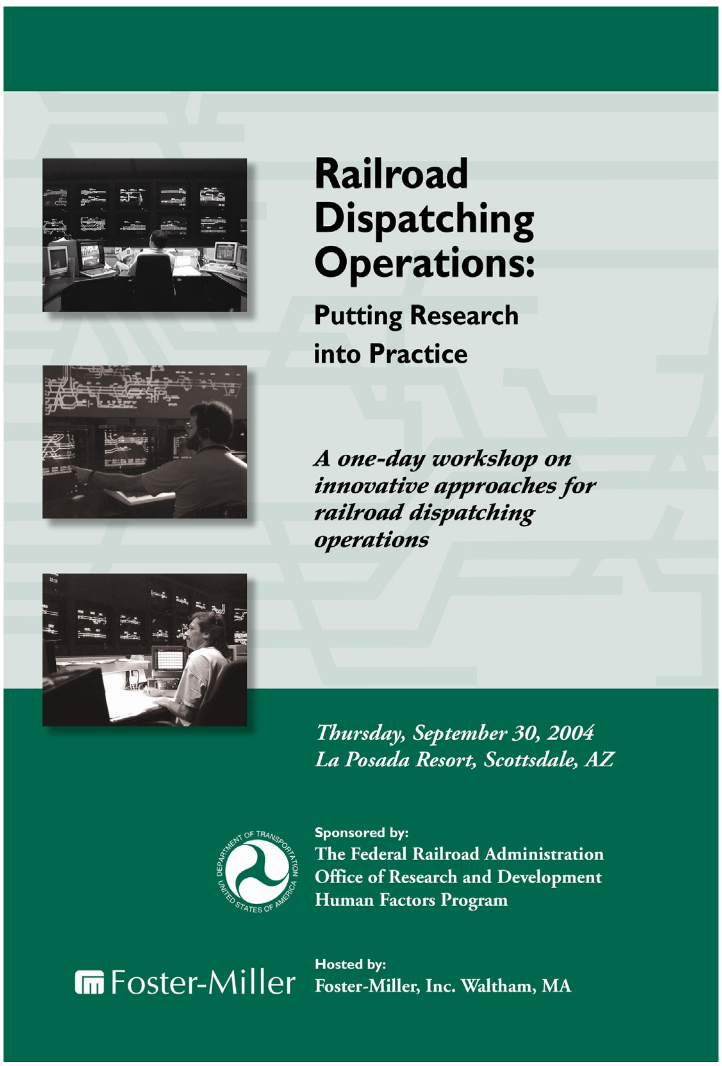
U.S. Department of Transportation

Federal Railroad Administration

Railroad Dispatching Operations: Putting Research into Practice–Workshop Summary

Office of Research
and Development
Washington, DC 20590



DOT/FRA/ORD-06/23

Final Report
October 2006

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	October 2006	Final Report, May-Sept. 2004

4. TITLE AND SUBTITLE
Railroad Dispatching Operations: Putting Research into Practice–Workshop Summary

5. FUNDING NUMBERS

6. AUTHOR(S)
Judith Gertler and Sarah Acton

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Foster-Miller, Inc.
350 Second Avenue
Waltham, MA 02451-1196

8. PERFORMING ORGANIZATION REPORT NUMBER
DFRA.010350.004

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-06/23

11. SUPPLEMENTARY NOTES
COTR: Michael Coplen

12a. DISTRIBUTION/AVAILABILITY STATEMENT
This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161. This document is also available at www.fra.dot.gov.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This report summarizes the material presented at a 1-day workshop, *Railroad Dispatching Operations: Putting Research into Practice*, sponsored by the Federal Railroad Administration (FRA) Office of Research and Development Human Factors Program. The purpose of the workshop was to share the most important findings of research on dispatching with railroad dispatching center management and labor and to identify problem areas where additional research is needed. A total of 63 people from the railroad industry, organized labor, government, and the research community participated. Speakers presented the results of FRA-sponsored research, industry-sponsored research, and current industry best practices. The luncheon speaker described European dispatching operations, and two panel sessions provided an opportunity for representatives from railroad industry and labor to share best practices and identify future challenges in dispatching operations. A majority of attendees rated the workshop content and organization as very good to excellent. Comments from workshop participants led to the identification of areas where additional research should be considered. These areas include retention of dispatchers, critical incident skills training, and the impact of positive train control on the dispatcher's job. Based on the success of this event, FRA should consider a broader program of workshops to share the results of human factors research projects.

14. SUBJECT TERMS
Railroad dispatcher, train dispatcher, rail traffic controller, workload, fatigue, stress, taskload, personnel selection, traffic planning

15. NUMBER OF PAGES
161

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	None

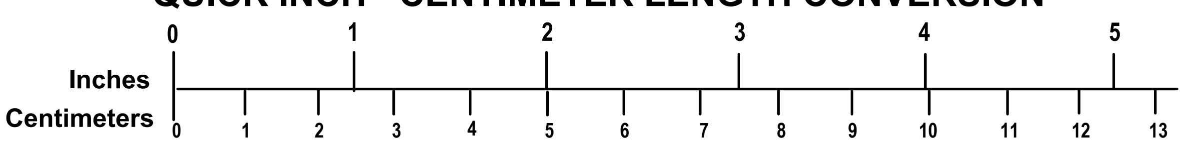
NSN 7540-01-280-5500

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

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC			METRIC TO ENGLISH		
LENGTH (APPROXIMATE)			**LENGTH** (APPROXIMATE)		
1 inch (in)	=	2.5 centimeters (cm)	1 millimeter (mm)	=	0.04 inch (in)
1 foot (ft)	=	30 centimeters (cm)	1 centimeter (cm)	=	0.4 inch (in)
1 yard (yd)	=	0.9 meter (m)	1 meter (m)	=	3.3 feet (ft)
1 mile (mi)	=	1.6 kilometers (km)	1 meter (m)	=	1.1 yards (yd)
			1 kilometer (km)	=	0.6 mile (mi)
AREA (APPROXIMATE)			**AREA** (APPROXIMATE)		
1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)	1 square centimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)	1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)	1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)	10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)			
MASS - WEIGHT (APPROXIMATE)			**MASS - WEIGHT** (APPROXIMATE)		
1 ounce (oz)	=	28 grams (gm)	1 gram (gm)	=	0.036 ounce (oz)
1 pound (lb)	=	0.45 kilogram (kg)	1 kilogram (kg)	=	2.2 pounds (lb)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)	1 tonne (t)	=	1,000 kilograms (kg)
				=	1.1 short tons
VOLUME (APPROXIMATE)			**VOLUME** (APPROXIMATE)		
1 teaspoon (tsp)	=	5 milliliters (ml)	1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 tablespoon (tbsp)	=	15 milliliters (ml)	1 liter (l)	=	2.1 pints (pt)
1 fluid ounce (fl oz)	=	30 milliliters (ml)	1 liter (l)	=	1.06 quarts (qt)
1 cup (c)	=	0.24 liter (l)	1 liter (l)	=	0.26 gallon (gal)
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 meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)	1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)
TEMPERATURE (EXACT)			**TEMPERATURE** (EXACT)		
[(x-32)(5/9)] °F	=	y °C	[(9/5) y + 32] °C	=	x °F

QUICK INCH - CENTIMETER LENGTH CONVERSION



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 a summary of a 1-day workshop, *Railroad Dispatching Operations: Putting Research into Practice,* which took place on September 30, 2004. The Federal Railroad Administration (FRA) Office of Research and Development Human Factors Program sponsored this workshop under contract DTFR53-01-D-00029.

The authors express their thanks to Mr. Michael Coplen, Office of Research and Development, for sponsoring this workshop and for providing guidance in planning and organizing the meeting. Dr. Thomas Raslear, another program manager for the Human Factors Program and a sponsor for many dispatcher research projects, provided additional suggestions in planning the meeting agenda. The authors are especially grateful to Mr. Grady Cothen, Acting FRA Associate Administrator for Safety, who took time from his busy schedule to attend the workshop and to welcome the participants to the workshop.

Credit and thanks go to several Foster-Miller employees. Mr. Stephen Reinach contributed to the organization of the meeting and assisted in summarizing the participant feedback. Ms. Susan McDonough efficiently managed the workshop registration process and served as the onsite workshop coordinator. Four individuals from Foster-Miller's publications department also contributed to the success of the workshop. Ms. Cynthia Black was responsible for the pre-event public relations. Ms. Gayle Staffiere designed the conference brochure, poster, and name tags and oversaw publication of the conference notebook. Ms. Pat Buchanan and Mr. Ed Blanchard were responsible for preparation of the CD included in the conference notebook.

Most importantly the authors wish to thank all of the speakers and panelists who volunteered their time to be present and share their ideas and research. Their participation and enthusiasm made the day a success. And finally, thanks to all participants who, by attending the workshop, showed their interest in improving railroad dispatching operations.

Executive Summary

The findings of two Federal Railroad Administration (FRA) dispatching center audits, one in 1987 and another in 1993, led FRA to undertake a program of research on a number of dispatching issues. This research program has included investigation of training requirements for dispatchers; selection of dispatcher candidates; dispatcher workload, stress, and fatigue; dispatcher taskload; dispatcher staffing and scheduling; and the development of a computer-based tool for visualizing train movements. Completion of the training requirements project led to FRA-sponsored dispatcher workshop, *Train Dispatcher Training: Preparing for the 21st Century*, held in 1998. The purpose of a workshop held on September 30, 2004, in Scottsdale, AZ, was to share the results of subsequent dispatcher research with the railroad industry, as well as to showcase current industry-sponsored research and best practices.

This document describes the proceedings of the 2004 workshop, which was sponsored by FRA's Office of Research and Development Human Factors Program. A total of 63 people from the railroad industry, organized labor, government, and research organizations participated in the workshop. The workshop had the following goals:

- Share most important findings of research on dispatching with railroad dispatching center management and labor.
- Provide a forum for railroad industry representatives to share their successes and experiences in management of dispatching operations.
- Provide an opportunity to learn about best practices from other types of dispatching operations.
- Identify problem areas where additional research is needed.
- Prioritize research needs.

Relationship to FRA Human Factors Program

FRA's Human Factors Program follows two operational areas of railroading: Railroad Systems and Operations, and Grade Crossings and Trespassers. Within each area three subprograms exist:

- Technology, including automation and systems design
- Railway worker/operator performance, safety, and health
- Organizational culture and safety performance

FRA Human Factors Program has 10 strategic goals. This workshop has particular relevance to four of these goals, which are:

- To promote the understanding, awareness, and utilization of human factors research in the railroad industry.
- To broaden the base of expertise on railroad human factors by educating and supporting critical FRA Human Factors Research and Development Program stakeholders (e.g., Office of Safety, Volpe Center, railroad labor, and railroad management).

- To establish a collaborative process that identifies and includes all key stakeholders in the conduct and application of human factors research, and in the evaluation of its impact in the railroad industry.
- To develop and implement a methodical process for identifying and prioritizing important safety critical issues in human factors in the railroad industry.

Presentations

This 1-day workshop consisted of nine technical presentations and two panel discussions. The following summarizes highlights of each speaker's presentation.

Development of a Dispatcher Selection Program–FRA sponsored this study to understand current approaches to dispatcher trainee selection and to offer alternative tools and techniques especially for selecting dispatcher candidates with no prior railroad experience. A job analysis helped to identify the knowledge, skills, abilities, and other characteristics (KSAOs) required for the job of a railroad dispatcher. Once the KSAOs were defined, methods for assessing candidates were identified. Case studies of seven dispatching operations provided information about each railroad's current candidate recruitment and selection process and formed the basis for recommended best practices. Recommended assessment methods include job previews, use of structured interviews by trained interviewers and the use of a thorough job analysis as the basis for any selection program.

Panel Discussion: Development of a Dispatcher Selection Program–Representatives from two Class I railroads, one commuter and one regional railroad, described their approaches to recruitment and selection of dispatchers. The Burlington Northern Santa Fe Railroad (BNSF) developed its own test instrument based on a job analysis. BNSF's overall process has the following steps: screening, job preview, testing, interviews, medical, drug screen, and background check. The Union Pacific Railroad (UP) is currently examining its recruitment and selection process in an effort to increase retention levels. They currently seek candidates with prior railroad experience, experience as a dispatcher, or experience as an air traffic controller. The UP selection and training process is similar to that of BNSF. Metro-North Railroad developed its own selection tests. They are now in the process of developing an in-house training program that will allow them to hire dispatcher trainees without rules knowledge. The representative from the Portland & Western (P&W) Railroad described the approach of the Genesee & Wyoming, P&W's parent company, to developing KSAOs for their dispatchers. Across the Genesee & Wyoming system, many dispatchers will be retiring in the coming years, and the company recognizes the need for a systematic recruitment and selection process. Several speakers on this panel, as well as workshop attendees, mentioned the challenge of dispatcher retention. Some suggested that increased starting pay may help to attract qualified candidates to this craft.

Dispatcher Workload, Stress, and Fatigue–FRA initiated a multiyear study of railroad dispatcher workload, stress, and fatigue in response to concerns that arose from an FRA Office of Safety audit of U.S. dispatching operations, dispatcher-caused accidents, and a concern for dispatchers' health and well-being. The purpose of the study was to identify sources of dispatcher workload, stress, and fatigue and to evaluate methods for measuring these outcomes. A total of 37 dispatchers, 20 from a freight operation and 17 from a commuter operation, volunteered to participate in this study. Volunteers provided data across all shifts over a 2-week (wk) period.

Subjective measures of workload appeared to be independent of the objective measures and did not reveal perceptions of excessively high workload in the aggregate. Overall, most of the reported stressors were not directly related to workload, and subjective stress generally increased through the shift. Cortisol levels, a physiological measure of stress, were within adult norms and followed a circadian pattern. The frequency of measurement may not have been adequate to detect physiological response to a stressful workplace event. As with other shift work populations, the dispatchers on the night shift had the shortest nighttime sleep, but when their nap periods were added, total daily sleep was the same as those working days. The study did not reveal any significant sleep debt.

Fatigue Management Behaviors: Effects of Feedback from Performance Actigraphs–This research evaluated the use of feedback actigraphs in helping dispatchers manage fatigue. The study involved 35 volunteer dispatchers who wore actigraphs for three 30-day periods. In the first trial period participants wore the actigraphs to establish baseline data. In second trial they wore feedback actigraphs that provided data on the need for sleep. The results for this period indicated that participants modified their sleep patterns and increased their sleep time by 10 percent. In the third trial, however, when they wore the non-feedback models again, they tended to revert to the sleep patterns exhibited in the first trial. This technology shows promise as an effective fatigue countermeasure, but more research is needed to establish the most effective way to implement it.

The 21st Century Short Line Dispatching Center–The American Rail Dispatching Center (ARDC), a wholly owned subsidiary of RailAmerica, began operation in 2003. The center controls rail traffic for both short line and Class I railroads in 19 states. They are active in emergency response and preparedness training and have developed relationships with first responder and rescue personnel along the right-of-way. In selecting its dispatching system, ARDC selected one that could be expanded as their operation grows.

European Dispatching Operations–European passenger and freight operations differ on many levels from their American counterparts. As a result, European dispatching operations also differ in many respects. The European dispatcher's sole job is to regulate traffic. Local operators control the interlockings. Because the entire European rail network is now operated under open access, train operations are controlled by train operating companies, and infrastructure companies are responsible for the scheduling of trains. The European dispatcher's workstation is similar to that of U.S. dispatchers, but it also includes a stringline function to keep track of train movements. Training for European dispatchers is through a railroad trade school following high school.

The Job of a Vessel Traffic Services Operator–The job of a Coast Guard Vessel Traffic Services (VTS) operator shares many similarities with that of a railroad dispatcher. The VTS operator manages ship traffic in and out of U.S. ports. Navigation rules and collision regulations (COLREG), similar to railroad rules, govern these movements. The VTS operator is the first responder to a ship collision. They must collect pertinent information, stabilize the scene, and notify responding agencies. VTS operators communicate over a busy radio network, monitor ship movements, and resolve conflicting paths, and in general they provide weather and other data to ship crews. Like railroad dispatchers, they have computer-based and sensor technology to assist them with their tasks. In contrast to dispatchers, many VTS operators work 12 hours (h) on and 12 h off. Within each watch shift, VTS operators have a break after every 1 h on duty.

Dispatcher Taskload Assessment Tool–The first phase of this project involved determining the requirements for a dispatcher taskload assessment tool and the appropriate data collection methods. Based on a survey of stakeholders, six primary dispatcher tasks were identified. For each task, the survey participants ranked the candidate methods of data collection. Data on observable dispatcher tasks can serve as the building blocks for a taskload assessment tool, but because of the high cognitive content of the job, basing such a tool solely on these data will be inadequate. Data collected as part of this project led to the development of a preliminary model of dispatcher performance.

Understanding How Dispatchers Manage and Control Trains–This study employed a cognitive task analysis (CTA) to identify the sources of expertise or skills that dispatchers possess. The CTA revealed that dispatchers use a variety of expert strategies (e.g., cheat sheets and streets maps) to meet task demands. They continually anticipate and plan ahead. The results have implications for the design of advanced displays and decision aids, data link technology, and training.

Visualizing Railroad Operations: A Tool for Traffic Planners and Dispatchers–This "proof of concept" software tool, which utilizes stringline diagrams, was initially designed for traffic planners, but it also has potential use as a training tool for dispatchers. It can help users compare different routing options, identify windows of opportunity, and set more realistic expectations for customers and other railroads.

Panel Discussion: Future Challenges and Research Needs–Representatives from railroad labor, a Class I railroad, a short line railroad, and a commuter railroad each presented their perspectives on the future challenges and research needs relative to dispatching. The labor representative emphasized the need to continue to improve training and to professionalize the position of dispatcher in railroading. The Class I representative from CSX described his railroad's challenge in upgrading its 1980s technology dispatching system. The short line representative from Indiana Harbor Belt Railroad addressed the challenges of joint dispatching operations. He cautioned that each situation is different and, as such, requires different strategies to make it successful. The commuter panelist from Metrolink also addressed the challenges of dispatcher training.

Attendee Feedback

A total of 33 (52 percent) workshop attendees completed the workshop evaluation form. Their feedback indicates that attendees found the content, organization, and utility of the information of exceptionally high quality and value.

Important Issues

Comments from workshop attendees and panelist remarks suggest that the following are areas where additional research should be considered:

- Recruitment and selection of dispatcher candidates
- Retention of dispatchers
- Critical incident skills training
- Impact of positive train control
- Integration of new technology

- Dispatcher as a team member
- Dispatcher work schedules and sleep patterns
- Stress reduction techniques
- Joint dispatching operations

Recommendations

The experiences of this workshop and the feedback from attendees led to two recommendations. The first, concerning future workshops, is that FRA should consider a regular program of workshops, perhaps expanding beyond just dispatchers. Future workshops should include more industry representatives and be expanded to 1½ d. The second recommendation is that FRA consider new dispatcher research that focuses on the following topics: development of an interactive dispatching simulator, retention strategies, team cognitive task analysis, work schedules and sleep patterns, stress reduction techniques, and critical incident skills training.

1. Introduction

The findings of two FRA dispatching center audits, one in 1987 and another in 1993, led FRA to undertake a program of research on a number of dispatching issues. The purpose of a workshop held on September 30, 2004, in Scottsdale, AZ, was to share the results of this program of research with the railroad industry, as well as to showcase industry-sponsored research and best practices. This document describes the proceedings of this workshop, which FRA's Office of Research and Development Human Factors Program sponsored. A total of 63 people from the railroad industry, organized labor, government, and research organizations participated in the workshop.

1.1 Background

The past 20 years (yr) have seen significant changes in the job of a railroad dispatcher. From the technology perspective, the availability of affordable computer systems has made computer-aided dispatching (CAD) feasible for many railroads, not just the Class I railroads. Improved communications systems led to the acceptance of radio transmitted directives in place of the traditional operator delivered train orders that had been used for over 100 yr. These changes in communications and signal technology have also resulted in the closing of block towers, eliminating the job of tower operator, a job on the career path to becoming a dispatcher. Today's dispatcher is likely to use multiple computer screens and work with a keyboard and mouse in addition to a communications system. But not all dispatching operations can be characterized as high tech. A short line railroad may still use hand-written or verbal authorities to move trains across dark (unsignalled) territory.

The industry's adoption of new dispatching technology, changes in operating rules and methods of operation, and railroad industry restructuring all had potential safety consequences. In addition, excessive workloads and increases in occupational stress could result from any of these factors. For these reasons, in 1987-1988, FRA conducted the National Train Dispatcher Safety Assessment.[1] Both this audit and the subsequent Train Dispatchers Follow-up Review in 1993 raised concerns about stress, workload, and fatigue of train dispatchers.[2] These audits also expressed concern that in the coming years a potential for reduced safety existed due to insufficient dispatching training and testing standards. In response to the findings of the dispatcher audits, in 1996 FRA Office of Research and Development initiated a program of research focusing on dispatching operations.

