a paper train sheet
___________ 4. Review of other paper record (please specify):____
___________ 5. Review of an audio tape
___________ 6. Direct observation of the dispatcher
___________ 7. Other (please specify): ____
___________ 8. Cannot be collected

How much *time* would it take to collect seven consecutive days' worth of CAD activity for a (CAD-enabled) dispatching desk? Assume you want data for all shifts for each day. Please circle the number that best matches your perspective.

1---------------2---------------3---------------4---------------5---------------6---------------7

1	4	7
Very little time	Some time	A lot of time

How much *effort* would it take to collect seven consecutive days' worth of CAD activity for a (CAD-enabled) dispatching desk? Assume you want data for all shifts for each day. Please circle the number that best matches your perspective.

1---------------2---------------3---------------4---------------5---------------6---------------7

1	4	7
Minimal effort	Moderate effort	Maximum effort

How *obtrusive* would it be to collect seven consecutive days' worth of CAD activity for a (CAD-enabled) dispatching desk? Assume you want data for all shifts for each day. Please circle the number that best matches your perspective.

1---------------2---------------3---------------4---------------5---------------6---------------7

1	4	7
Not at all obtrusive	Somewhat obtrusive	Very obtrusive

TASK 2: ISSUE/VOID MANDATORY DIRECTIVES

This task involves issuing or voiding written or verbal mandatory directives. The voiding of a mandatory directive should be counted only if it requires active participation by the dispatcher to cancel or void the directive. Typically, this might involve the dispatcher recording the date the directive has become void.

Some examples of this task include the following:

- Issuing (or canceling) Form Ds
- Issuing track warrants
- Issuing DTC block authorities
- Issuing track bulletins (e.g., Form B)
- Issuing track permits
- Issuing track and times
- Issuing work and times
- Issuing joint track and times
- Issuing joint work and times

How can data on the number of mandatory directives (i.e., movement authorities) issued and canceled over a consecutive seven-day period (i.e., one week) be collected? Please check all that apply:

___________ 1. From a computer-aided dispatching (CAD)-generated record/report
___________ 2. From some other computer-generated record/report (please specify):_______________________
___________ 3. Review of a paper train sheet
___________ 4. Review of other paper record (please specify):____
___________ 5. Review of an audio tape
___________ 6. Direct observation of the dispatcher
___________ 7. Other (please specify): ____
___________ 8. Cannot be collected

How much *time* would it take to collect the number of mandatory directives issued and canceled over a seven consecutive day period for a given dispatching desk? Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7
Very little time | Some time | A lot of time

How much *effort* would it take to collect the number of mandatory directives issued and canceled over a seven consecutive day period for a given dispatching desk? Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7
Minimal effort | Moderate effort | Maximum effort

How *obtrusive* would it be to collect the number of mandatory directives issued and canceled over a seven consecutive day period for a given dispatching desk? Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7
Not at all obtrusive | Somewhat obtrusive | Very obtrusive

TASK 3: GRANT TRACK-RELATED PERMISSIONS, PROTECTIONS, AND CLEARANCES

This task involves providing all permissions, protections and clearances to occupy a segment (or segments) of track. These permissions, protections and clearances may be verbal or written.

Some examples of this task include the following:

- Granting permission to pass a red signal
- Granting permission to open up a switch onto a main line
- Granting permission to close a main track switch
- Granting permission to make a reverse move
- Granting permission to leave a passenger station/terminal
- Granting other permissions, clearances, and protections
- Protecting for other-than-normal switch operations
- Protecting passengers crossing main tracks between platform and station (station "cut-outs")
- Providing blue flag protection
- Providing RWP/foul time
- Issuing plate orders (catenary out of service) and other electrified territory maintenance protections
- Issuing yard protection
- Issuing "Stop and protect" orders (to protect highway users at grade crossings with reported activation failures)
- Following cab signal failure procedures
- Issuing heat orders for welded rail/catenary territories

How can data on the number of permissions, protections and clearances granted over a consecutive seven-day period (i.e., one week) be collected? Please check all that apply:

___________ 1. From a computer-aided dispatching (CAD)-generated record/report
___________ 2. From some other computer-generated record/report (please specify):______________________
___________ 3. Review of a paper train sheet
___________ 4. Review of other paper record (please specify):____
___________ 5. Review of an audio tape
___________ 6. Direct observation of the dispatcher
___________ 7. Other (please specify): ____
___________ 8. Cannot be collected

How much *time* would it take to collect the number of permissions, protections and clearances granted over a seven consecutive day period for a given dispatching desk? Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7

Very little time	Some time	A lot of time

How much *effort* would it take to collect the number of permissions, protections and clearances granted over a seven consecutive day period for a given dispatching desk? Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7

Minimal effort	Moderate effort	Maximum effort

How *obtrusive* would it be to collect the number of permissions, protections and clearances granted over a seven consecutive day period for a given dispatching desk? Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7

Not at all obtrusive	Somewhat obtrusive	Very obtrusive

TASK 4: CARRY OUT NON-AUTHORITY OR NON-PERMISSION, PROTECTION, AND CLEARANCE COMMUNICATIONS

This task entails the communications that the dispatcher carries out that are not part of issuing or voiding an authority or granting a permission, clearance or protection. These communications generally involve advisories, coordinating activities, and the exchange of work-related information to facilitate the dispatcher's ability to plan for and control track usage.

Some examples of this task include the following:

- Issuing traffic advisories
- Issuing weather advisories
- Issuing track condition advisories
- Issuing speed restrictions, slow orders, bulletins, etc.
- Issuing line-ups
- Coordinating between parties
- Communicating with train crews (e.g., time train crew goes on duty, outlaw-related information, initial terminal Form D check)
- Communicating with dispatchers at other centers and with other departments: yardmasters, crew callers, police dept., etc.
- Communicating with other railroads (e.g., dispatcher, CTD)
- Calling for taxis/crew transportation for outlawed/incoming crews
- Communicating and coordinating incident-related matters
- Conducting conference calls with freight agents and clerks
- Fielding incoming wrong number calls
- Fielding passenger complaints
- Fielding requests from emergency responders to intrude into right-of-way to handle emergencies
- Communicating with power manager (electric traction territory)
- Communicating with those inside the dispatching center, such as another dispatcher, an ACTD or CTD, or other supervisor in the same center

How can data on the *amount of time* spent participating in these types of communications be collected for a consecutive seven-day period (i.e., one week)? Please check all that apply:

___________ 1. From a computer-aided dispatching (CAD)-generated record/report
___________ 2. From some other computer-generated record/report (please specify):_______________________
___________ 3. Review of a paper train sheet
___________ 4. Review of other paper record (please specify):____
___________ 5. Review of an audio tape
___________ 6. Direct observation of the dispatcher
___________ 7. Other (please specify): ____
___________ 8. Cannot be collected

How much *time* would it take to collect seven consecutive days' worth of data on the amount of time a dispatcher spends on these types of communications at a dispatching desk? Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7
Very little time — Some time — A lot of time

How much *effort* would it take to collect seven consecutive days' worth of data on the amount of time a dispatcher spends on these types of communications at a dispatching desk? Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7

Minimal effort	Moderate effort	Maximum effort

How *obtrusive* would it be to collect seven consecutive days' worth of data on the amount of time a dispatcher spends on these types of communications at a dispatching desk? Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7

Not at all obtrusive	Somewhat obtrusive	Very obtrusive

TASK 5: PERFORM GENERAL RECORDKEEPING TASKS

This task entails routine and general recordkeeping not otherwise associated with written directives/authorities, permissions, protections, or clearances.

Some examples of this task include the following:

- Entering train sheet data (e.g., train times, crew duty times, unusual events, equipment defects such as signal failures, etc.)
- Completing train delay reports
- Entering train ID data
- Preparing train consist reports
- Completing incident logs
- Setting up train sheet
- Preparing daily Bulletin Order
- Keeping payroll records
- Checking AEI readers and record car numbers
- Transferring on/off duty
- Maintaining block register territory record
- Completing various other FRA and railroad-required reports (e.g., grade-crossing malfunction, signal failure)

How can data on the number of records[9] that are completed be collected for a consecutive seven-day period (i.e., one week)? Please check all that apply:

___________ 1. From a computer-aided dispatching (CAD)-generated record/report
___________ 2. From some other computer-generated record/report (please specify):______________________
___________ 3. Review of a paper train sheet
___________ 4. Review of other paper record (please specify):________________________________
___________ 5. Review of an audio tape
___________ 6. Direct observation of the dispatcher
___________ 7. Other (please specify): ____
___________ 8. Cannot be collected

How much *time* would it take to collect the total number of records completed for each record type over a seven consecutive day period for a given dispatching desk. Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7

Very little time	Some time	A lot of time

How much *effort* would it take to collect the total number of records completed for each record type over a seven consecutive day period for a given dispatching desk. Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7

Minimal effort	Moderate effort	Maximum effort

How *obtrusive* would it be to collect the total number of records completed for each record type over a seven consecutive day period for a given dispatching desk. Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7

Not at all obtrusive	Somewhat obtrusive	Very obtrusive

[9] Assume that each unique record type that a dispatcher completes at a given dispatching desk has already been identified. For example, desk A may have 10 different record types that a dispatcher must maintain- a Form D log, a foul time permit log, a grade crossing malfunction log, etc. Assume that you must collect data on the total number of records completed for each record type.

TASK 6: REVIEW REFERENCE MATERIALS

This task involves the review of various manuals, references, and other supporting materials that a dispatcher may use in the course of a day to help him/her to plan for, and control, track usage on his/her territory.

Some examples of this task include time spent reviewing…

- Rulebook(s)
- Special bulletins, speed restrictions, general orders, etc.
- Dispatcher notes
- Dispatcher manual of instructions
- Bridge maps and track charts
- Train consist reports
- Rule-of-the-day and other daily postings

How can data on the amount of time a dispatcher spends reviewing reference materials for a consecutive seven-day period (i.e., one week) be collected? Please check all that apply:

___________ 1. From a computer-aided dispatching (CAD)-generated record/report
___________ 2. From some other computer-generated record/report (please specify):______________________
___________ 3. Review of a paper train sheet
___________ 4. Review of other paper record (please specify):____
___________ 5. Review of an audio tape
___________ 6. Direct observation of the dispatcher
___________ 7. Other (please specify): ____
___________ 8. Cannot be collected

How much *time* would it take to collect seven consecutive days' worth of data on the time spent reviewing reference materials? Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7

Very little time	Some time	A lot of time

How much *effort* would it take to collect seven consecutive days' worth of data on the time spent reviewing reference materials? Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7

Minimal effort	Moderate effort	Maximum effort

How *obtrusive* would it be to collect seven consecutive days' worth of data on the time spent reviewing reference materials? Assume you want data for all shifts for each day.

1---------------2---------------3---------------4---------------5---------------6---------------7

Not at all obtrusive	Somewhat obtrusive	Very obtrusive

Please estimate, from 0-100%, how much of a dispatcher's time you feel a dispatcher typically spends on each of the following tasks in a typical 8 hr shift. The amounts you provide should total 100.

	Task	**Estimate of the percentage of time a dispatcher spends on each task during a typical 8 hr shift**
1.	CAD actuation of switches, signals, blocking devices and bridge controls	**%**
2.	Issuing and canceling mandatory directives	**%**
3.	Granting track-related permissions, protections and clearances	**%**
4.	Carrying out non-authority, permission, protection or clearance-related communications	**%**
5.	Performing general recordkeeping tasks	**%**
6.	Reviewing reference materials	**%**
	TOTAL	**100 %**

Thank you for your participation!!

Abbreviations and Acronyms

ACTD	Assistant Chief Train Dispatcher
AEI	automatic equipment inspection
ATCS	Air Traffic Control Specialist (a.k.a. Air Traffic Controller)
ATDA	American Train Dispatchers Association
CAD	computer-aided dispatching
CTC	centralized traffic control
CTD	Chief Train Dispatcher
d	day(s)
DTC	Direct Traffic Control
FRA	Federal Railroad Administration
h	hour(s)
HOS	Hours of Service
HRA	human reliability assessment
mi	mile(s)
mo	month(s)
OP	Operating Practice (Supervisor, Specialist, Safety Inspector)
PTC	Positive Train Control
SME	subject matter expert
TWC	track warrant control
wk	week(s)
yr	year(s)