The first project under this research program focused on training requirements for railroad dispatchers. Completion of the training requirements project led to FRA-sponsored dispatcher workshop, *Train Dispatcher Training: Preparing for the 21st Century*, held in 1998. One concern raised by workshop participants in 1998 was that due to the closing of towers, railroads were faced with hiring dispatchers with no prior railroad experience. Workshop participants

---

[1] Federal Railroad Administration. (1990). *National Train Dispatcher Safety Assessment*. Washington, DC: U.S. Department of Transportation.

[2] Federal Railroad Administration. (1995). *National Train Dispatcher's Follow-up Review*. Washington, DC: U.S. Department of Transportation.

unanimously agreed that they needed selection criteria and methods to help them recruit and evaluate dispatcher candidates. Subsequent to this workshop, FRA initiated a project on selection of dispatcher candidates, which is one of the studies presented at the workshop described in this report. Since 1996 the FRA dispatcher research program has grown to include study of dispatcher workload, stress, and fatigue; dispatcher taskload; dispatcher staffing and scheduling; and the development of a computer-based tool for visualizing train movements.

Two factors led FRA to sponsor a second dispatcher workshop. First, the 1998 workshop proved successful as a means to seek industry input on operational issues requiring research. Second, and perhaps more important, the workshop format provides the means to disseminate the results of FRA-sponsored dispatcher research, as well as to get firsthand feedback from FRA Office of Research and Development's customers on that work.

1.2 Workshop Goals

The workshop had the following goals:

- Share the most important findings of research on dispatching with railroad dispatching center management and labor.
- Provide a forum for railroad industry representatives to share their successes and experiences in management of dispatching operations.
- Provide an opportunity to learn about best practices from other types of dispatching operations.
- Identify problem areas where additional research is needed.
- Prioritize research needs.

1.3 Organization of the Report

Section 2 provides an overview of FRA Human Factors Research and Development (R&D) Program and explains how the workshop fits into the overall program. Section 3 includes summaries of each technical presentation and the two panel discussions. Section 4 summarizes participant feedback. Discussion at the workshop led to the identification of the important issues presented in Section 5. Section 6 presents recommendations with regard to future workshops and research. Appendix A contains the workshop agenda, and Appendix B provides the list of attendees. Speaker biographies are in Appendix C, and copies of each speaker's slides are in Appendix D. Appendix E contains a bibliography of dispatcher research. A list of abbreviations and a glossary follow the appendices.

2. FRA's Human Factors R&D Program

This section describes FRA Human Factors R&D Program, including its structural framework and strategic planning. The broad goals of this program are to improve rail transportation safety and mobility. These goals are achieved through research, dissemination of research results, and ongoing program evaluation. The workshop was one means of disseminating research results and obtaining industry evaluation of the portion of the program that concerns dispatching operations.

2.1 Program Overview

Human factors accidents in the railroad industry occur in two areas: Railroad Systems and Operations, and Grade Crossings and Trespassers. The organization of the Human Factors R&D Program follows these two operational areas. In each area the following three subprograms exist (see Figure 1):

- Technology, including automation and systems design
- Railway worker/operator performance, safety, and health
- Organizational culture and safety performance

Specific projects support each program area/subprogram. Strategic planning and other programmatic activities help knit the entire program together, including the prioritization and selection of research projects, ongoing planning, coordination, development, and evaluation of the program activities. Periodic assessments of the legal, regulatory, and sociological barriers in the industry provide the necessary contextual understanding needed for building long-term collaborative research and evaluation partnerships. In addition, strategic planning and contextual assessments help increase the feasibility, utilization, and overall positive impact of the program.

2.2 Mission and Vision

The mission of FRA Human Factors R&D Program is:

> *To use the scientific method, the science of human factors research, and program evaluation standards to systematically improve safety and mobility in the U.S. railroad industry.*

The vision for the program is:

> *To become an international center for excellence in railroad human factors research in the next 5 years.*

2.3 Key Functions

FRA defines the following four key functions for its Human Factors R&D Program:

- *Provide technical, analytical, and scientific support* to Office of Safety policy makers and other key agency decision makers (e.g., Railroad Safety Advisoty Committee (RSAC) and Safety Assurance and Compliance Program (SACP) activities).

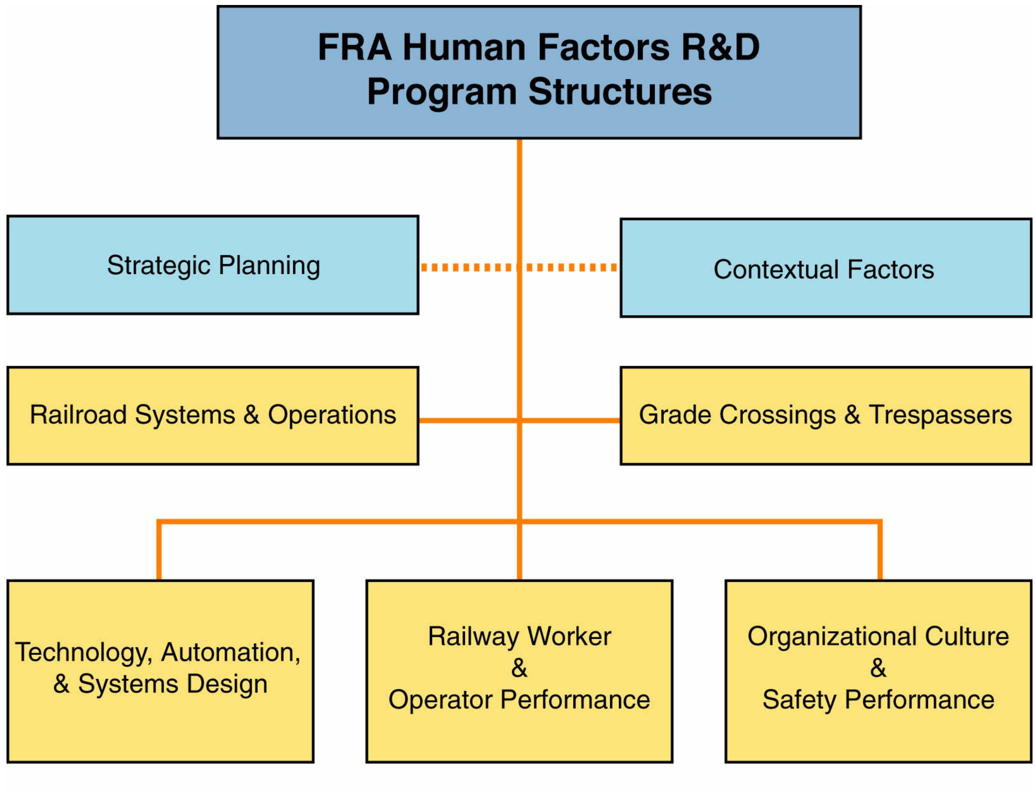


Figure 1. Structure of Human Factors R&D Program

- *Initiate innovative, collaborative, scientifically-based research and evaluation programs* that lead to significant industry-wide reductions in the number of accidents, injuries, and deaths related to human error in railroad operations and railroad systems design.
- *Evaluate the utilization, impact, and effectiveness of human factors-related safety initiatives* to systematically determine the cost and safety benefit of these initiatives.
- *Collaborate with interagency, interdepartment, intergovernment, and other non-government research institutions* (e.g., National Institute for Occupational Safety and Health (NIOSH)) on cross-cutting research and evaluation programs, as well as the development and application of human factors standards (e.g., International Standards Organization (ISO)).

2.4 Strategic Goals

FRA Human Factors R&D Program has the following strategic goals:

1) To develop and implement a methodical process for identifying and prioritizing important safety critical issues in human factors in the railroad industry.
2) To develop and implement scientific methodologies that systematically measure, analyze, and monitor safety critical trends in human factors in the railroad industry.
3) To prioritize and set specific target reduction goals (in cooperation with the Office of Safety) for human factors accidents, injuries, and deaths in railroad operations.
4) To promote the understanding, awareness, and utilization of human factors research in the railroad industry.

5) To broaden the base of expertise on railroad human factors by educating and supporting critical FRA Human Factors R&D Program stakeholders (e.g., Office of Safety, Volpe Center, railroad labor, and railroad management).
6) To establish a collaborative process that identifies and includes all key stakeholders in the conduct and application of human factors research, as well as in the evaluation of its impact in the railroad industry.
7) To develop and implement systematic methodologies for continuously measuring and evaluating human factors program performance (i.e., outcomes, impact, and effectiveness of human factors research) in the railroad industry.
8) To develop and implement performance-based guidelines on Program Evaluation Standards for utility, feasibility, propriety, and accuracy of human factors applications in the railroad industry, and to institutionalize a process for how FRA's Human Factors Program meets those standards.
9) To enhance critical human factors program areas, such as positive train control, behavior-based safety, digital communications, and fatigue.
10) To create and coordinate railroad human factors research partnerships with key academic, government, industry, and community stakeholders, both nationally and internationally, as a means to leverage resources and establish international prominence in the field.

This workshop has particular relevance to four of these goals. Perhaps most important, this workshop provided a means to disseminate the results of FRA research programs (goal 5) and facilitate industry utilization of this information (goal 4). Feedback from workshop participants will help FRA to identify and prioritize safety critical issues (goal 1). The discussions that occurred at the workshop were a collaborative process where stakeholders commented on the value of the various research projects (goal 6).

2.5 Human Factors Research in a Socio-Technical System

Human factors research can be seen as part of a human-centered systems approach, which focuses on human capabilities and limitations with respect to human/system interfaces, operations, system integration, and organizational influences on safety. Increased attention to human performance and behavior using a systems approach will reduce crashes, loss of life, injuries, property damage, and resultant personal and financial costs. The Human Factors R&D Program follows a systems model based on Neville Moray's Structure of Socio-Technical Systems, shown in Figure 2. In this model of nested influences, each layer encompasses the content of inner layers.[3]

The Human Factors Program R&D includes three layers. The contextual factors, which influence research and development, are the outer layer: Social, Legal, and Regulatory Context. As shown in Figure 1, the Human Factors R&D Program has two broad program areas: Railroad Systems and Operations, and Grade Crossings and Trespassers. Grade Crossings are a special case of a Physical System, since they involve both railroad and highway vehicles and infrastructure. Grade Crossings are considered apart from Railroad Systems but have all the same layers in the structure illustrated in Figure 2. Each of the two program areas has subprogram elements that correspond to the layers identified above. Specifically these subprogram elements are Organizational Culture and Safety Performance; Railway Worker and

[3] Moray, N. (2000). Culture, politics and ergonomics. *Ergonomics*, 43(7), 858-868.

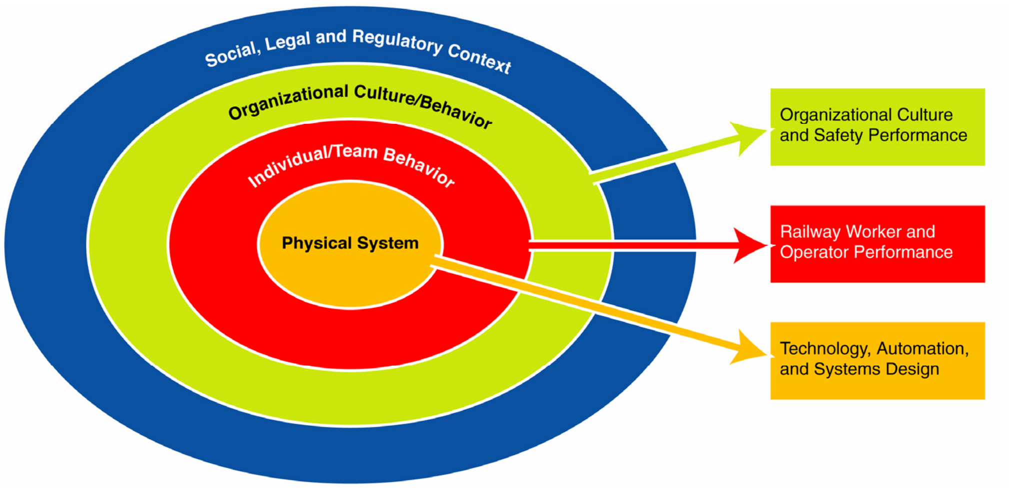


Figure 2. Human Factors Program in Relation to Elements of a Socio-Technical System

Operator Performance; and Technology, Automation, and Systems Design. This is a systems approach to dealing with human factors issues. It is important to remember that outer layers of FRAmework contain elements of inner layers and influence the inner layers. This gives the program elements a great deal of interconnectivity.

The human factors R&D Program consists of several subprogram elements that form a systematic, multilayered approach to enhancing the safety of railroad operations. The core elements of the program are the physical systems (e.g., a locomotive) that individuals interact with to perform their jobs. Physical system characteristics (e.g., displays and controls) affect how individuals interact with the system to perform their jobs. Changes in physical systems cause changes in how jobs are performed and affect safety. Individuals perform their jobs within the context of personal (biological and psychological), environmental, and social conditions that affect job performance and safety. Teams of individuals communicate, coordinate, and cooperate to perform inter-related tasks on various physical systems to achieve a common goal (e.g., move a train between two locations). This teamwork is performed within the context of group dynamics that affect task performance, safety, and goal attainment. Teams set goals and engage in communication, coordination, and cooperation to meet those goals in accordance with organizational values and assumptions about appropriate goals (e.g., productivity versus safety), communication, coordination, and cooperation. Organizational culture affects team and individual job performance, physical system design, and safety. Organizational behavior is influenced by laws and regulations and by societal and cultural pressures.

FRA is working on a model for prioritizing its research program to assure that it is relevant for the industry. This workshop plays a role in this process in two ways. As shown in Figure 3, FRA uses information from a variety of sources to establish project priorities. Stakeholder input is especially important. Workshops such as this one are a means for FRA to obtain stakeholder input to help prioritize the Human Factors R&D Program. FRA selects the various projects for its Human Factors R&D Program with the goals of improving safety, increasing productivity, developing technology products, and meeting stakeholder needs. One measure that FRA uses to

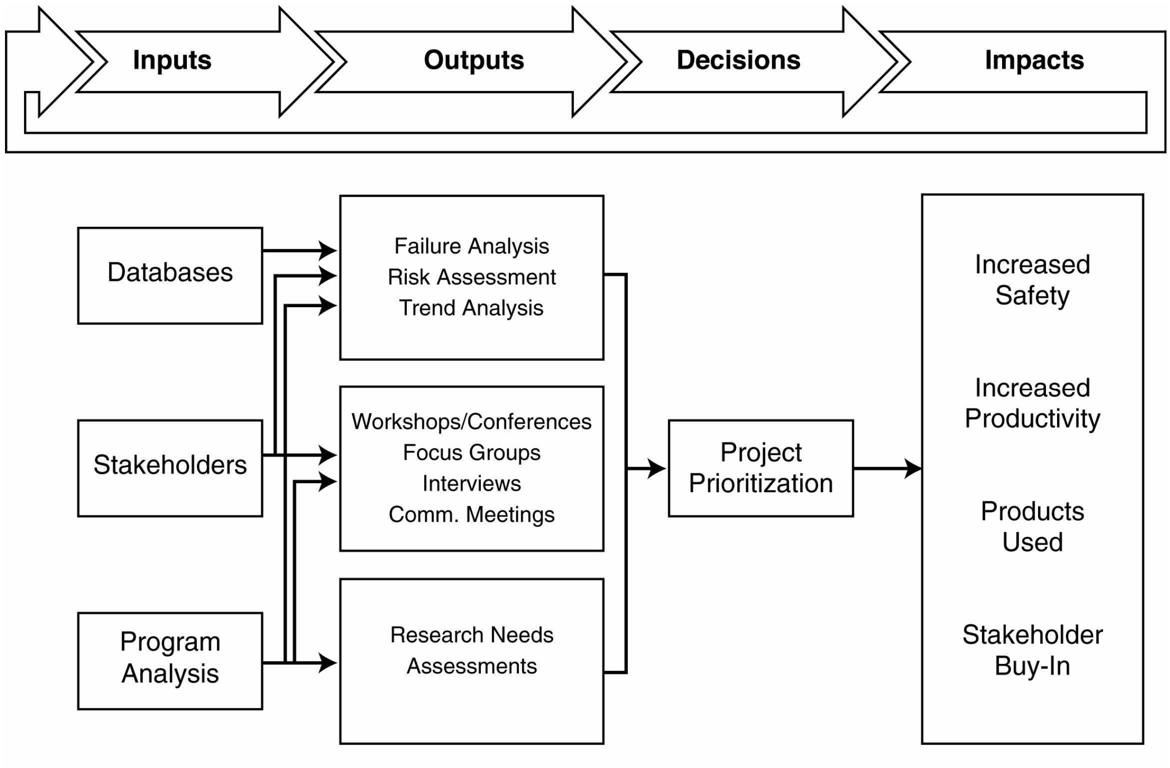


Figure 3. Human Factors Research Prioritization and Project Selection Model

judge the success of its program is the extent to which industry stakeholders use the results of FRA-sponsored research. This type of workshop may lead to increased utilization of the research.

3. Presentations

This section provides summaries of each of the nine presentations and two panel sessions. Appendix C contains a biographical sketch for each speaker and panelist, and Appendix D contains copies of each speaker's slides.

3.1 Development of a Dispatcher Selection Program (Judith Gertler)

Based on feedback from participants at a 1998 FRA-sponsored workshop where dispatcher training issues were discussed, FRA initiated this research project. The objectives of the project were to understand railroad industry approaches to dispatcher trainee selection and to offer alternative tools and techniques, especially for evaluating and selecting dispatcher candidates with no prior railroad experience.

Background–Advances in communications technology have all but eliminated the need for tower operators. With the closing of control towers, the industry's in-house source of dispatcher candidates is all but gone, causing railroads to recruit individuals with no prior experience. The training of a dispatcher costs upwards of $50,000 and takes a minimum of 6 mo. Because of the railroad's significant investment in each candidate, selection of suitable dispatcher candidates is an important decision.

Process for developing a selection program–Development of a selection program requires a focused effort. The organization wants to be certain that the information that is collected from applicants is closely related to job performance and that the information is effectively used to identify the best candidates for the position. The process for development of a selection program has four steps: job analysis, employee specification, assessment instrument development/identification, and validation.

The first step, a job analysis, is a systematic process for identifying tasks, duties, responsibilities, and working conditions. The results of the job analysis are used to determine the KSAOs that an employee must possess to perform the job. This is the employee specification step. Once the KSAOs are known, it is possible to identify and validate appropriate selection instruments and methods for the position. The instruments must measure the relevant KSAOs and must help to differentiate among candidate dispatchers. Validation assures that the identified characteristics are related to job performance. Once the selection methods have been validated, the selection program is ready for implementation. This study focused on the first three steps of the selection program development process.

The Position Analysis Questionnaire (PAQ®), a widely used systematic methodology for conducting a job analysis, was selected to develop a generic description of the job of railroad dispatcher. The PAQ begins with a description of the position to be analyzed. The job description from an earlier FRA-sponsored study, *Training Requirements for Railroad Dispatchers*, was used. The next step was a series of structured group interviews with 36 dispatchers from four different dispatching centers. The PAQ methodology takes the results of these interviews and characterizes work behaviors, such as color perception, supervision of track occupants, and use of remotely controlled equipment. The PAQ methodology also provides information about job dimensions, such as the amount of information that has to be processed, the mental processes that are involved, and relationships with other people.

The PAQ job analysis indicated that simple reaction time was the only significant psychomotor skill required of a dispatcher. No significant physical skill requirements existed. In terms of abilities, the PAQ identifies three categories of abilities: sensory, perceptual, and cognitive. Auditory acuity was the most important sensory ability. The dispatcher's need to deal with peaks in workload, characterized by multiple sources of information, rapidly changing conditions, and the need for decisiveness, was reflected in the PAQ-identified perceptual abilities of closure, perceptual speed, selective attention, and time sharing. The job of railroad dispatcher requires seven cognitive abilities, including short-term memory, long-term memory, intelligence, and convergent thinking.

In terms of other characteristics, the PAQ job analysis identified two significant interest characteristics and a total of seven temperament characteristics. A dispatcher should have interest in directing/controlling/planning and a variety of duties. With respect to temperament, the two most important characteristics are working under pressure of time and attainment of set standards.

Assessment methods–Candidate assessment methods include interviews, biodata questionnaires, references, and tests. Interviews are most suitable for assessing personal relations, good citizenship, and job knowledge. An effective interview should be structured and should be conducted by a skilled, trained interviewer. A biodata inventory is an application blank that collects job-related factual information from the candidate. Each question is weighted to reflect its predictive value in differentiating good from poor performers. All items must deal with events under the applicant's control. For example, the names of prior employers may be obtained, but the applicant cannot be asked about his/her birthplace or names of family members. The biodata inventory is easy to administer, but developing a validated instrument is time consuming and can be costly.

Successful railroad strategies–Site visits to seven dispatching centers, representing Class I, commuter, and short line/regional railroads, provided information about each railroad's current candidate recruitment and selection process. The size of these dispatcher centers ranged from 24 to 485 dispatchers, and the number of desks ranged from 3 to close to 100. All seven railroads use interviews and selection by committee consensus; five use structured interviews. Five of the railroads use some type of test instrument. The two Class I railroads use a dispatcher aptitude test instrument that was developed specifically for their organization.

Some innovative strategies are worthy of note. UP uses internet job postings but warns that if the posting is left up too long, there are a large number of resumes to review. LIRR employs a pre-screen process that involves testing candidates for their ability to learn railroad terminology.

The overall selection procedure used by the seven centers begins with screening of candidates for minimum education and experience. Those meeting the education and experience requirements may be screened with an ability test. Those who pass the ability test are brought back for a series of interviews. Finally, a selection panel, consisting of someone from HR and one or two people from the operating department, selects from among the candidates.

Potential sources of dispatcher candidates–This research used two methods to identify occupations that may be potential sources of dispatcher candidates. The PAQ methodology provided one set of occupations, and a U.S. Department of Labor occupational database allowed for the identification of additional similar occupations. Occupations in the protective services, transportation, mining, and utilities industries have skill and ability requirements similar to that of the railroad dispatcher. These occupations include fire alarm operator, radio dispatcher, protective-signal operator, interstate bus dispatcher, traffic or system dispatcher, dispatcher (mine and quarry), and oil dispatcher.

Conclusions and recommendations–Conclusions and recommendations with regard to the development and implementation of a selection program for railroad dispatcher candidates include the following:

- A thorough job analysis should be the foundation for any railroad dispatcher selection program. The results of the composite job analysis conducted as part of this research can be a starting point for organizations lacking resources to conduct a job analysis.
- Structured interviews are preferable over unstructured interviews because they have been shown to have higher predictive validity.
- Only reliable test instruments and procedures should be included in a dispatcher selection program.
- An intensive job preview of the dispatcher's job and work environment may help to identify those candidates not suited to the requirements of the job.
- Occupations in the protective services, transportation, utilities, and mining industries that have job requirements similar to those of a railroad dispatcher are a potential source of dispatcher candidates.

3.2 Panel Discussion: Development of a Dispatcher Selection Program

The purpose of this panel was to provide a forum for representatives of the railroads that were case studies for the dispatcher selection project, summarized above, to describe their approach to recruitment and selection of dispatchers (see Figure 4). Panelists were asked to discuss any or all of the following topics:

- Describe your railroad's approach to recruitment and selection of dispatchers and why these have worked. What lessons learned have you had over the years?
- If you use any test instruments, explain how you developed and validated them.
- What challenges, if any, do you anticipate in the coming years in recruiting and selecting dispatchers?
- Comment on the report, *Selection of Dispatcher Candidates*. In what ways is this type of report helpful to your railroad?

Frank Ferrara, Metro-North Railroad

Metro-North's Operations Control Center (OCC) dispatches over 600 trains daily on three lines. The OCC has a staff of 59 rail traffic controllers (RTC), including four management chiefs and six assistant chiefs.[4] The RTCs also dispatch three branch lines in Connecticut, of which two are manual block.

[4] Metro-North refers to their dispatchers as rail traffic controllers.

Figure 4. Selection Panel–Jo Lynne Lehan, Ron Vincent, Jayan Sen, Frank Ferrara, and Judith Gertler, Moderator

In the 1980s, incumbent RTCs recommended tower operators to become RTCs. As the towers closed, the pool of qualified candidates shrunk. Metro-North realized that it needed new methods for recruiting and selecting candidates. The opening of the OCC in 1993 was a significant change for Metro-North. Prior to the cutover to the OCC, six towers with 19 operators per shift existed. With the OCC, it was now possible for four RTCs to handle this entire workload. Metro-North found it necessary to hire 21 new dispatchers as it expanded from 6 to 10 districts under the control of the OCC.

Metro-North's HR department led the effort to develop new selection methods. After observing dispatchers for 3 to 4 mo, they were able to identify the duties, tasks, and behaviors associated with the job. Prototype tests were developed and given to interviewees. The final test battery consists of three tests: vocabulary, ship destination test, and selective audio test. The vocabulary test is based on the book of rules. The ship destination test was purchased from a test publisher. The audio test measures hearing acuity and the ability to follow instructions.

Metro-North procedures require that a position be vacant before recruiting for a replacement. Internal candidates must have a minimum of 2 yr of experience in a craft that requires knowledge of the book of rules. Outside candidates must be qualified dispatchers.

Metro-North has had only 20 percent of candidates pass the tests. Most failures occur on following instructions. Both HR and the Chief Rail Traffic Controller interview those candidates who pass the tests.

Without a formal training program for RTCs, Metro-North has been unable to hire people without a rules background. The challenge at this point is to move away from the 2-yr rules experience requirement. Specifically, Metro-North is taking steps to develop a selection and 6-month (mo) training program, similar to that for locomotive engineers, which is open to all Metro-North employees with 2 yr of railroad experience. Metro-North is currently looking at job requirements and how they could be changed to enhance the selection process.

Another challenge for Metro-North is selling the job to the work force.

Metro-North has used the results of two FRA-sponsored research projects in improving its dispatcher selection and training program. The reports that Mr. Ferrara mentioned are *Training Requirements for Railroad Dispatchers: Objectives, Syllabi and Test Designs* and *Selection of Railroad Dispatcher Candidates*. He said,

> We have referred to both [the selection report] and the training report. Both documents have proved to be beneficial in developing an outline for our new training program. The *Selection of Dispatcher Candidates* report has helped us revamp the job requirements for candidates for our future training program. The job analysis section has been particularly helpful in bringing an understanding of the job to such departments as personnel, employment, and labor relations. The training requirements report is being used to develop the new training syllabus.

Jayan Sen–BNSF

In the early 1990s, the BNSF determined that it needed a more systematic approach to selection of dispatchers. From the start of the process to develop a new selection program, BNSF tried to get as many stakeholders involved as possible. They sought input from union leaders, job incumbents, and chief dispatchers.

The first step was a comprehensive job analysis. BNSF looked at the importance of each task, frequency of performance, importance of skill requirements, estimates of skill level, and the work environment. Rather than choosing a more general method like the PAQ, BNSF, working with an outside firm, developed its own format for the job analysis.

The job task profile resulting from this analysis showed that managing conflicting demands and reviewing written information were extremely important. Other important skills were reporting and documenting, language skills, analytic skills, perceptual skills, and interaction skills. Computer skills are important and will continue to be important as technology continues to change. Mr. Sen commented that BNSF needs to find a way to measure and reinforce computer skills. The work environment factors identified by the job analysis were frequent distractions, alertness, workload variation, precision, repetitive work, and time pressure.

Based on the job analysis, BNSF developed and validated a test battery. Working dispatchers were used to establish norms for the tests. The test battery was designed to measure the four dimensions that accounted for 92 percent of job performance: 1) learning, problem solving, and handling information; 2) attention to safety; 3) performing calculations and analytic skills; and 4) communication and teamwork. The four specific tests are troubleshooting; job orientation, which measures work orientation, stability, and agreeableness; coding; and workplace practices test. The tests have been shown to have minimal adverse impact, a concern in terms of job discrimination.

Before testing, dispatcher candidates are given a realistic job preview. Some may select out at this point. Individuals who pass the four tests participate in a structured panel interview. The structured interview is designed to capture job dimensions that are not measured by the tests. These dimensions include interaction skills, memory, problem solving, and judgment.

The overall BNSF process has the following steps: screening, job preview, testing, interviews, medical, drug screen, and background check. The BNSF process incorporates the recommended practices of *Selection of Dispatcher Candidates*.

Jo Lynne Lehan, UP

UP currently has a dispatcher retention problem. Between January 1999 and May 2004, 8 percent of dispatcher trainees failed during training, 7 percent were subsequently dismissed for poor performance, and 20 percent resigned or exercised seniority in other crafts. As a result, UP is examining its recruitment and selection process in an effort to increase retention levels.

UP looks for dispatcher candidates with railroad experience, experience as a dispatcher, air traffic controller, or military logistics. They look for 4 yr of railroad experience or 4 yr of management experience in any industry. Candidates with a bachelors degree in transportation, logistics, business administration, or economics are preferred.

Work ethic characteristics are important to UP. Specifically it looks at an individual's experience handling multiple jobs concurrently, working through college, maturity, and motivation during periods of unemployment. This information is obtained through the interview process, the candidate's work history, and legacy referrals. The interview process also provides a means to assess dispatching issues, such as attention to detail, adherence to predetermined rules and policies, planning and coordination skills, and the decisiveness and assertiveness of the candidate.

UP is currently looking at pay levels for dispatchers. Of particular concern is starting pay.

An individual's ability to adapt to the lifestyle of a dispatcher is an important consideration. A realistic job preview is part of the screening process and helps to assess this factor. Ms. Lehan reported that in a recent group of dispatcher candidates, one individual walked out after realizing the reality of working nights.

Currently UP is looking for degreed candidates in maintenance-of-way, mechanical, clerical, and train service jobs.

The UP selection and training process has the following steps:

- Human Resources (HR) Department representatives and staff members from Harriman Dispatching Center (HDC) review and select top candidates from internet applications.
- HR administers the management test and selects top candidates for interviews.
- Four managers of train dispatchers and four managers with dispatching experience or active train dispatchers constitute the HDC interview team. The interview team interviews the top candidates, selecting the best to become apprentice dispatchers.
- Apprentice dispatchers complete 3 mo of training and 3 mo of on-the-job training (OJT).
- After completing the OJT, the employee works for 4 to 6 wk followed by a territory familiarization trip.

Ron Vincent, P&W, a Genesee & Wyoming Company

P&W operates 588 miles (mi) of track, all of it dark territory that is under track warrant control (TWC). Four trick dispatchers and one chief dispatcher control train movements on the system. The railroad is currently experimenting with a global positioning system (GPS) to aid dispatchers in locating locomotives.

When the railroad began operation, two experienced dispatchers were hired. Train volume was low enough that they only worked 5 days (d) per wk. On weekends the two dispatchers took turns coming into the office for a few hours each day to issue train orders. Eventually business grew but not to the extent that a third dispatcher was required. The company created the position of trainman/train dispatcher extra board. When an extra dispatcher was needed, individuals from this extra board filled in. Otherwise they worked as trainmen. This solution worked for about 2 yr at which time the two dispatchers retired. The railroad was fortunate to be able to hire two additional experienced dispatchers. As the operation grew to its present size, additional dispatchers were recruited from the customer service center. One requirement was that the candidate know General Code of Operating Rules (GCOR).

Last year the Genesee & Wyoming parent company recognized that 75 percent of the dispatchers on its system would be retiring. The company assembled a meeting of supervisors, and, with the assistance of a consultant, it explored the job of dispatcher and related skills. The company defined six key elements of the recruitment and selection process: job descriptions, core competencies, methods to seek qualified applicants, elements of a behavioral interview, assessment testing, and references and background checks. Each railroad identified six additional skill sets that fit with their operation. P&W wants its dispatchers to have the following characteristics: good communications skills, adaptability, good organizational skills, good negotiating skills, database and computer skills, and initiative. Negotiating skills are important because the P&W dispatchers are also crew callers, and many times they must convince people to work at undesirable times.

In the coming years P&W faces two major challenges. The first is to handle the projected growth in traffic, including operation of a commuter service. Technology will most likely have to be introduced. In addition, another 12 dispatchers will be needed to handle the increase in workload. The second challenge is finding a way to retain dispatchers. Current dispatchers do not appreciate the importance of their job and become bored. P&W has its dispatchers work with the train master and ride trains as a way for them to appreciate the job. Mr. Vincent surmised that if P&W had incorporated a more structured interview process, as recommended in *Selection of Dispatcher Candidates*, perhaps the dispatchers would not get so bored.

3.3 Dispatcher Workload Stress and Fatigue (Stephen Popkin)

In 1997 FRA initiated a multiyear study of railroad dispatcher workload, stress, and fatigue in response to concerns that arose from an FRA Office of Safety audit of U.S. dispatching operations, dispatcher-caused accidents, and a concern for dispatchers' health and wellbeing. The purpose of the study was to identify sources of dispatcher workload, stress, and fatigue and to evaluate methods for measuring these outcomes.

Methodology–The study was a naturalistic field study that involved observation and data collection in the workplace. Volunteers at two dispatching centers, one passenger and one freight, provided data across all shifts over a 2-wk period. The sample was one of convenience, not a statistically designed sample. In reviewing the study results, due to location specific characteristics and the limited sample size, results may not be representative of the overall U.S. dispatcher population.

A variety of data collection instruments were used. A survey, completed before the data collection period, provided background information on the participants. The modified task analysis workload (mTAWL) methodology, originally developed to assess the workload of helicopter pilots, was used to assess workload. Because it is a labor-intensive method, not all dispatchers were observed. Workload was also measured through subjective ratings and dispatcher records. Subjective ratings were used for stress and fatigue throughout the workday. Analysis of salivary cortisol provided a physiological measure of stress. Actigraphy and sleep logs recorded sleep patterns and self-assessments of sleep quality and alertness.

Once railroad management concurred on participation of their site in the study, participants were recruited. Participants collected data for 14 consecutive days, including rest days. At the end of the data collection period, they completed a debriefing survey to provide feedback on the study procedures.

Demographics–A total of 37 dispatchers, 20 from a freight operation and 17 from a commuter operation, volunteered to participate in the study. They were, on average, overweight middle age males with 8 yr of dispatching experience. Education level ranged from a high school degree to an undergraduate college degree. Approximately 20 percent held a non-railroad job before becoming a dispatcher.

In comparison with U.S. health norms, the younger dispatchers, ages 25 to 44, experienced back pain, headaches, and skin disorders at a significantly greater rate. The older group of dispatchers reported back pain, gastrointestinal problems, and headaches more frequently than U.S. norms. All of these medical problems could be indicative of stress.

Workplace Context–In terms of the physical environment of the dispatching center, over half rated the air quality as unacceptable. Temperature was also a concern for slightly less than half.

The majority of participants reported that their work schedule was 5 consecutive days. Over half reported working 8 or more h of overtime per week, and overall a quarter reported being "expected to work overtime." A labor shortage at the time of the study was most likely the reason for these responses.

When considering both commute time and time at work, dispatchers at the passenger operation had 11 h of work-related time each day. This leaves only 13 h in which to sleep, spend time with family, and conduct personal business. It is likely that many of these dispatchers compromise their sleep to accommodate work and personal demands. Statistical analysis of self-assessments of fatigue throughout the workday indicated that those with longer commute times tended to be more fatigued at work.

Overall the dispatchers at the two sites felt that they rarely had to bend the rules to complete the job and were able to handle emergencies. They felt that they had a moderate or high level of control over work quality and task ordering but little control over policy decisions.

Workload–The information from the mTAWL observations allowed for comparisons of relative workload of the desks within a center. This method appears to be suitable for documenting a desk suspected of having a workload imbalance, although the mTAWL process is quite labor intensive. Subjective measures of workload appeared to be independent of the objective measures (e.g., number of trains and other track users, number of Form Ds) and did not reveal perceptions of excessively high workload in the aggregate.

Stress–Workplace stress has been documented in recent studies. In a 1995 NIOSH study of workplace stress, 40 percent of U.S. workers reported their job as very or extremely stressful, and 25 percent viewed their jobs as the major stressor in their lives. A 2000 Gallup poll documented workplace stress and incidence of verbal outbursts or other actions arising from this stress. The study revealed evidence of stress-related behavior in the dispatching center. Three quarters of the study participants reported that they “rarely” or “never” lost their temper at work, but 92 percent reported that other dispatchers “sometimes” or “frequently” lose their temper.

In terms of individuals that the dispatcher interacts with, dispatchers reported the greatest levels of cooperation with the chief and train and engine crews but also reported conflict with train and engine crews and maintenance-of-way workers. Another indicator of work-related stress was the fact that a third of the participants reported sometimes or frequently calling in sick due to stress. Major sources of stress for novice dispatchers were “personality conflicts with crews” and “quality of workstation and equipment.” In contrast, the most senior dispatchers found “juggling T&E and MOW needs” the most stressful part of their jobs. Overall, most of the reported stressors were not directly related to workload, and subjective stress generally increased through the shift. Cortisol levels, the physiological measure of stress, were within adult norms and followed a circadian pattern. The frequency of measurement may not have been inadequate to detect physiological response to a stressful workplace event.

Fatigue–Fatigue is a multidimensional issue. Time of day and time awake are the primary determinants of fatigue and thus account for increases in subjective fatigue with time on duty. As with other shift work populations, the dispatchers on the night shift had the shortest nighttime sleep, but when their nap periods were added, total daytime sleep was the same as those working days. Second shift dispatchers got the most sleep, averaging over 7 ½ h daily. The study did not reveal any significant sleep debt.

3.4 Fatigue Management Behaviors: Effects of Feedback from Performance Actigraphs (Patrick Sherry)

Supported by a grant from FRA Office of Safety, the National Center for Intermodal Transportation, and BNSF, this research was conducted to help identify ways of improving individual sleep habits of dispatchers. Specifically, the purpose of this study was 1) to help assess whether or not people have the capacity to deal with the stress, demands, and fatigue that come with the dispatcher job and 2) to help identify ways in which dispatchers can lower stress and fatigue and deal with crisis and the demands of the job.

Methodology–The data collection effort in this study focused on individual sleep cycles. Each participant was involved in three data collection trials. The objective of the data collection was to record sleep habits and identify ways to improve sleep hygiene. Sleep data was recorded using an actigraphy monitor, which is a wrist-worn device that detects motion. Actigraphs provide an objective assessment of the hours of sleep. In contrast, sleep diaries can be less accurate. The individual’s activity level indicates the work and rest schedule each day and can be used to predict fatigue. The monitor uses an algorithm to give the person a number indicating his/her fatigue level. This number is displayed on the watch face and is referred to as feedback. Ideally, the wearer adjusts his/her sleep schedule based on this feedback.

This study involved three 30-d trials using actigraphy monitors. The first trial involved the participants wearing the actigraphy monitor to obtain sleep data. The feedback function was added to the second trial to give participants an indication of their fatigue levels throughout the day. The participants were instructed how to respond to their fatigue number. The third trial was a repeat of the baseline and did not include actigraphy feedback.

Demographics–A total of four women and 31 men volunteered to participate in this study. Two women and 18 men completed all three trials. While several people from each shift volunteered, the majority were third shift.

Results from Baseline Trial–Actigraphy data was collected from 18 volunteers. The participants wore the watch for 30 d without feedback. Each participant was given his/her own results on the baseline study and then asked how he/she could improve his/her sleep habits. The researchers taught the study participants how to identify problem areas, identify goals to be addressed, and use feedback from the watch.

Because first and second shifts sleep at approximately the same time at night, the researchers combined both shifts into a day shift and left third shift as night. The average the day shift worker slept 5.51 h, and the average night shift worker slept 6.48 h. Typically day shift workers get more sleep than night shift; however, the people who volunteered for the study may have had more sleep issues than the average shift worker.

Results from Second and Third Trials–During the second trial, the participants wore the feedback actigraphy watch for 30 d. At the end of the 30-d period, participants were asked how they would continue to change their sleep/rest habits. Finally, they wore the regular watch without feedback for 30 d to again record work and rest habits.

From the data, it appears that the day shift improved from Trial 1 to Trial 2 and then went back to Trial 1 level during Trial 3. The night shift seemed to change very little between the first two trials but then improved in the last trial. It may be important to study habit change in different shifts in order to get a better idea of why the different shift workers responded differently to the trials in this study. The average amount of sleep of participants in this study increased by about 10 percent. This, however, might change in further studies due to the variability of a larger sample.

Participant Comments–The participants were asked to comment on the study and what they gained from wearing the watch. Participants found the following aspects of the study to be valuable:

- The ability to keep track of fatigue
- Learning about fatigue levels
- Aware of sleeping habits and lack of adequate sleep
- Knowledge of how they were dealing with fatigue and what they should be doing to improve their fatigue levels

Overall, the participants reported liking the watch but did not always rate the device as particularly helpful. Suggested improvements included incorporating an alarm into the monitor to indicate to the wearer when it was time to take a nap.

Future Research with Actigraphs–Dr. Sherry recommends that future efforts should focus on developing better measures of the improvements that people make in their personal fatigue management and integrating coaching with feedback technology. In addition, future efforts should address developing ways to identify people who are not suitable candidates for this fatigue countermeasure.

Future research efforts should include exploring ways to use actigraphy as a fatigue countermeasure. Because all employees have the potential to suffer from fatigue issues, railroads should provide an intervention tailored to personnel not in train service. Management/supervisors should also be trained in fatigue management.

3.5 The 21st Century Short Line Dispatching Center (Thomas Murphy)

Background and Procedures–ARDC, a wholly owned subsidiary of RailAmerica, opened in 2003. Located in Vermont, ARDC dispatches 17 railroads from New England to the Midwest, and down to the southern United States. The center controls rail traffic for both short line and Class I railroads on 3,000 mi of track in 19 states. The territory under ARDC's control is growing each year. ARDC moves over 500,000 car loads annually with upwards of 200 crew starts each day.

ARDC's goal is to establish continuity in procedures and operating practices. The short lines are often behind the Class Is in dispatching technology, procedures, and other advancements. To help update the short line dispatching process, ARDC trains both dispatchers and other short line employees in the important core elements of train dispatching: bulletins, track warrants/track and time, radio communication, and rules compliance. ARCD also makes sure the C.F.R. § 228.17 standards are met and that documentation and reporting takes place. Safety and efficiency are a result of trying to meet these goals.

Safety–ARDC takes a serious and aggressive approach to safety within its company and along its tracks. No FRA reportable injuries or incidents have occurred since the start of operations in the facility. ARDC wants safety to be instilled as part of the employee mentality. Another service ARDC provides is 24 h/365 d a year emergency and safety coverage, as well as a hotline that services over 50 of its railroads.

ARDC is active in emergency response and preparedness training and has developed relationships with the first responders and rescue personnel along the right-of-way. The dispatching center also hosts training sessions on emergency procedures as part of continuing education. These relationships and training to the emergency response community give the short lines extra support to help prevent accidents and assist in more rapid accident recovery.

ARDC also assists its short line customers with efficiency testing. It has developed a program on operational testing for train dispatchers.

Control Systems–In searching for a control system for ARDC, the following capabilities were important:

- Redundancy backup (dual servers)
- Full conflict checking and validation logic (mission critical)
- Ability to manage mixed territory, as well as yards
- Compatibility with GCOR
- Additional modules, such as train sheets
- Supports minimum of five workstations
- Microsoft Windows Operating System

ARDC was also looking for a scaleable platform that has full-featured desktop applications and complex networked system applications.

Weather Alertness–Advanced and accurate weather information is critical for any railroad operation. ARDC uses WeatherData, a system which gives advanced warnings that are track-specific through a program that incorporates latitude and longitude. WeatherData is content tailored to the railroad's specific needs to enhance safety. Stopping or slowing trains costs money, so it is important that weather warnings are timely and railroad-specific. WeatherData gives warnings 20 min prior to weather events, and its staff is available around the clock for consulting. In addition, a WeatherData meteorologist will contact ARDC within 2 min of an unanswered alert.

ARDC Safety and Service–ARDC strives to make a safe working environment for its employees, as well as to offer service to its railroads. It offers rail traffic control services and maintains personal relationships with each railroad. ARDC strives to afford even the smallest railroad greater safety, professional service, and efficiency.

3.6 European Dispatching Operations (Joern Pachl)

European passenger and freight operations differ on many levels from train service in North America. For this reason European dispatching also differs from its American counterparts. Dispatching in European railroad operations differs mainly in scheduling, traffic control principles, and the influence of open access. In addition, the qualification and training of a dispatcher plays a major role in distinguishing European from North American dispatchers.

European Railroad Operations–European operations are predominately passenger trains. This is the opposite of railroad operations in North America. Passenger operations make up between 75 and 80 percent of all European train miles. Freight trains typically carry less cargo and travel at higher speeds than North American freight trains. In addition, the average traffic density is about five times higher than in North America, with most lines having double tracks. Many passenger trains travel at speeds of up to 100 mph on traditional main lines. On high speed lines, such as Inter City Express (ICE) and Train à Grande Vitesse (TGV), travel speed goes up to 180 mph. All train operations are entirely scheduled, with passenger trains often having clockface schedules. All mainline operation is signal-controlled. Even the lines with older technology have signals, and track warrants are only used on a few branches.

Scheduling–The role of scheduling is important in European operations because the majority of the train service is passenger rail. Most passenger trains are scheduled a long time in advance, even months, as well as some freight trains. Freight trains, however, can be scheduled a few hours in advance. Every train must have a pre-determined train path that does not conflict with other trains. Due to the principle of open access, the train path is also the product that is sold by the infrastructure company to the train operating company.

The time-distance traffic diagram of the stringline style is one of the most essential tools in European railroad operation. It is used not only as a scheduling document but also to control traffic in many ways, such as on dispatcher screens. A stringline diagram shows both the times and the locations of a train's schedule. A scheduled trip is represented by a line, or string, that gives the location of each train at a given time. Crossing strings indicate where train paths will intersect. Some railroads use stringline diagrams with a horizontal station axis (e.g., Germany) while others prefer a vertical station axis. In advanced computer-based scheduling systems, for each block section, a blocking time is calculated and displayed around the stringline. The blocking time is the total elapsed time a section of track is exclusively allocated to a train. When coordinating train paths, the blocking times of different trains must never overlap each other.

Traffic Control Principles–In traditional European operations, the dispatcher's sole job is to regulate traffic. Local tower operators perform all safety-relevant work. The dispatcher gives assignments to local operators who control the interlocking when needed. The dispatcher uses a stringline styled train sheet to keep track of train movements. With the introduction of computer-based dispatching, the stringline sheet was computerized. The dispatcher is relieved of the drawing work and can concentrate on traffic management. These systems also provide a stringline-based foresight into the future, which gives the dispatcher a better view on upcoming conflicts. Beside the stringline screen, the dispatcher also has a screen with an electronic track chart. This track chart is a simplified version of the electronic track charts of the centralized traffic control (CTC) screens.

As mentioned before, on most European lines, trains are governed by signal indication. A few of these lines are still controlled by towers of different types. A lot of lines are controlled by traditional CTC, such as from CTC offices or CTC towers. An increasing part of the network is controlled by control centers, which, step-by-step, replace traditional CTC in large areas. Only a very few branch lines are operated by written or verbal authority similar to TWC, either completely without signals or with a simplified signaling system as a safety overlay.

The main characteristic of current development in traffic control is centralization. The area of a new control center is divided into control districts. Two kinds of dispatchers exist. The CTC operators have direct control of signals, routes, and switches. Each control district has a traffic controller who works with an electronic stringline diagram. Both the traffic controller's and the CTC operator's workstations are part of a timetable-based automatic route setting system. By moving train paths, the traffic controller can alter timetable data, which is used for automatic route setting. That relieves the CTC operators from most manual route setting. In Germany, currently seven operation control centers are under construction. In the final state, there will be 75 control districts with about 400 control desks. The traffic controller's desks are already in operation for the entire network. The CTC desks follow step-by-step with renewals of old interlocking and CTC systems.

Influence of Open Access–In accordance with European Union law, the entire European rail network is now operated under open access. For this reason, the former railroads are now divided in infrastructure companies and train operating companies (TOCs). This splitting has changed dispatching significantly. The operation control centers belong to the infrastructure company. These control centers only perform train dispatching. For management of crews and equipment, the TOCs have their own control centers. In contrast to the operation control centers of the infrastructure companies, these control centers are called transportation control centers. In the scheduling process, the TOCs must order the required train paths (i.e., schedules) from the infrastructure company. The infrastructure company will then coordinate these train paths with the train paths of other TOCs and build the final timetable. In current operation, the train dispatcher of the operation control center will inform the transportation dispatcher of the TOC about incoming conflicts. The TOC dispatcher may suggest how to solve the conflict, but the final decision is always made by the train dispatcher of the infrastructure company. This principle ensures that only one authority person is always responsible for train control in the network.

Qualification and Training of a European Dispatcher–Training for the job of dispatcher is more formalized than in North America as the career path is chosen after high school and 3 yr of schooling in the railroad trade school follows. During the first year of trade school, the fundamentals of railroad operation are taught. After this first year, the student chooses his/her field of interest and then begins specialization in the area of dispatching, train engineering, or yard service and industrial railroading. The third year involves OJT and finally licensing as a qualified professional.

3.7 The Job of a Vessel Traffic Services Operator (Ed Wendlandt)

The job of a Vessel Traffic Service operator shares many similarities with that of a railroad dispatcher. A Vessel Traffic Service operator helps to guide vessels in and out of busy ports within the United States. Similar to the cargo that are transported by rail, vessels carry oil, products, hazardous materials, and passengers from port to port everyday.

Vessel traffic management uses several tools to manage traffic with minimal intervention to ensure the safe and efficient movement of vessels. VTS also manage conflicts with vessels in the water, such as converging traffic area. They are responsible for designing traffic separation schemes, which is essentially laying out safe distance between vessels during entry and departure routes that help with the flow in and out of ports.

VTS also handles the navigation COLREG, which are the rules of the road for vessels in the water. VTS is the U.S. representative with the International Maritime Organization (IMO), as well as the International Association for Aids to Navigation and Lighthouse Authorities, which issues equipment carriage requirements for bridge-to-bridge radios and navigation equipment.

VTS also conducts ports and waterway safety analysis (risk assessment) for ports that are having problems managing their vessel traffic. VTS will take responsibility for managing the port or will implement other measures, such as rules or regulations, in an effort to mitigate the port's problems.

VTS follows the IMO guidelines, which state that vessel management operations should be implemented by a competent authority and should assure safe and efficient vessel traffic management while protecting the surrounding environment. The service should also be able to interact with traffic and respond to developing traffic situations in the VTS area.

History and Background–The U.S. Coast Guard implemented VTS in accordance with the Ports and Water Way Safety Act of 1972. Congress enacted this law following two collisions, one under the Golden Gate Bridge and one on Chesapeake Bay.

Usually, VTS is the first responder following a collision. At this time VTS has three primary responsibilities:

- Collect pertinent information.
- Stabilize the scene (on-scene safety).
- Notify responding agencies.

They also deal with other unusual phenomenon, such as melting glaciers that create hazards to passing vessels. VTS has a new role in maritime domain awareness, staying alert for terrorist and other national security dangers.

VTS has 10 major sites, including Houston, New York, Puget Sound, and Los Angeles. In some places, they manage vessels up to 12 mi off shore, especially in places like the Houston-Galveston area where there are many oil platforms in the Gulf of Mexico.

Puget Sound provides an interesting port complex with 3500 mi^2 of responsibility, some bordering Canada, requiring that VTS works jointly with the Canadian Coast Guard. Every year VTS manages the movement of billions of gallons of oil, large cruise ships, and the Alaskan Fishing Fleet and the U.S. Naval strategic port. The Washington State Ferry Service is also located in this area and transports 26 million passengers per year. The ferry service operates on a schedule and moves back and forth across the main traffic lanes. VTS monitors this complex area carefully.

Responsibilities–The main responsibilities of VTS are to:

- Ensure safe, efficient movement of vessels in a prescribed area by creating good order and predictability.
- Communicate with vessels over the busy radio, which can be challenging.
- Monitor vessel movements using sensor suite.
- Respond to calls for assistance. This involves knowing the geography so that correct and helpful information can be given to those in distress or foreign vessels who are unfamiliar with U.S. waterways.
- Collect, sort, and analyze information for future use to make recommendations or direct ship movements.
- Provide clear, concise, accurate, timely, and purposeful information. Purposeful means tailoring the information to the situation. Weather, tides, and currents are all important if a squall is forming or fog is setting in. Operators should provide information, navigational assistance, and help with traffic organization.

Training with Technology–Manual boards were the original tools used by VTS for traffic management. Each board represents a segment of waterway, and each card represents a vessel. The cards are placed in slots on boards to determine appropriate traffic organization. While manual boards work well for traffic management, they require much manipulation by the operator and require many hours to become proficient. Over the past 10 yr, technology has advanced to provide better computerized systems for VTS to use. Vessel Transit Management Systems use radar images on the integrated display system and have remote sensors, such as radar, VHF-FM radio, camera, automatic identification system, and trip line. They also use a physical oceanographic real-time system that provides real-time information on height of tides and current speed and direction.

Operator training is both national and local. National VTS schools have state-of-the-art simulators to teach basic Vessel Traffic Management. These schools offer a certification course and are used to ensure that national policies are understood and carried forward in a standard manner. Local training provides the operator with an understanding on the local port complex and history, as well as an opportunity to become familiar with the equipment and regulations.

Work Hours and Schedules–Work hours and schedules vary by location, but most common are:

- 12 h on and 12 h off

  - 3 d on and 3 d off
  - Either all day or all night shifts
  - Shifts are from 6 a.m. to 6 p.m. and 6 p.m. to 6 a.m.

- 8 h sliding shifts
- Within each shift, after 1 h on duty a break with rotation

3.8 Dispatcher Taskload Assessment Tool (Stephen Reinach)

As part of a contract with FRA, Foster-Miller, Inc. conducted research to develop a tool for assessing railroad dispatcher taskload. FRA previously developed a dispatcher taskload assessment method to identify desks that were overloaded or over-tasked. However, limitations to this particular assessment method existed because it was was railroad-specific, time-consuming to collect data, and required numerous personnel. The goal of this project was to design a software tool to assist FRA Operating Practice inspectors and railroad officers from any railroad to quickly, easily, and unobtrusively assess railroad dispatcher taskload.

Concept–The main idea for the assessment tool was to modify the taskload method developed by Office of Safety for their safety audit and make it widely applicable to railroads. To ensure utilization in the field, the design had to be quick, easy, and unobtrusive to implement. The tool itself needed to be able to:

- Support future dispatcher research.
- Support internal railroad dispatcher desk studies.
- Ensure even distribution of taskload across desks.
- Support FRA Office of Safety dispatch audits.

Approach–The approach to designing the assessment tool consisted of two phases. In phase one the three main objectives were to 1) identify a comprehensive set of observable dispatcher tasks; 2) discern factors that affect dispatcher taskload; and 3) determine how data can be collected, as well as the level of effort and difficulty required to collect taskload data. Phase two involved development of the actual taskload calculation methodology and converting that methodology into a portable software application suitable for use by railroad personnel in the field. Mr. Reinach's presentation discussed results from the first phase.

Taskload is defined as the average time demanded of a dispatcher in carrying out all job-related tasks at a particular desk, over a specified period of time (e.g., one shift). Time is the common denominator among all operations and allows for collection of data on different tasks at different railroads.

Methods–First an initial set of dispatcher tasks were developed. Next was development and distribution of two rounds of questionnaires. These questionnaires expanded upon the initial tasks and identified suitable data collection methods. The questionnaires were distributed to representatives from all eight FRA regional offices, two railroads (one passenger/commuter and one freight) and the American Train Dispatchers Association. A total of 11 respondents completed the first questionnaire, and 10 of the 11 completed the followup questionnaire.

Results–The initial set of dispatcher tasks were developed by conducting a literature review of dispatcher training materials; other documentation, interviews, and input from a subject matter expert; and naturalistic observation. From this set, the two questionnaires were developed and distributed. Based on data from the first questionnaire, a total of 67 dispatcher tasks were identified and organized into the following categories:

- Actuation of signals, switches, blocking devices, and bridge controls via CTC/CAD
- Issuance and cancellation of dispatcher-authorized mandatory directives
- Granting of other track-related permissions, protections, and clearances (non-mandatory directives)
- Carrying out non-movement authority or non-permission/protection/clearance communications
- General recordkeeping tasks
- Review of reference materials

Respondents were asked about time and effort demands on certain tasks. The majority said that it took about the same amount of *time* to route passenger and local freight trains as it did to route a through freight train, but it took relatively more time to route work trains and high-rail vehicles. Respondents also said that it took relatively more *effort* to route local freight, work trains, and high-rail vehicles as compared to through freight trains.

Respondents indicated which of the following data sources were applicable to the six categories of dispatcher tasks:

- CAD report
- Other computer report
- Paper train sheet
- Other paper record
- Audio tape
- Direct observation
- Other
- Cannot be collected

CAD reports were identified most frequently as a source to collect data on CAD/CTC activity, mandatory directives, and general recordkeeping. Audio tape data was thought to be a good method for collecting data on track-related permissions, protections, and clearances. Direct observation was seen to be helpful with data from non-movement authority and non-permission/protection/clearance communications, general recordkeeping, and review of reference material.

Discussion–The research suggests that not all trains are created equal and that no one method is effective at collecting data on all six dispatcher task activities. Data on track-related permissions, protections, clearances; other communications; and general recordkeeping appear to be the most time-consuming, effortful, and obtrusive to collect. Over 50 percent of a dispatcher's work-related time was estimated to be spent actuating signals and switches via CAD/CTC and issuing and canceling mandatory directives to track occupants.

Previous research on dispatching combined with these results suggests that railroad dispatching is heavily cognitive in nature. Although this research helped to identify tasks and data collection methods, the relationship between observable taskload and unobservable cognitive workload is unknown. As a result, development of a taskload assessment tool based only on observable task activity may not be the most appropriate approach to characterizing railroad dispatching.

Data on observable dispatcher tasks can serve as the building blocks to a preliminary model of dispatcher performance and safety that incorporates both the physical and cognitive aspects of a dispatcher's job. This research led to a preliminary model of dispatcher performance. The model describes the four job functions that drive the job of a dispatcher, the cognitive aspects of the work, and the performance-shaping factors that affect dispatching performance.

3.9 Understanding How Dispatchers Manage and Control Trains (Emilie Roth)

The purpose of this research was to identify the sources of expertise or skills that dispatchers possess. This is important in terms of training and the introduction of new technology, which includes advanced train control systems, new display, and communications technology, such as Data Link, and high-speed trains. Understanding the required skill set is also important in terms of the hiring process for dispatchers.

The methodology for this study was CTA. CTA provided the means to:

- Examine how experienced dispatchers schedule trains and manage track use.
- Identify cognitive activities that could be more effectively supported.
- Identify features of the existing environment that contribute to effective performance and should be preserved in transition to new technologies.

CTA involves observing people in the field as they do their job. The goal is twofold: 1) to try to understand what makes the set of tasks difficult and 2) to understand the skills and strategies that the job incumbents have developed to cope with problems.

The study approach was an iterative bootstrap approach. Three researchers observed dispatchers for 4-h periods to get a sense of the nature of the dispatchers' tasks and how they executed them. They also observed shift turnovers. A second set of followup observations were made at a second dispatch center, as well as at the original center. Researchers identified and documented sources of task complexity, skills, and strategies used by experienced dispatchers to cope with task demands and opportunities for performance improvement from training or the introduction of new technologies. The researchers looked for illustrative incidents and deviations from "the way it is supposed to be done."

Train dispatchers are responsible for:

- Managing track use.
- Insuring the safe and efficient routing of trains.
- Insuring the safety of personnel working on and around the track.

Dispatchers carry out these responsibilities as part of a distributed planning task that also involves dispatchers handling adjoining territories, locomotive engineers, and maintenance-of-way workers.

Handling unpredictable situations makes the dispatcher's job difficult. This involves dynamically re-computing train routes, meets, and passes. The dispatcher must also satisfy multiple, possibly conflicting, demands for track usage. High knowledge requirements and memory load, as well as heavy attention and communication demands, also make the job a difficult one.

Examples of dispatcher decisions include the following:

- Which train gets priority?
- Is it possible to help a train make up time?
- Is there adequate time to give track time to a maintenance-of-way crew?

Dispatchers employ a variety of expert strategies to meet task demands. They use cheat sheets, desk files, and personal street maps to off-load memory requirements. Dispatchers continually anticipate and plan ahead. Specific strategies include:

- Maintaining a big picture system, Big Picture using the wall display, other dispatchers, PC-based ticketing system, and radio communication
- Planning cooperatively with dispatchers for other territories
- Listening to radio communications
- Contingency planning

Dispatchers also employ expert strategies. These strategies are acting proactively and leveling their workload by taking action in anticipation of a need.

The results of the CTA have implications in three areas:

1) Advanced displays and decisions aids could provide more precise train location, facilitate access to information affecting train routing and track usage decisions, and provide train routing aids.
2) Data Link technology would provide a means to off-load some radio channel communication.
3) Training could be enhanced through the use of a dynamic simulator that provides a means to develop skills for handling challenging scenarios.

3.10 Visualizing Railroad Operations: A Tool for Traffic Planners and Dispatchers (Mary Lee)

The Volpe Center and Massachusetts Institute of Technology have been working on the development of this tool since 1996. The Massachusetts Bay Transportation Authority, Guilford Rail, and Fulcrum Corporation, as well as two railroads, North Shore Railroad and the Paducah and Louisville Railway, participated in the tool's design and development. The purpose of the project was to develop proof-of-concept software to demonstrate the potential benefits of this type of tool. An iterative user-centered approach was employed. The tool was initially developed for traffic planners, but it has potential use with dispatchers.

Traffic planning requires complex decisionmaking and many tradeoffs. Similar to dispatchers, traffic planners must determine the operational sequence of future events.

Stringline diagrams illustrate the times and locations of a scheduled trip. Railroads have employed them for over a century. The horizontal axis on a stringline diagram displays time and, on the vertical axis, the location. When a string is horizontal, the train is stopped. Where two strings cross, a meet and pass must occur. The slope of the line indicates direction and relative speed. A paper schedule shows just the stops while the string line shows the entire trip.

The Railroad Traffic Planner Tool main window provides access to the string line. Supporting popup windows provide the means to enter trips and track restrictions. Settings files contain the track geography. Data can be output to an Excel file. A recent enhancement incorporates near real-time tracking using GPS data sent via cell phone. The GPS tracking function supplements existing data but is not intended for safety-critical applications.

This tool could be incorporated into a dispatcher training program to help trainees learn to estimate future positions and how decisions can impact traffic flow across territories. The dispatcher's preliminary planning and response to unexpected events could also benefit from the tool.

The tool has the potential to provide safety and productivity benefits. It can help users compare different options, identify windows of opportunity, and set more realistic expectations for customers and other railroads. The tool developers are anxious for railroad feedback on its potential use for dispatchers.

3.11 Panel Discussion: Future Challenges and Research Needs

Representatives of the various stakeholder groups comprised this panel (see Figure 5). Panelists were asked to consider the following questions:

- How will the introduction of new technology (e.g., positive train control (PTC), high-speed rail) impact your dispatching operation?
- Will the decreasing cost of computer technology allow more widespread use of computer-based training?
- What challenges do you face in hiring dispatchers, especially those who do not have railroad backgrounds?
- If the position of dispatcher at your railroad has become a stepping stone to other positions at your railroad, how is this affecting your operation?

Figure 5. Future Challenges Panel–Gary Lettengarver, Carl Barneyback, John Campbell, Leo McCann and Thomas Raslear, Moderator

- Have joint dispatching operations been as effective or successful as anticipated? Are there specific challenges in joint operations?
- How can FRA's Human Factors Research program help the railroad industry in dealing with the above issues?

Leo McCann, American Train Dispatchers Association

Mr. McCann opened his remarks with the observation that, "The more things change, the more they stay the same." He referred to the fact that dispatching centers began small but then moved to large centralized centers. The recent trend for dispatching centers is to move away from centralization to smaller settings or joint train dispatching. Each of these operating styles, however, presents different challenges.

Mr. McCann questioned whether or not too much emphasis is placed on the testing of dispatcher candidates. He commented that perhaps the Long Island Railroad has the best system in which it gives a glossary of railroad terminology to the applicant to study and tests them on this.

Another trend is to hire candidates who have college degrees, promising the college graduate promotions soon after employment. Mr. McCann questions if this practice is harming the dispatcher craft by not giving the promotions as advancements in the field by learning the position. Mr. McCann also advocates higher salaries for the position of dispatching. Inadequate pay and little investment in dispatching to make it a career within the industry may harm the craft.

Another future challenge is identifying pools from which to draw dispatchers. Because the job of block operator has been eliminated, the two main resources are air traffic controllers and the military.

Training is sometimes overlooked in the aging railroad. The next 10 yr will see significant changes in technology along with employee turnover. Before the dispatching community can look at the future, it needs to look at the past and see where dispatchers have come from and where the dispatcher craft needs to go.

Current dispatching training practices began in 1970 when Congress passed the Federal Safety Act to ensure safe operations on railroads. Next, the Devoe Report in 1974[5] defined the duties of a train dispatcher and described the tasks that dispatchers should be qualified to perform. Devoe defined the main categories as:

- Prepare documentation.
- Monitor/coordinate train movements.
- Conduct preliminary planning.
- Respond to unplanned events.
- Respond to emergency events.
- Initiate/stop train movements.

Even though technology has changed over the last 30 yr, the core functions of a dispatcher have not.

In the 1990s, an FRA assessment of railroad dispatcher training revealed a large variability among railroad training practices. A lack of consistent standards for measuring trainee competency existed. In addition, there was a dependence on informal and ill-structured OJT. Uneven practice on territory familiarity and a lack of refresher training were also common among the railroads. FRA believed that the combination of poor training methods and the addition of new trainees created a potential for reduced safety.

In 1992, Congress required FRA to conduct a followup study on dispatcher training. In 1995, FRA reported its findings that included the following problem areas within OJT:

- Inconsistent standards and policies for re-training
- Lack of objectives and measurements
- Lack of opportunity for supervisor training
- Foregoing training because of personnel shortage
- Lack of training opportunities for dispatchers to become familiar with the technology before having to use it in a real life situation

Mr. McCann feels that these poor training methods, especially with regard to becoming familiar with new technology, will be a problem when positive train control (PTC) takes effect.

Following the 1995 Report to Congress, FRA looked for recommendations with respect to minimum training standards, objectives, duration, methods, and frequency. FRA compiled these recommendations in a 1998 report, *Training Requirements for Railroad Dispatchers: Objectives, Syllabi, and Test Design*. This document provides fundamental objectives for train dispatcher training programs.

---

[5] Devoe, D. (1974). *An Analysis of the Job of Railroad Train Dispatcher*. (Report No. FRA-ORD&D-74-37). Springfield, VA: National Technical Information Service.

In 2003, FRA published a report on its findings designed to examine methods for evaluating and selecting railroad dispatcher candidates. FRA concluded that, as railroad dispatching technology continues to change, the knowledge, skills, and abilities of the dispatcher will also have to change. As seen with the advent of PTC, the job of actively dispatching trains will become one of passively monitoring a closed-loop system. Regardless of future changes and challenges to the job, Mr. McCann feels that this report contains valuable information that can be used in the selection of appropriately qualified candidates.

Within the industry, formal training methods exist. The main problem occurs when trainees go through the OJT phase. Carriers rely heavily on this phase of training, yet no systematic guidelines for training consistency exist. Therefore, OJT tends to be unstructured and haphazard. With dispatchers taking on more and more responsibility, it is imperative to develop a standardized training program as a matter of safety, as well as a good business practice.

John Campbell, CSX Transportation

CSX's primary challenge for the next 5 yr will be the introduction of new dispatching software for the entire CSX system. CSX began to update the company's entire dispatching system. Currently CSX operates with two dispatching systems. One CAD system is used in Jacksonville, and a different one is in Albany and Indianapolis. Recent research showed that both systems have 1980s technology and needed to be updated to accommodate increasing traffic volume. Because there is a need to update these systems, a rolling 6-yr plan has been developed to convert the current CAD system into the next generation of dispatching software. The system that will be introduced consists of hardware that will:

- Be updateable.
- Be highly reliable.
- Allow changes for railroad rules and operations.
- Allow for PTC functionality.
- Include full disaster recovery.
- Be capable of dispatching from multiple locations.

CSX's 6-yr plan started in 2002 and will continue through 2007 with the hopes of the entire company using one system by 2005. The first phase has already been implemented in Chicago. The standalone system is open platform with new software functionality. The next phase will include deploying dispatcher authorities and messages into the integrated system. The train sheet phase will follow. A new communication system has already been implemented in Chicago and Jacksonville with Indiana and Albany scheduled to follow early in 2005.

The new system will be point and click and possibly have touch-screen technology. Because this new system is physically different from the current system, testing the software and training the user are of utmost importance for system success. The training process will take place over the next 5 yr. As part of this testing and training process, current dispatchers have been brought from dispatching centers to be a part of the training team. These dispatchers have helped to develop the system and will be conducting the training of other dispatchers. Many tools are available for the railroads to incorporate into their systems; however, successful use of these tools lies in proper training of the dispatcher. As technology is rapidly changing and improving, it is important to keep up with user training for both efficiency and safety.

For CSX, which operates in areas prone to disastrous weather events, having a weather-update interface program is highly desirable. The new system will have a weather tracker using GPS satellite, as well as an integrative planner. A disaster recovery plan is also very important to test and have in place so that the dispatcher is prepared before disastrous events occur.

CSX has been very successful in implementing the first phase of the technology change-over plan that was implemented in Chicago. It hopes to be successful with the future phases over the next few years. The introduction of this new technology will not change the number of dispatchers at CSX's dispatching centers.

Carl Barneyback, Indiana Harbor Belt Railroad (IHB)

IHB shares a dispatching center with CSX in Chicago. Trends may lead to more joint facilities, but some concerns and issues to consider also exist. Mr. Barneyback is a part of this joint effort in Chicago. He offered some advice when considering starting a joint operation.

The first question to ask is, "What is the motivation for a join operation?" For CSX and IHB, it was a natural fit because it was easy to share track and divert traffic to each other's rails in order to keep the terminal fluid. If the two companies do a lot of business with each other and communication problems or hand off problems occur, then joining the two companies might benefit both companies. The owners must make sure that the employees buy into the concept and that everyone will benefit from dispatching within the same operation. The company must make sure that this is good for them and not strictly look at what benefits other companies had from joint operations.

The next point to consider is the corporate culture and history between the two companies. Employees do not want to sit in the same room with people that they have been trained to dislike because they are from a rival railroad. The management has to understand the impact of the merger on the employees working together.

CSX and IHB were old rivals. When they joined operations, however, many new dispatchers were hired who had not been a part of the rivalry. This helped to make the merger more peaceful.

The two companies joining must also consider the size of each railroad and the cultural differences. Is the working climate similar or very different? Agendas, motivations, and even requirements for service deliveries must be considered. Before joining, the two companies must consider if there is more to be gained than conflicts in climate and schedules. They must be willing to run the operation equally and not allow size imbalances affect the way the dispatching occurs.

Another aspect to consider is differences in operating practices between the railroads. Vast differences could exist in the rules system in place at each railroad. The hardware and dispatching software could also be different. Data processing systems should be considered. At least one of the railroads should have a capable Information Technology department to help bridge any software gaps. In general, the railroads need to have people on staff who are capable of coordinating the merger.

In addition, one must determine if the facility is capable of handling the computer processing needs for one large dispatching center. The building should be wired for the appropriate amount of computer and phone lines. The physical location is very important and should be on neutral ground where neither party has to go to the other company's location to work.

A problem can arise if the two companies have different pay rates among the employees. Adjustments should be made so that all employees are earning at the same rate. Working side by side with people on higher pay scales can cause strain among the employees.

Another consideration is perhaps to consolidate the work force to doing all the jobs. Joint operations function successfully without consolidation of the work force, but it is a possibility to consider. The management would be training employees to work all the different jobs within the one dispatching center instead of treating the center like two operations. Perhaps combining the work force and cross training them is the new joint dispatching center of the future.

One last consideration is for management not to assume that putting people together from different companies is going to work without any hitches. Some issues will need to be worked through to make the operations work smoothly. No one answer can cover every joint operation. Each company must decide for itself what will work best for the two parties involved.

Mr. Barneyback concluded his talk by emphasizing the need to conduct research on reducing dispatcher stress. There is a strong need to learn about ways to make the job less stressful. Research should focus on why dispatchers are stressed and how to reduce the factors that contribute to the stress on dispatchers. He sees a need to learn about both the physical and mental factors that lead to occupational stress on dispatchers.

Gary Lettengarver, Metrolink

Mr. Lettengarver believes that adequate dispatcher training will continue to challenge the railroad industry. The industry must move toward standardized training, particularly those railroads that do not hire a sufficient number of dispatchers to conduct their own classroom-based training. From experience Metrolink found that a dispatcher cannot be adequately trained solely through OJT. Metrolink sends all of its new hire dispatchers to the Terrant County Community College program which BNSF helped to establish. After completing this program, Metrolink dispatcher trainees return to Metrolink for territory training. Mr. Lettengarver encouraged the workshop participants to consider sending their trainees to this program.

All Metrolink dispatchers have 2 wk of refresher training annually. One wk is classroom training, and the other is field training. Field training involves spending time with a track gang and a switchman, as well as riding the territory that the dispatcher covers. During the classroom portion, 2 d are spent on rules and 3 d on procedures. Mr. Lettengarver reported that during the classroom session the dispatchers share their experiences and effectively "take over the class." Before implementing this type of refresher training, dispatchers averaged 70 to 80 procedural errors annually. Now they average less than 10 per yr.

Coaching is also an important part of the Metrolink training program. Mr. Lettengarver and his chiefs have been trained to work with the Metrolink dispatchers to improve their skills. This type of training has also contributed to the improvement in efficiency ratings.

4. Attendee Feedback

A total of 33 (52 percent) of the 63 workshop attendees completed the Workshop Evaluation form. This section summarizes the feedback obtained through this process.

Attendees rated four overall aspects of the workshop. A majority of the attendees assigned a rating of excellent or very good for all four aspects of the meeting. Table 1 summarizes these ratings. These ratings indicate that the attendees found the content, organization, and utility of the information of exceptionally high quality and value.

Table 1. Summary of Attendee Ratings

Aspect	Excellent	Very Good	Good	Fair	Poor
Overall workshop organization	18	14		1	
Workshop content and discussions	12	13	5	3	
Workshop facility and location	21	10		2	
Usefulness of the information presented	7	18	6	1	1

Responses to the question, "What part of the workshop had the most value? Why?" included the following:

- The selection panel appeared to be the most valuable. Ten respondents felt this topic was particularly relevant, and it was beneficial to hear from others on their problems/approaches. Not everyone, however, agreed with panelist approaches.
- Six respondents liked the panel session format because it enabled an efficient way to provide a cross section of ideas on a topic.
- Four respondents noted that they enjoyed hearing about German dispatch operations.
- Four found the presentation on dispatcher workload, stress, and fatigue most valuable.
- More generally, many respondents liked the exposure to different viewpoints and practices. This enabled benchmarking and generation of new ideas.
- Three respondents noted that the social hour the evening before was valuable in allowing one-on-one conversation with others and that the entire workshop was a great way to network within the dispatching field.

Individual comments included the following:

- "The recognition of the difficulties of the train dispatcher's job and the need to continue to find ways to address those difficulties. Complicated concepts and analyses were presented in easily understandable terms."
- "Each topic was very well organized and presented which made this program interesting and valuable."
- "German Transportation System–gave perspective on what we could do/have if we wanted more efficiencies."
- "Mr. Pachl's presentation at lunch was excellent for comparison with our operations."
- "Panel discussions [were] good for benchmarking and generating ideas."
- "Panel discussions [were a] time-effective way of presenting several different perspectives on a common topic."
- "It was all good."

Attendees were also asked "What part had the least value? Why?" Two attendees commented that they would have liked to have more emphasis on the next steps with regard to implementing the results of the various research studies. Three attendees felt that one of the presentations covered the duties and decisionmaking process of a dispatcher at a level of detail that was below the understanding level of most of the audience.

The final question on the evaluation form was, "What can FRA do to improve future workshops?" Responses fell into three categories: changes to the workshop process, suggestions for future workshop topics, and suggestions for FRA Office of Research and Development.

Workshop Process Suggestions

- Expand the number of days to cover the agenda, or reduce the agenda, to enable participants to explore topics more thoroughly.
- Hold these workshops more frequently (e.g., once a year). Rotate topics yearly (e.g., focus on whatever is a "hot" topic that year).
- More participation by working dispatchers as speakers and panelists.
- Include breakout groups to facilitate discussion of ideas among attendees. Facilitate information exchange.
- Announce meeting details further in advance to aid organizations to fiscally plan for meeting.
- Advertise meetings to railroad HR departments.
- More involvement [in audience] by short lines. Also make sure conference announcement is put out to short lines more effectively.
- Include more presentations from those outside the industry but who perform jobs similar to dispatching (e.g., air traffic control, 911 dispatchers).
- Invite industry to submit topics for workshops.

- Pose specific questions to the audience.
- More breaks and opportunities to network and meet people.

Workshop Topic Suggestions

- Examine existing regulations, including Hours of Service, to determine what is outdated and what needs to be updated.
- Identify solutions (e.g., stress management), not just research problems. Focus on taking research results and implementing in the industry.
- "Have a panel of train dispatchers discuss their jobs and how they workplace could be made safer and more efficient, why they chose the job and what can be done to make the job more attractive to new hire or transfers."
- Presentation on how FRA Office of Safety conducts its dispatcher assessments.
- Facilitated session on planning dispatcher research/research needs (rather than an open panel session).

Office of Research and Development Suggestions

- Develop a dispatcher simulator, (e.g., to aid training).
- Set standards for radio communications.
- Add dispatcher-related information to FRA Web site on ongoing basis.
- Develop a trade school for dispatchers, as well as train and engine crafts, based on the German model presented by Joern Pachl. This could be a public/private partnership.

5. Important Issues

Comments from workshop participants in response to individual research presentations and panelist remarks suggest that the following are areas where issues exist and additional research efforts may be needed:

- *Recruitment and Selection of Dispatcher Candidates*–Participants at the 1998 dispatcher workshop unanimously agreed that they needed help with selection criteria and methods for recruiting dispatchers. Participants at the 2004 meeting voiced the same concerns. FRA sponsored a research project on this subject in response to industry concerns voiced at the 1998 workshop; however, many workshop participants were not aware of the report. As a result of the workshop, participants said that they will incorporate the study's recommendations into their dispatcher recruitment and selection process.
- *Retention of Dispatchers*–Closely related to the issue of recruitment and selection is the issue of retention of dispatchers. Training of dispatchers can cost in excess of $50,000 per trainee, and it may take several years before a dispatcher is fully proficient and capable of mentoring trainees. High turnover among dispatchers has economic, as well as operational, consequences for the railroad. Numerous workshop participants expressed a desire to find new ways to boost retention of their dispatchers.
- *Critical Incident Skills Training*–An important element of the dispatcher's job is to respond to emergency events. While this is a rare occurrence, the dispatcher must have the skills to handle these situations when they arise. Workshop participants sought guidance on methods for identifying individuals who are able to handle emergencies, as well as ways to train dispatchers to handle critical incidents.
- *Impact of PTC*–In recent years PTC has been implemented through a number of FRA-sponsored demonstration programs. PTC will change how the dispatcher manages and communicates with track occupants. Issues related to the impact of this change on the job of the dispatcher remain to be explored.
- *Integration of New Technology*–Continuing technological advances have the potential to facilitate the tasks of the dispatcher. For example, train position information obtained through GPS may aid in managing trains and other track users in dark territory. As a second example, commercial sources of weather data are available and may provide information to help the dispatcher in planning future train movements. The most efficient integration of the information from these two sources, as well as other new technologies into the dispatcher's workstation has not been explored.
- *Dispatcher as Team Member*–The functions and cognitive aspects of the dispatcher's job are well-documented and understood. The interaction and decisionmaking process of the dispatcher with the chief dispatcher and other dispatchers, however, is not as well-understood. Team cognitive task analysis provides a methodology for understanding the dispatcher's role in this railroad team.
- *Dispatcher Work Schedules and Sleep Patterns*–Staffing shortages at some dispatching centers result in significant overtime for the dispatchers, leading to increased stress levels. FRA-sponsored study of dispatcher workload, stress, and fatigue collected data from

dispatchers at two dispatching centers. While this study provided a preliminary assessment of these issues, there is need for a more complete picture of work patterns and fatigue for this craft. A more complete characterization of of dispatcher work patterns and fatigue will help determine if alternatives to current dispatcher staffing and scheduling practices are needed.

- *Stress Reduction Techniques*–FRA-sponsored study of dispatcher workload, stress, and fatigue documented occupational stress among dispatchers. Participants suggested that there should now be a focus on identifying appropriate stress reduction techniques.
- *Joint Dispatching Operations*–In the 1980s, railroads moved to centralized dispatching operations with one center controlling trains for the entire railroad. The next decade saw a move back to regional dispatching centers. The trend now is to supplement these with joint operations where dispatchers from two different railroads sit side-by-side in one facility to dispatch trains in a specific geographic region. The benefits and shortcomings of this arrangement are uncertain at this time but should be determined and documented.

6. Recommendations

The experiences of this workshop and the feedback from participants led to two recommendations. One recommendation concerns future events of this nature, and the other concerns the content of a dispatcher research program.

Future Workshops

The workshop achieved the goals as presented in Section 1.2. Workshop participants especially liked the opportunity to share best practices and to learn about other dispatching operations. Future events of this type should include more industry representatives and working dispatchers and be expanded to 1½ d to allow adequate time for additional interactive sessions. The current workshop covered FRA-sponsored research that took place over a period of 6 yr. No current dispatcher research projects are underway so it is unlikely that there will be enough research projects to support another workshop like this one for several years. An event that combines research with discussion of operational issues and jointly sponsored by both FRA Office of Research and Development and the Office of Safety, however, might be feasible.

FRA's Human Factors Research and Development Program sponsors research on many aspects of railroad operations. The success of this event can serve as a prototype for a way to disseminate research results and obtain stakeholder input on other aspects of the human factors research program. Establishing a periodic FRA Human Factors Research and Development workshop would assure that stakeholders have an opportunity to learn firsthand from FRA-sponsored research and to provide input to the FRA's human factors research program. This program of periodic workshops should be accompanied by a systematic evaluation methodology to enable FRA to gauge the success of both its research program and the individual events.

Dispatcher Research

To date FRA Human Factors Research and Development Program has sponsored a number of research studies that concern railroad dispatching. Issues raised at the workshop suggest the following new research programs:

- *Interactive Dispatching Simulator*–The development of an interactive dispatching simulator would address several of the issues raised by workshop participants. Current dispatching simulators are simply a replica of the CAD workstation in the dispatching center and are designed for training dispatchers on the mechanics of operating the system. An interactive simulator would provide a means for the dispatcher to communicate and interact with the train crew, maintenance-of-way crews, the chief dispatcher, and other dispatchers on adjoining territories. It could be used for activities, such as critical incident skills training, examining the impact of PTC, and evaluating new technologies.
- *Retention Strategies*–A study of best practices for encouraging retention of dispatchers, similar to what was done with regard to selection, would provide valuable information to railroad management and labor. Railroads of various types and sizes could be contacted to document their experiences. The experience of other industries where retention has been a problem (e.g., nursing) could also be reviewed. Materials for use by railroads could also be prepared. These materials may include a brochure describing the job of a

dispatcher and the importance of this job to the railroad, and possibly a short videotape with testimonials from working dispatchers.

- *Team CTA*–As follow-on to the CTA described at the meeting, a team CTA would explore the dispatcher's interactions with the chief and other dispatchers and their group decisionmaking processes. A clearer understanding of decisions that involve multiple players can have implications for training, design of workstations displays, and organizational structure.
- *Work Schedules and Sleep Patterns*–A survey of working dispatchers can provide data on their work schedules and sleep patterns, as well as the demographics of the work force. At least 2 wk of data should be collected from a random sample of actively working dispatchers. This type of data will provide a profile of the typical work schedule and sleep pattern of U.S. dispatchers. From this data it will be possible to identify work patterns that may lead to excessive fatigue and job stress.
- *Stress Reduction Strategies*–The survey described above can include inquiring about sources of workplace stress. Once the sources of stress are identified, specific strategies can be developed or adopted from other environments.
- *Critical Incident Skills Training*–The objective of this project would be to develop a set of training materials designed for both initial and refresher training. A survey of dispatching supervisors could identify situations that their dispatchers have faced. Based on these actual cases histories, role playing exercises could be developed. The exercises would be pilot tested with working dispatchers before finalizing the training materials.

Appendix A.
Workshop Agenda

8:30 a.m.	**Welcome** - Grady Cothen, FRA **Goals for the Day** - Michael Coplen, FRA
8:45 a.m.	**Selection of Dispatcher Candidates** - Judith Gertler, Foster-Miller, Inc.
9:15 a.m.	**Panel Discussion: Development of a Dispatcher Selection Program** - Frank Ferrara, Metro-North Railroad - Jayan Sen, Burlington-Northern Railway - Jo Lynne Lehan, Union Pacific Railroad - Ron Vincent, Portland & Western Railroad, a Genesee & Wyoming Company Moderated by Judith Gertler, Foster-Miller, Inc.
10:00 a.m.	**Break**
10:30 a.m.	**Dispatcher Workload, Stress and Fatigue** - Stephen Popkin, Volpe National Transportation Systems Center
11:00 a.m.	**Fatigue Management Behaviors: Effects of Feedback from Performance Actigraphs** - Patrick Sherry, University of Denver
11:30 a.m.	**The 21st Century Short Line Dispatching Center** - Thomas Murphy, American Rail Dispatching Center
12:00 p.m.	**Lunch** **European Dispatching Operations** - Joern Pachl
1:30 p.m.	**The Job of a Vessel Traffic Services Operator** - Ed Wendlandt, U.S. Coast Guard Vessel Traffic Services
2:00 p.m.	**Dispatcher Taskload Assessment Tool** - Stephen Reinach, Foster-Miller, Inc.
2:30 p.m.	**Understanding How Dispatchers Manage and Control Trains** - Emilie Roth, Roth Cognitive Engineering
3:00 p.m.	**Break**
3:15 p.m.	**Visualizing Railroad Operations: A Tool for Traffic Planners and Dispatchers** - Mary Lee, Volpe National Transportation Systems Center
3:45 p.m.	**Panel Discussion: Future Challenges and Research Needs** - Leo McCann, American Train Dispatchers Association - John Campbell, CSX Transportation - Carl Barneyback, Indiana Harbor Belt Railroad - Gary Lettengarver, Metrolink Moderated by Thomas Raslear, FRA
4:45 p.m.	**Adjourn** - Michael Coplen

Appendix B.
List of Attendees

Name	Title	Organization
Sarah Acton	Project Engineer	Foster-Miller, Inc.
Jay Anderson	Project Engineer	Union Switch & Signal, Inc.
Paul Ayers	Trustee	American Train Dispatchers Department
Sterling R. Barker	Director, Dispatcher Scheduling/Productivity	BNSF Railway Company
Carl Barneyback	Manager Train Operations	Indian Harbor Belt Railroad
Dan E. Bodeman	General Director, Rules/Field Support	BNSF Railway Company
Crawford Boggs	Trustee	American Train Dispatchers Department
Theodore Bundy	Technical Training Manager	Federal Railroad Administration
John Campbell	Director Network Operations	CSX Transportation
Raymond Ciarlo	Superintendent Dispatching Center	Amtrak
Michael Coplen	Human Factors Program Manager	Federal Railroad Administration
Grady Cothen, Jr.	Acting Associate Administrator for Safety	Federal Railroad Administration
Rich Detar	Project Engineer	Union Switch & Signal, Inc.
Terry Doyle	Operating Practices Training	Federal Railroad Administration
Ralph Elston	Fatigue Countermeasures Coordinator	Federal Railroad Administration
Cary E. Emmons	General Chairman -CSXT-East ATDA	CSXT/ATDA
Frank Ferrara	Superintendent - Train Ops	MTA Metro-North Railroad
Rick Gallant	Senior Transportation Supervisor	CA Public Utilities Comm.
Judith Gertler	Division Manager	Foster-Miller, Inc.
Larry Graham	Chief Dispatcher	Metrolink (SCRRA)
S.A. Hunnicutt	Vice President	American Train Dispatchers Department
Albert S. Kaye	Project Coordinator	Federal Railroad Administration
Sam Kimbro		Nashville & Eastern Railroad Corp
Daniel Knepper	Sr. Vice President	Digital Concepts, Inc.
Mary Lee	Engineering Psychologist	U.S. Dept of Transportation, Volpe Center
Jo Lynne Lehan	General Director Operations Support	Union Pacific Railroad
Brenda Lettengarver	Manager Operating Rules	Amtrak-Southwest DUN
Gary Lettengarver	Superintendent of Dispatching	Metrolink
F. Leo McCann	Secretary/Treasurer	American Train Dispatchers Department
Susan McDonough	Program Administrator	Foster-Miller, Inc.
Gary L. Melton	Secretary/Treasurer	American Train Dispatchers Department
Jeffrey F Moller	Executive Director Operations	Association of American Railroads
Jordan Multer	Manager, Rail Human Factors Program	U.S. Dept of Transportation, Volpe Center
Tom Murphy	Manager, American Rail Dispatching Center	RailAmerica
Joern Pachl	Professor, Railway Engineering	Technical University of Braunschweig
Gregory Pardlo	VP	American Train Dispatcher's Association
Richard Pennisi	OP Inspector	Federal Railroad Administration
Steve Popkin	Human Factors Research Psychologist	Volpe National Trans. Systems Center
Thomas Raslear	Senior Human Factors Program Manager	Federal Railroad Administration
Stephen Reinach	Senior Engineer	Foster-Miller, Inc.
John L Reininger	Director Dispatching Services	Union Pacific Railroad
Ron Robusto		Amtrak

Name	Title	Organization
Dale Roddy	President	Digital Concepts, Inc.
Howard Rosen	Principal	Rosen Consulting
Emilie Roth		Roth Cognitive Engineering
Jayan Sen	Director Human Resources and Medical	Burlington Northern Santa Fe
Irene Shapiro	Manager, Human Resouces	Southern California Regional Rail Authority
Patrick Sherry	University of Denver	Transportation Institute
A.M. Snyder	Vice President	American Train Dispatchers Department
Michael Steffen	Senior Manager Operations	Elgin, Joliet & Eastern Railway
Jon Stuart	Sr. Human Performance Investigator	Transportation Safety Board of Canada
Marci Valdivieso	Vice President of Sales Engineering	RailComm, Inc.
Ron Vincent	Vice President	Portland & Western Railroad
David W. Volz	Vice President	American Train Dispatchers Department
Craig Wade	Vice President/General Mgr.	Nashville & Eastern Railroad Corp
G.S. Wasserman	Trustee	American Train Dispatchers Department
Scott Weaver	Director Labor Relations	Norfolk Southern Corp.
Gerald Weeks	Chief, Human Performance & Survival Factors Div.	National Transporation Safety Board
Ed Wendlandt	Commandant (G-MWV)	U.S. Coast Guard
Thomas A. White	Senior Operations Specialist	Transit Safety Management
Michael S. Wolly	General Counsel - ATDA	Zwerdling, Paul, Kahn & Wolly, PC
Daniel Yerina	Sr. Project Manager	Union Switch & Signal, Inc.

Appendix C.
Participant Biographies

Grady Cothen is the acting FRA Associate Administrator for Safety. Grady has served with FRA since 1973 in various legal and program positions.

In his current "Acting" role, Grady is responsible for executive direction of the railroad safety program nationwide. He also retains responsibility for management of agency teams participating in working groups of the Railroad Safety Advisory Committee. Over his years at FRA, Grady has been pivotally involved in development of the alcohol and drug regulations, tank car crashworthiness requirements, Passenger Equipment Safety Standards, FRA's highway-rail crossing program, and many other safety initiatives.

Grady is a member of the District of Columbia bar and a 1975 graduate of the Georgetown University Law Center. He received his undergraduate degree from Oklahoma Baptist University in 1968, and served in the United States Army during 1969-70.

Michael Coplen is a Human Factors Program Manager for FRA's Office of Research and Development, and co-manages (along with Tom Raslear) FRA's Human Factors Program. He worked in the railroad industry first as a brakeman and conductor, and then for several years as a locomotive engineer. He holds a Master's degree in Management and Organizational Behavior from the University of Nebraska, and has completed extensive post-master's coursework toward a Ph.D. in Human Factors at the University of Connecticut. He holds professional memberships in the Association of Professional Sleep Societies and the American Evaluation Association, and is credited with several scientific publications in areas such as on-call work/rest schedules, cognitive task analyses, and visual displays. Mr. Coplen also sits on a variety of government and industry committees and working groups, including the North American Rail Alertness Partnership and the NIH Sleep Research Disorders Advisory Board. He is currently the Co-Chair of Operator Fatigue Management (OFM) Initiative through the DOT's Human Factors Coordinating Committee.

Judith Gertler has over 20 yr of transportation-related experience. Currently she manages the Human Performance and Operations Research Division at Foster-Miller. Since joining Foster-Miller in 1995 she has been involved in human factors research on a variety of railroad operational issues including training, worker stress and fatigue, and yard worker safety. She is currently managing a study of work schedules and sleep patterns of signalmen and maintenance of way employees. Earlier in her career she worked at the Volpe National Transportation Systems Center where she was involved with the early planning for improved rail service in the Northeast Corridor and grade crossing safety. She holds both a B.S. and M.S. from Carnegie Mellon University.

Frank Ferrara is the Deputy Chief Operations Services for Metro-North's Operations Control Center. He started his railroad career in 1974 as a telegrapher/leverman with Penn Central, Metro-North's predecessor railroad. Frank was promoted to train dispatcher in 1979 and chief dispatcher in 1989. In July 1993 he was promoted to Superintendent of Train Operations and in 2000 he was promoted to his current position which includes responsibility for all aspects of Metro-North's Control Center Operations.

Jayan Sen began his career with the BNSF in 1998. Since December 2003 he has been the Director Human Resources for BNSF's Powder River Division. He has been involved with all aspects of recruiting, testing, interviewing and selection as well as performance assessment. Jayan has also trained recruiters how to conduct behavioral structured interviews. Prior to joining the BNSF, he was a test and selection specialist for the Ball Foundation. While working at the BNSF Jayan has been completing the requirements for a Ph.D. in industrial-organizational psychology and he hopes to finish that process this coming December.

Jo Lynne Lehan hired out in 1977 off the former Missouri Pacific Railroad as an operator. She started dispatching trains in 1981 in Houston, Spring and Little Rock. In 1988 she became part of the implementation team to convert all the dispatching offices to the Computer Aided Dispatching system. Jo Lynne became a director in 1981 working the Southern, Central and Northern Regions at the Harriman Dispatch Center. While a director she was involved in the mergers with CNW and SP. In 1999 Jo Lynne became a Director of Network Operations leading the Service Restoration Process and QSP202 Curfew Process. This past February she was promoted to General Director Operations Support at the Harriman Dispatch Center.

Ron Vincent is the Vice-President for Customer Service/Marketing and Sales at the Portland & Western, which is a Genesee & Wyoming Company. In this position he is responsible for managing, designing and scheduling operational plans, including train movements. He began his career with the Portland & Western in 1997. Previously he held positions with the UP, the SP and the Denver & Rio Grande Western Railroads. Although the Portland & Western is part of a larger holding company, they manage their operation as if they were an autonomous short line railroad.

Stephen Popkin has been researching the effects of shiftwork and fatigue for the past 15 yr. Studying under Dr. Donald Tepas at the University of Connecticut, and at the Finnish Institute of Occupational Health, Steve focused his doctoral research efforts on the health and performance effects of irregularly scheduled locomotive engineers in the U.S. rail freight industry. He has spent the past several years studying the effects of fatigue and potential countermeasures for various transportation modes, including rail passenger and freight operations, commercial trucking, and pipeline dispatching. In addition, he co-chairs the DOT Human Factors Coordinating Committee's Operator Fatigue Management team. This team is responsible for overseeing the development of fatigue mitigating tools and disseminating information on fatigue-related initiatives and findings to the transportation enterprise.

Pat Sherry is a researcher at the University of Denver. Since receiving his doctorate from the University of Iowa in 1981, Pat has been involved in studies of fatigue, job stress, occupational safety, and human factors associated with job performance. His research projects have included railroad train dispatchers and job stress, a project that has been expanded to include the trucking industry.

Most recently, Pat has been involved in assessing and designing fatigue countermeasure programs for the railroad industry. Pat has conducted numerous studies and seminars for railroad personnel. He was responsible for developing the Dispatcher Aptitude Test that the Burlington Northern Santa Fe, Southern Pacific, Denver Rio Grande, and Montana Rail Link use in selecting dispatchers. In the early 90's he conducted a system wide training program in behavioral based safety for the BNSF. He is currently engaged in a project designed to determine the training and educational needs of transportation personnel for the next decade.

Tom Murphy is Director of the American Rail Dispatching Center which is located in St. Albans, VT. The ARDC was incorporated this past January and is a wholly-owned subsidiary of RailAmerica.

Tom began his affiliation with RailAmerica as a RAILTEX employee in 1998 where he filled a position as a train dispatcher for the New England Central Railroad (NECR). In 2000 he was promoted to Chief Dispatcher at the NECR, and was responsible for consolidating RailAmerica's Atlantic Region railroads into one center. Last January Tom was promoted to the Director of ARDC, where he is now responsible for the Center's daily operation, marketing, financial reporting and future growth. Prior to his employment with RailAmerica, Tom was a qualified dispatcher for the New York and Susquehanna Railroad in Cooperstown, NY. Tom holds an honors degree from the State University of New York at Brockport.

Since 1996 **Joern Pachl** has held the position of Professor of Railway Systems Engineering at the Braunschweig Technical University. From 1982 to 1984 he was a block operator and assistant train director at German Railways. In 1984 he began his study of transportation engineering. After receiving his degree he became a project manager for German Railways. He subsequently completed the requirements for a doctorate in engineering and began his teaching career. He is the author of several textbooks on railway operation, including one in English, *Railway Operation and Control*.

Commander Ed Wendlandt assumed the duties of Chief of the U.S. Coast Guard Vessel Traffic Services program in July 2002. Prior to his current assignment, he served as the Technical Director for the Coast Guard's Fleet Logistics System Project that developed the first enterprise-wide system, to automate the Coast Guard's Logistic cycle. From 1995 to 1998 Ed served as Executive Officer, Vessel Traffic Service Houston/Galveston, where he transformed its operations from a manual board to a state-of-the-market Vessel Traffic Management System.

Ed began his Coast Guard career as a deck watch officer and operations officer aboard a Coast Guard cutter. Following that assignment, he served as Commanding Officer of the cutter POINT ROBERTS, a patrol boat based in Mayport, FL where he conducted numerous Search and Rescue and Maritime Law Enforcement operations. He graduated from the U.S. Coast Guard Academy in 1985 and later earned an M.S. in Computer Sciences from the University of Central Florida.

Stephen Reinach is a Senior Engineer with Foster-Miller, where he has been studying railroad operations safety issues for the past 8 yr. He has supported or taken the lead on several research studies that have focused on railroad dispatchers, including the development of a set of recommended railroad dispatcher training objectives and model syllabi for the railroad industry, and the first railroad dispatcher workshop held in 1998. Most recently Stephen has been studying safety issues related to remote control locomotive operations, and has been working on developing a root cause analysis methodology that can be used by the railroad industry to learn more about the human factors contributions to train accidents and injuries. Stephen earned a B.S., Psychology at the University of Michigan and an M.S., Industrial Engineering at the University of Iowa.

Emilie Roth is a cognitive psychologist whose work has involved analysis of human problem-solving and decision-making in real-world environments, and the impact of support systems on performance.

For the past 5 yr, Emilie has been actively involved in performing cognitive task analyses of railroad dispatchers, locomotive engineers and roadway workers. Most recently she has been participating in a comprehensive study examining the potential impact of a new train control system on human performance and human error of train crews, roadway workers, dispatchers and mechanical maintenance personnel.

Since 1997 Emilie has operated her own company, Roth Cognitive Engineering. Prior to that she worked at the Westinghouse Science and Technology Center where she pioneered the application of cognitive work analysis methods and advanced visualization and representational aiding concepts to the design of first-of-a-kind systems. She received her Ph.D. in Cognitive Psychology from the University of Illinois at Champaign-Urbana.

Mary Townsend Lee is an Engineering Psychologist at the Volpe National Transportation Systems Center. She began working at the Volpe Center as a co-op student while earning her undergraduate degree in Engineering Psychology from Tufts University. After she graduated in 1997, Mary worked for a software company where her responsibilities included project management, design, and development of software applications, primarily for the credit card industry. In 2001, Mary returned to transportation and the Volpe Center. Her current work for FRA includes research on organizational safety at railroads, and the development of a computerized aid for railroad traffic planning.

Thomas Raslear is the Senior Human Factors Program Manager in FRA's Office of Research and Development. He is a member and former chair of the Department of Transportation's Human Factors Coordinating Committee. During his more than 11 yr at FRA, Tom has sponsored several of the dispatcher projects that were presented at this meeting. Tom earned a Ph.D. in experimental psychology from Brown University.

Leo McCann is currently serving his second term as President of the American Train Dispatchers Association. He has 30 yr experience in the railroad industry. Besides train dispatching; Leo has worked as a block operator, freight agent, intermodal supervisor, and Labor Relations officer. Railroading is an inherited trait in Leo's family. His father worked as a locomotive engineer for 42 yr and his grandfather performed service as a conductor for 50 yr. All three generations have their roots beginning with the Pennsylvania Railroad. Prior to becoming President, Leo also served as ATDA Secretary-Treasurer. While working as a train dispatcher in the Conrail Pittsburgh office, he held the positions of General Chairman, Vice General Chairman and Local Chairman.

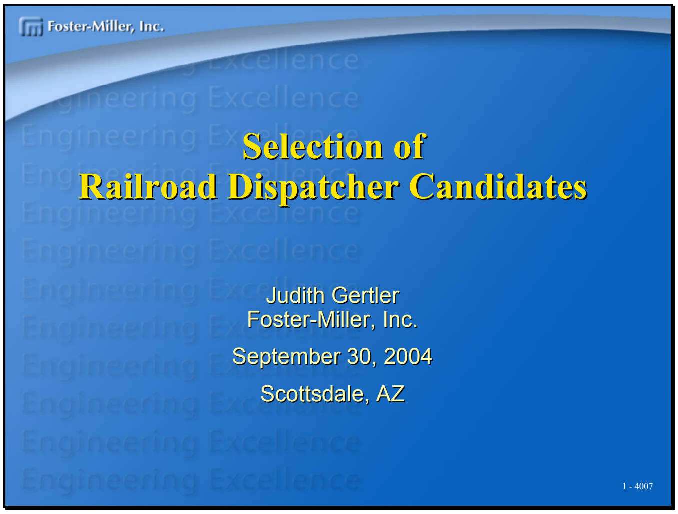
John Campbell has been with CSX since 1970 and has been involved with dispatching since 1974. He has held numerous operating positions including operator, clerical yardmaster, train dispatcher, chief dispatcher, and director. Currently he is General Manager of Dispatching in Jacksonville. John's current focus is on CSX's Next Generation Dispatching System.

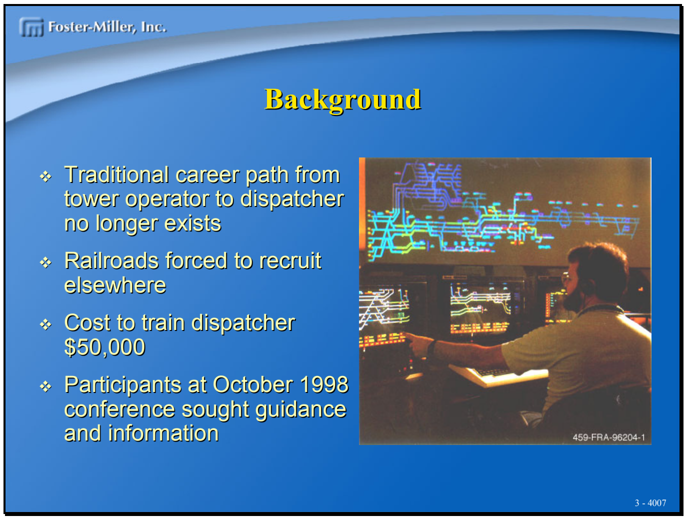
Carl Barneyback has worked in the railroad industry for 16 yr. Prior to joining the Indiana Harbor Belt Railroad, he was with the Santa Fe and the Chicago South Shore and Southbend. He has gone from pulling pins, wrestling with "armstrong" levers and dispatching with train orders to managing on of the busiest terminal traffic control office in the U.S. He currently manages the IHB Operations Center in Calumet City, IL, which is a joint facility with CSX. On a daily basis, this office handles thousands of rail movements of over a dozen rail carriers in the Chicago area.

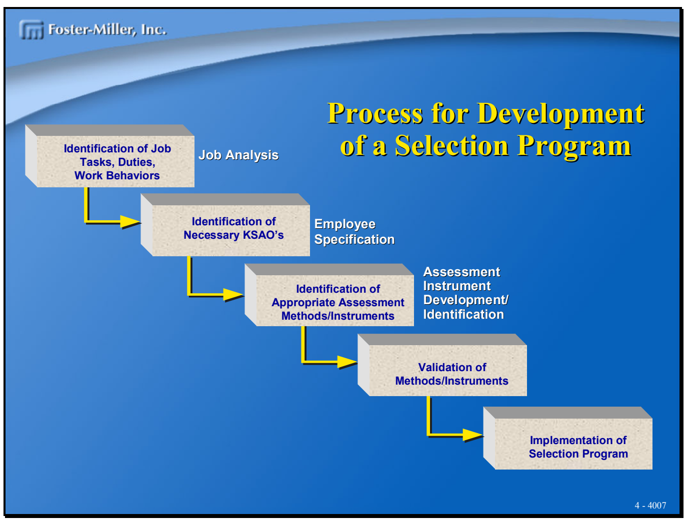
Gary Lettengarver began his railroad career with Penn Central as a Block Operator. In 1976, he was he was promoted to Train Dispatcher at Conrail, and held positions as Assistant Chief Dispatcher and Chief Dispatcher. From 1983 to 1992, he was a Station Master and then Supervisor of Operations at Chicago Union Station for Amtrak.

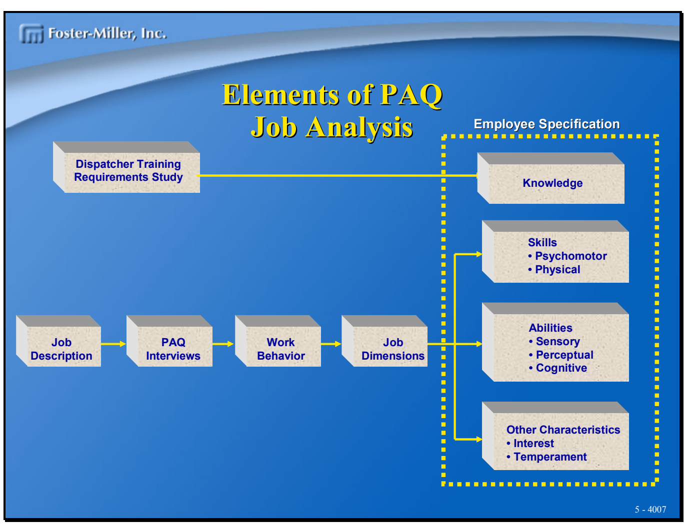
In 1992, Gary was selected as Superintendent of Dispatching for the soon-to-be commuter rail service, Metrolink. One of his proudest accomplishments is participating as a Metrolink team member working to meet the October 26, 1992 inaugural grand opening. He saw the system grow from one sub-division and one dispatching desk overseeing 12 daily trains on 32 mi of railroad to seven sub-divisions, four dispatching desks, overseeing more than 270 passenger and freight trains daily in a territory covering 512 mi in Southern California. Gary is the currently the Superintendent of Dispatching for the Southern California Regional Rail Authority which operates the Metrolink service in a six-county area.

Appendix D.
Speaker and Panelist Slides




Foster-Miller, Inc.
Background
Traditional career path from tower operator to dispatcher no longer exists
Railroads forced to recruit elsewhere
Cost to train dispatcher $50,000
Participants at October 1998 conference sought guidance and information
459-FRA-96204-1
3 - 4007


Foster-Miller, Inc.
Process for Development of a Selection Program
Identification of Job Tasks, Duties, Work Behaviors
Job Analysis
Identification of Necessary KSAO's
Employee Specification
Identification of Appropriate Assessment Methods/Instruments
Assessment Instrument Development/ Identification
Validation of Methods/Instruments
Implementation of Selection Program
4 - 4007


Foster-Miller, Inc.
Elements of PAQ Job Analysis
Employee Specification
Dispatcher Training Requirements Study
Knowledge
Skills • Psychomotor • Physical
Job Description
PAQ Interviews
Work Behavior
Job Dimensions
Abilities • Sensory • Perceptual • Cognitive
Other Characteristics • Interest • Temperament
5 - 4007

Foster-Miller, Inc.

Job Analysis
Distribution of Interviewees

Dispatching Operation	Number of Interviewees	Number of Interview Groups
Metro/North	6	2
Metra	3	1
Conrail Shared Assets	3	1
BNSF	24	8
Total	36	12

6 - 4007

Foster-Miller, Inc.

Knowledge Requirements

- High school degree
- Specialized knowledge typically learned on-the-job

7 - 4007

Foster-Miller, Inc.

Skill Requirements

Skill	Attribute
Psychomotor	Simple reaction time
Physical	None

8 - 4007

Foster-Miller, Inc.

Ability Requirements

Ability	Attribute
Sensory	Auditory acuity
Perceptual	Closure, perceptual speed, selective attention, time sharing
Cognitive	Short-term memory, long-term memory, intelligence, convergent thinking, divergent thinking, problem sensitivity, verbal comprehension

9 - 4007

Foster-Miller, Inc.

Other Characteristics

Characteristic	Attribute
Interest	Directing/controlling/planning, variety of duties
Temperament	Pressure of time, attainment of set standards, measurable/verifiable criteria, sensory alertness, conflicting/ambiguous information, working under specific instructions, social welfare

10 - 4007

Foster-Miller, Inc.

Highest Ranked Skills, Abilities, Other Characteristics

- Pressure of time (O)
- Attainment of set standards (O)
- Closure (A)
- Measurable, verifiable criteria (O)
- Perceptual speed (A)
- Sensory alertness (O)
- Selective attention (A)

11 - 4007

Foster-Miller, Inc.

Assessment Methods

Characteristic	Item	Method(s)
Knowledge	Railroading, dispatching	Interview Biodata questionnaire References
Skills	Psychomotor	Test
Abilities	Sensory - auditory	Test
	Perceptual	Interview References
	Cognitive	Test
Other Characteristics	Interest	Interview Test
	Temperament	Interview Test

12 - 4007

Foster-Miller, Inc.

Interviews

- Most suitable for assessing personal relations, good citizenship and job knowledge
- Effective interview must be structured *and* conducted by a skilled interviewer

13 - 4007

Foster-Miller, Inc.

Biodata Inventory

- Application blank collects job-related factual information from the candidate
- Each question weighted to reflect ability to differentiate good versus poor performers
- Items must deal with events under applicant's control
- Easy to administer
- Validation time consuming

14 - 4007

Foster-Miller, Inc.

Case Study Sites

Type	Railroad	Total Staff
Commuter	Metra	24
	Metro-North	52
	LIRR	33
Class I	BNSF	485
	UP	375
Shortline/Regional	Conrail Shared Assets	24
	Wisconsin Central	32

15 - 4007

Foster-Miller, Inc.

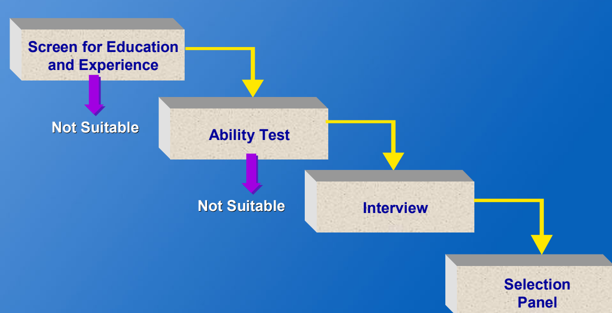
Successful Strategies

- Class 1's have dispatcher aptitude/screening test
- Metro-North developed test battery
- All use interviews and selection by committee consensus
- Internet job posting (UP)
- Pre-screen by testing for ability to learn railroad terminology(LIRR)

16 - 4007

Foster-Miller, Inc.

Overall Selection Procedure



17 - 4007

Foster-Miller, Inc.

Jobs Requiring SAO's Similar to Railroad Dispatcher

Industry	Jobs
Utilities	Gas dispatcher, service or work dispatcher, radioactive waste disposal dispatcher, cable dispatcher, oil dispatcher
Transportation	Bus and trolley dispatcher, traffic or system dispatcher, tugboat dispatcher, motor vehicle dispatcher, interstate bus dispatcher
Mining	Mine and quarry dispatcher
Protective Services	Alarm operator, radio dispatcher, protective-signal operator, telecommunicator

18 - 4007

Foster-Miller, Inc.

Recommendations

- Composite job analysis a starting point for organizations lacking resources to conduct job analysis
- Structured interviews preferable
- Use only *reliable* test instruments
- "Job preview" may help to assess "will do" characteristics of candidates
- Explore candidates in similar occupations in other industries

19 - 4007

Union Pacific
Hiring
and
Candidate
Selection Process

Retention Issues
Jan 1999- May 2004

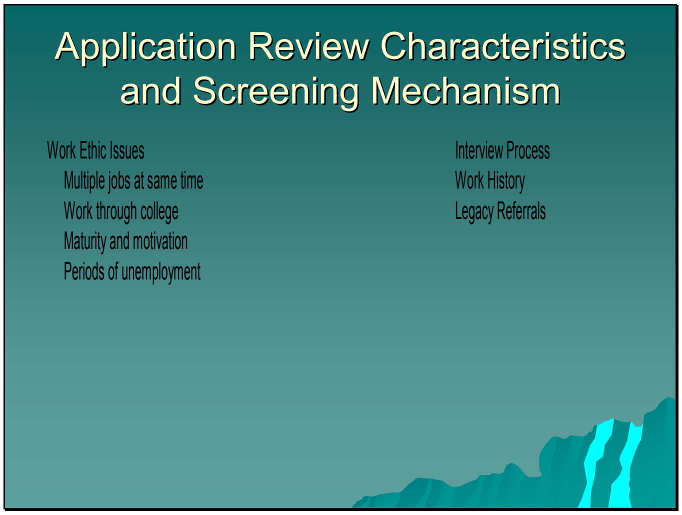
◆ Failure during training	8%
◆ Dismissal	7%
◆ Resign/Exercise Seniority	20%

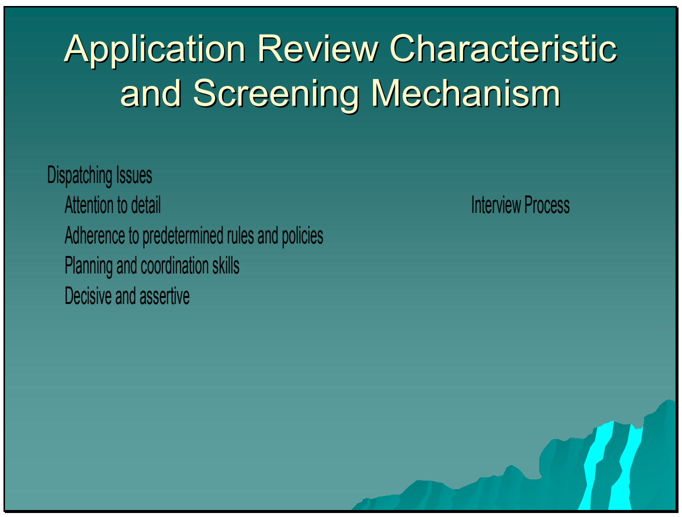
Application Review Characteristics and Screening Mechanism

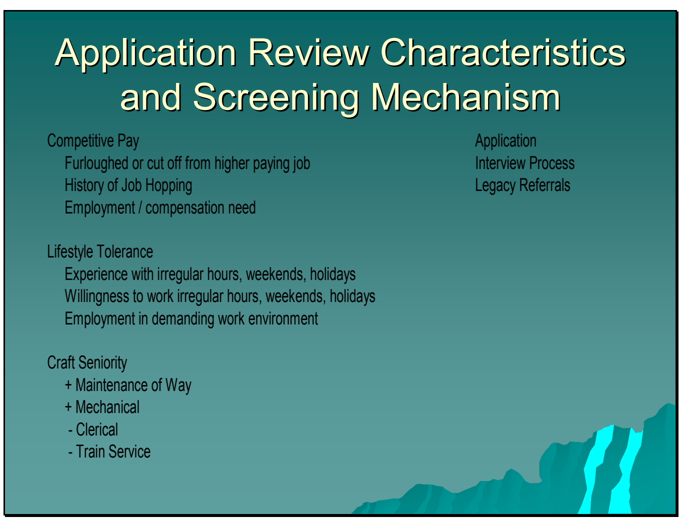
Experience
- Train Dispatcher or other railroad experience
- Air Traffic Control
- Military Logistics
- 4 Years Managerial Experience in any industry
- 4 Years Railroad Experience

Education
- BA or BS preferred
- Transportation, Logistics, Bus Admin, Economics preferred

Application
Preemployment Test
Interview Process


Application Review Characteristics and Screening Mechanism
Work Ethic Issues
Multiple jobs at same time
Work through college
Maturity and motivation
Periods of unemployment
Interview Process
Work History
Legacy Referrals


Application Review Characteristic and Screening Mechanism
Dispatching Issues
Attention to detail
Adherence to predetermined rules and policies
Planning and coordination skills
Decisive and assertive
Interview Process


Application Review Characteristics and Screening Mechanism
Competitive Pay
Furloughed or cut off from higher paying job
History of Job Hopping
Employment / compensation need
Lifestyle Tolerance
Experience with irregular hours, weekends, holidays
Willingness to work irregular hours, weekends, holidays
Employment in demanding work environment
Craft Seniority
+ Maintenance of Way
+ Mechanical
- Clerical
- Train Service
Application
Interview Process
Legacy Referrals

Candidate Hiring Process

- H.R. and HDC reviews & selects top candidates from internet applications
- H.R. administers Management test and selects top candidates to interview.

Candidate Selection Process

- Four MOTDS -Managers of Train Dispatchers and four Managers with Train Dispatching back ground or active Train Dispatchers make up the HDC interview team
- The HDC interview team interviews the top candidates selecting the best to become Apprentice Dispatchers

Territory Familiarization Process

Apprentice Train Dispatchers complete three months of class room training and three months of on the job training.

After completion of their on-the-job training, the employee will work for 4 to 6 weeks as a Train Dispatcher and then take a territory familiarization trip.

Railroad Dispatching Operations:
Putting Research into Practice

Railroad Dispatcher Workload, Stress and Fatigue

Stephen Popkin, Ph.D.

2004 September 30

This work was conducted by Foster-Miller under FRA Contract DTFR53-95-C-0049, Task Order No. 6

Background

- This was a larger, multi-year effort precipitated by:
  - Problems identified by FRA safety audits
  - Dispatcher-caused accidents
  - A concern for the dispatchers' health and well-being

  "***A Preliminary Examination of Railroad Dispatcher Workload, Stress, and Fatigue, DOT/FRA/ORD-01/08***"
- Goals of this project were to:
  - Identify sources of workload, stress and fatigue
  - Evaluate field methods to measure these outcomes

2

Presentation Topics

- Methodology
- Demographics
- Workplace Context
- Workload
- Stress
- Fatigue
- Conclusions

3

Methodology

U.S. Department of Transportation
Research and Special Programs Administration

Key Points

- Naturalistic field study
- No controls or manipulations
- Convenience sample
- Two locations involved
  - Freight (n=20)
  - Passenger (n=17)
- Data collected from all three shifts
  - Day: 7am-3pm
  - Evening: 3pm-11pm
  - Night: 11pm-7am

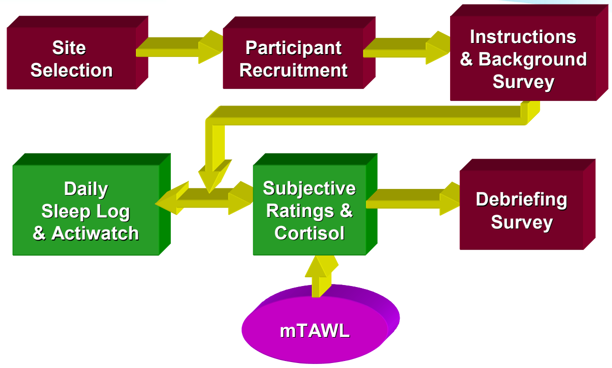
5

Measurement Instruments

Background Information →	**Survey**
Workload →	**Observation** **Dispatcher records** **Subjective ratings**
Stress →	**Cortisol measurement** **Subjective rating**
Fatigue →	**Actigraphy** **Sleep logs** **Subjective rating**

6

Procedure



7

Dispatcher Sample Demographics

U.S. Department of Transportation
Research and Special Programs Administration

Demographic Data

	Freight (n=20)	Passenger (n-17)
Sex (percent male)	90	76
Age (subjective)	43.5 (35)	43 (36.5)
Overweight [US - 64%]	74%	82%
Months at job	99.5	100
Percent moonlighting [US - 6%]	15	0
Percent married [US - 57%]	80	59
Children	1.5	1.6
Years of education	12 to 16	12 to 16

9

Employment Background

Position	Number
Block operators	11 (29.7%)
Railroad clerks	10 (27.1%)
Railroad operations	6 (16.2%)
Other railroad positions	3 (8.1%)
Non-railroad	**7 (18.9%)**

10

Dispatcher Health versus U.S. Norms

Rate per 1000

	Age Range	
	25 to 44 (n=26)	45 to 59 (n=11)
Anxiety	115.4 (126)	90.9 (126)
Asthma	0 (60.7)	0 (31.4)
Back pain	307.7 (42.4)	272.7 (110.3)
Depression	38.5 (50)	181.8 (50)
Gastrointestinal	38.5 (2.7 to 24.9)	90.0 (7.2 to 33.5)
Headaches	230.8 (21.8)	90.9 (31.7)
Heart disease	38.5 (24)	0 (143.1)
Hypertension	38.5 (34)	181.8 (233.2)
Skin disorders	153.8 (5.4 to 33.3)	0 (4.1 to 26.8)
Sleep problems	269.2 (350)	363.6 (350)

11

Workplace Context

U.S. Department of Transportation
Research and Special Programs Administration

Physical Environment

Factor	% Acceptable
Lighting	70 %
Noise	62 %
Temperature	57 %
Air Quality	49 %

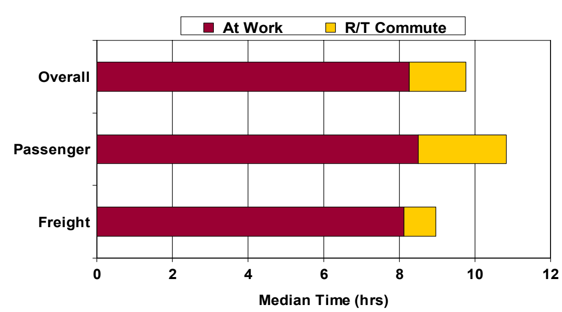
13

Work Period

- Majority (89%) scheduled to work five consecutive days
- Over half report working 8 hrs or more overtime per week
- Overall, 27% reported "expected to work overtime"

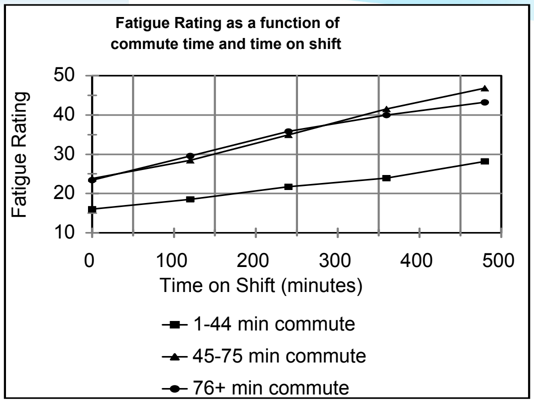
14

Work-Related Daily Time



15

Effect of Long Commute Time



16

Break Patterns

Breaks per shift (median)	**4**
Difficulty getting coverage	**65%**
Too busy for break **Occasionally** **Frequently**	 **57%** **41%**
Meals eaten at desk	**97%**

17

Volume and Pace of Work

	% Reporting Often or Very Often
Working fast	84%
Large volume of work	81%
Heavy concentration	95%
Heavy memory usage	97%
Lulls between heavy periods	22%

18

Work Performance

	% Often or Very Often
Bending rules to complete job	9 %
Assignments without support	14 %
Comprehension of work expectations	86 %
Able to handle emergencies	95 %

19

Workplace Control Issues

Factor	% Reporting Moderate or High Level of Control
Work quality	97 %
Task ordering	81 %
Number simultaneous tasks	57 %
Work pace	43 %
Policy decisions	16 %

20

Workload

U.S. Department of Transportation
Research and Special Programs Administration

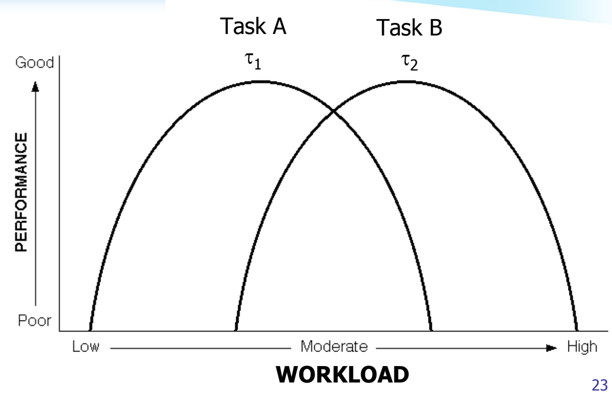
Contributors to Dispatcher Workload (FRA, 1995)

- Number of trains handled
- Number of authorities issued
- Number of control points in territory
- Total track miles

- Number, type and effectiveness of communications
- Methods of operation
- Administrative duties and paperwork

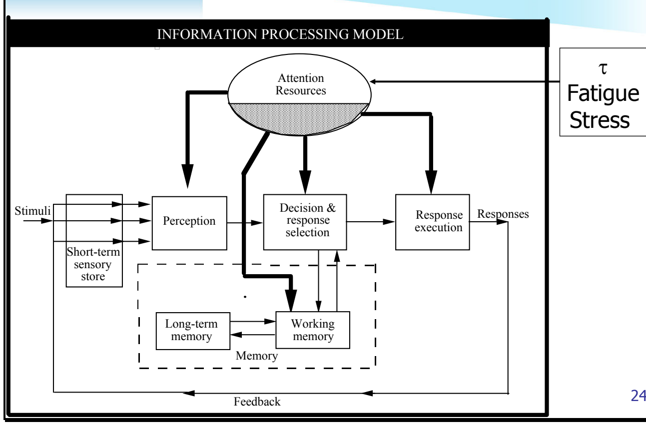
22

Yerkes-Dodson U (1908)



23

Wickens Attention Model (2002)



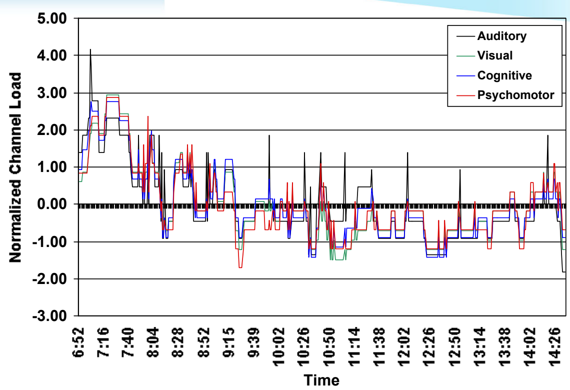
24

mTAWL Channel Loadings

		Channels			
		Auditory	Visual	Cognitive	Motor
Background auditory monitoring	F	1	0	0	0
	P	2	0	0	0
Background visual monitoring	F	0	1	1	0
	P	0	2	0	0
Background radio/telephone	F	3	1	2	2
	P	4	1	2	1
Foreground radio/telephone	F	3	1	2	2
	P	3	1	3	1
Background clerical	F	0	2	2	6
	P	0	2	2	3
Planning for unopposed track movement	F	1	1	1	1
	P	1	1	2	0
Handling unopposed track movement	F	1	1	1	1
	P	1	2	2	2
Planning for opposed track movement	F	1	1	3	1
	P	2	1	3	0
Handling opposed track movement	F	1	1	3	2
	P	3	1	3	2
Foreground clerical	F	0	2	2	6
	P	2	2	3	5

25

Passenger Dispatcher mTAWL Workload Across Shift

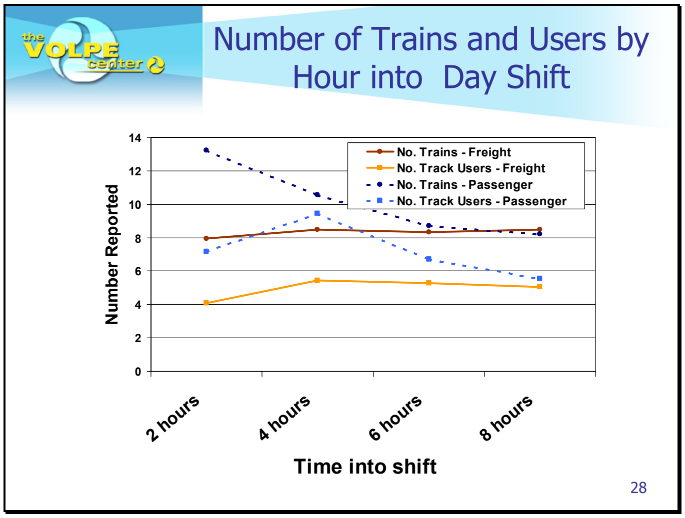


26

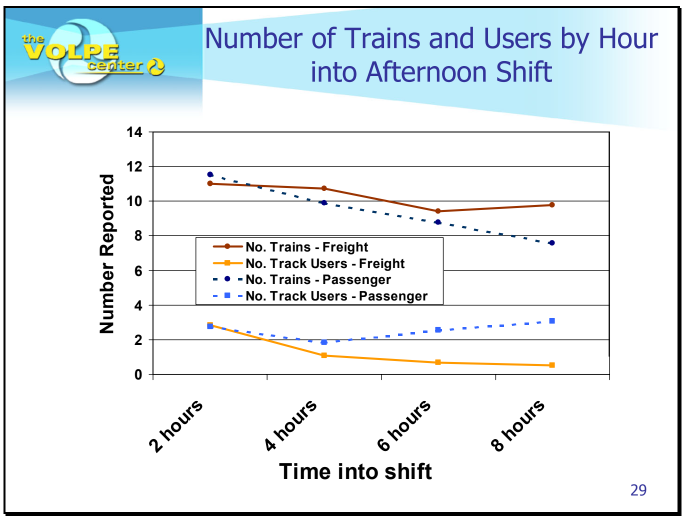
Passenger mTAWL Overload Rating by Desk

Date	Shift	Desk	% of Time Overloaded within Shift	% of Time Overloaded Across Desks
14 Sep	1	1	4.5%	0.0%
15 Sep	1	2	0.0%	0.0%
16 Sep	1	3	6.7%	21.0%
17 Sep	1	2	4.0%	0.2%
18 Sep	1	4	1.0%	1.3%
19 Sep	1	5	2.5%	0.0%
20 Sep	1	5	2.6%	0.0%
21 Sep	1	6	2.1%	4.2%
22 Sep	1	1	7.5%	0.0%
23 Sep	2	2	0.9%	0.0%
24 Sep	2	4	0.0%	0.0%
25 Sep	3	7	4.5%	0.0%

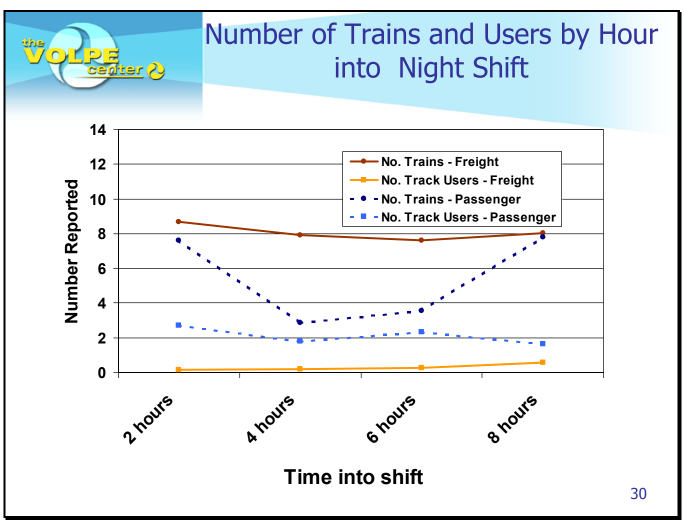
27



the VOLPE center
Number of Trains and Users by Hour into Day Shift
14
12
10
8
6
4
2
0
Number Reported
No. Trains - Freight
No. Track Users - Freight
No. Trains - Passenger
No. Track Users - Passenger
2 hours
4 hours
6 hours
8 hours
Time into shift
28

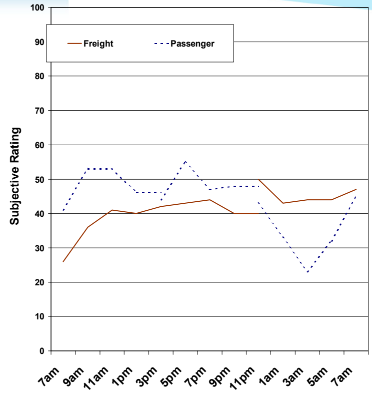


the VOLPE center
Number of Trains and Users by Hour into Afternoon Shift
14
12
10
8
6
4
2
0
Number Reported
No. Trains - Freight
No. Track Users - Freight
No. Trains - Passenger
No. Track Users - Passenger
2 hours
4 hours
6 hours
8 hours
Time into shift
29



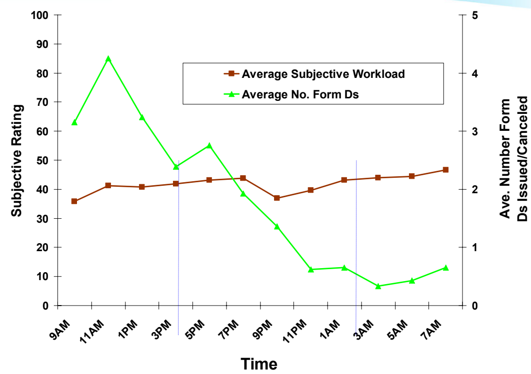
the VOLPE center
Number of Trains and Users by Hour into Night Shift
14
12
10
8
6
4
2
0
Number Reported
No. Trains - Freight
No. Track Users - Freight
No. Trains - Passenger
No. Track Users - Passenger
2 hours
4 hours
6 hours
8 hours
Time into shift
30

Subjective Workload



31

Freight Form Ds and Subjective Workload Across 24 Hours



32

Workload Conclusions

- mTAWL appears to be a possible metric for documenting a desk suspected of having a workload imbalance
- Subjective feelings of workload seem independent of number of Form Ds, route blocks, and number of train and track users handled
- Subjective workload measurements did not reveal perceptions of excessively high workload in the aggregate

33

Stress

U.S. Department of Transportation
Research and Special Programs Administration

NIOSH (1995)

- 40% of workers reported their job was very or extremely stressful;
- 25% view their jobs as the number one stressor in their lives;
- 29% of workers felt quite a bit or extremely stressed at work;
- 26 percent of workers said they were "often or very often burned out or stressed by their work";
- Job stress is more strongly associated with health complaints than financial or family problems.

35

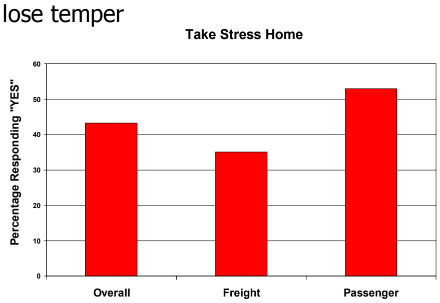
Gallup (2000)

- 80% of workers feel stress on the job, nearly half say they need help in learning how to manage stress and 42% say their coworkers need such help;
- 14% of respondents had felt like striking a coworker in the past year, but didn't;
- 25% have felt like screaming or shouting because of job stress, 10% are concerned about an individual at work they fear could become violent;
- 9% are aware of an assault or violent act in their workplace and 18% had experienced some sort of threat or verbal intimidation in the past year.

36

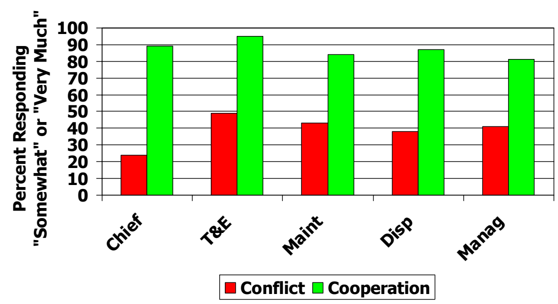
Evidence of Workplace Stress

- 73% “rarely” or “never” lose temper at work
- 92% reported other dispatchers “sometimes” or “frequently” lose temper



37

Level of Dispatcher Conflict and Cooperation



38

Dispatchers’ Subjective Responses and Behaviors

- Nearly all (97%) felt “a great deal” of responsibility
- 43% reported “a lot” or “a great deal” of anxiety
- 63% “never” or “rarely” called in sick due to stress

39

Sources of Dispatcher Stress (FRA, 1995)

- Work overload or surges
- Juggling maintenance and traffic
- Ambiguous rules and procedures
- Inconsistent application of rules
- Safety responsibilities
- Threat of relocation
- Radio interference
- Training
- New technology

40

Source of Stress by Type of Operation

✓=30%, ✓✓=40%, ✓✓✓=50+%

Factor	Overall	Freight	Passenger
Management Policies	✓		✓✓
Demands of T&E and MOW crews		✓	
Personality conflicts with T&E and MOW crews			✓✓
Amount of work	✓	✓	
Difficulty of work		✓	
Pace of work	✓✓	✓✓✓	
Lack of control		✓	
Surges in workload		✓	
Juggling T&E and MOW needs	✓✓	✓✓✓	
Quality of workstation and equipment			✓✓
Communication problems	✓		✓✓✓
Unnecessary phone calls			✓✓
Duplicate reporting procedures		✓	
Training new dispatchers		✓✓	

41

Sources of Stress by Job Tenure

✓=30%, ✓✓=40%, ✓✓✓=50+%

Factor	Overall	< 2 yrs	2 to 5 yrs	> 5 hrs
Management Policies	✓		✓	✓✓
Demands of T&E and MOW crews			✓	✓
Personality conflicts with crews		✓✓✓	✓	
Personality conflicts with other dispatchers			✓	
Amount of work	✓		✓✓✓	✓
Pace of work	✓✓		✓✓✓	✓
Lack of control				✓
Emergencies			✓✓✓	
Surges in workload			✓✓✓	✓
Juggling T&E and MOW needs	✓✓			✓✓✓
Loss of sleep			✓✓✓	
Physical environment		✓	✓	
Quality of workstation and equipment		✓✓✓		✓
Communication problems	✓	✓		✓
Unnecessary phone calls			✓✓✓	✓
Duplicate reporting procedures			✓✓✓	✓

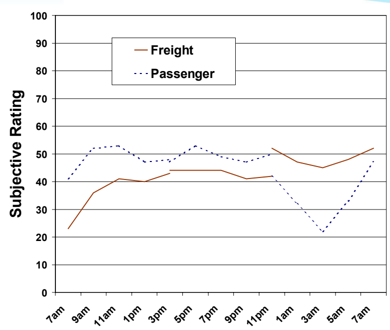
42

Self-Reported Contributors to Job Stress

- No rest breaks
- Always working with a different crew
- Number of concurrent tasks
- Equipment design and failure
- Emergencies and unexpected events
- Office environment
- Personality conflicts
- Training
- Management meddling

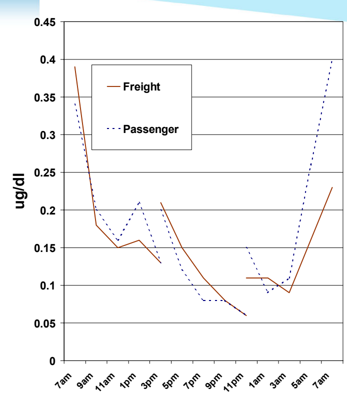
43

Subjective Time Pressure



44

Salivary Cortisol Levels by Operation and Shift



45

Stress Conclusions

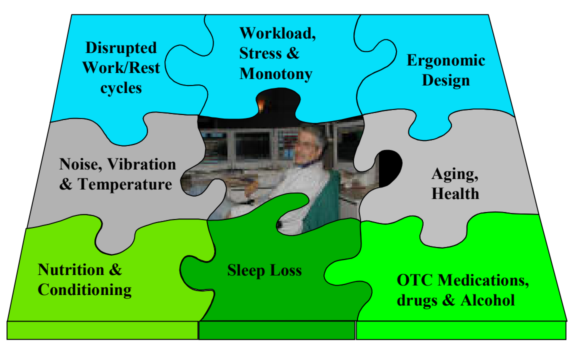
- Most reported stressors not directly related to workload
- No physiological indication of heightened stress*
- Subjective stress generally increases through shift, though never reaches top quartile

46

Fatigue

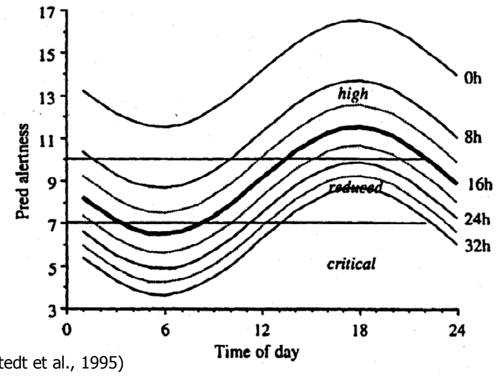
U.S. Department of Transportation
Research and Special Programs Administration

Fatigue Puzzle



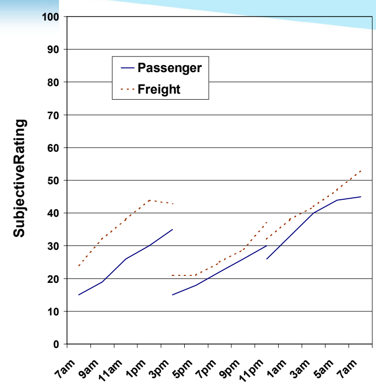
48

Influence of Time of Day and Time Awake on Alertness

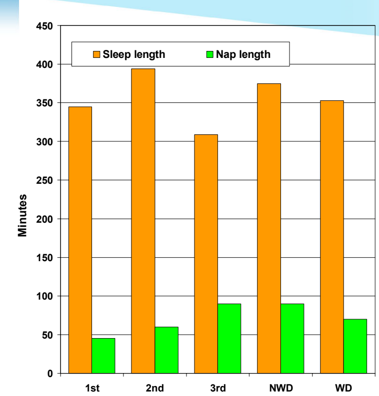


(Åkerstedt et al., 1995)

Subjective Fatigue



Daily Sleep Patterns



Rate and Frequency of Sleep-Related Problems

	Shift				
	D	A	N	X	O
Problem falling asleep (%yes)	33	33	40	27	32
Frequency of problem (days/week)	2.5	4	2	2	2
Problem with frequent awakenings	33	33	60	46	46
Frequency of problem	5.5	4	5	2	4
Problem with early awakenings	33	33	60	27	35
Frequency of problem	5.5	2	3	3	3
Frequency of waking up tired: Workdays	33	17	80	36	41
Non-workdays	33	17	40	9	22

52

Fatigue Conclusions

- Cumulative subjective fatigue throughout all shifts
- Sleep patterns typical of other shiftworkers
- No evidence of significant acute sleep debt
- Napping strategy employed by majority of night shift

53

Overall Conclusions

- Workplace stress appears to be function of not only volume of work but also environmental and interpersonal issues
- While observed levels of stress and fatigue are characteristic of shift workers, there is evidence of consistently increasing levels throughout all shifts
- Due to location specific characteristics and limited sample size, results may not be representative of US dispatcher population

54

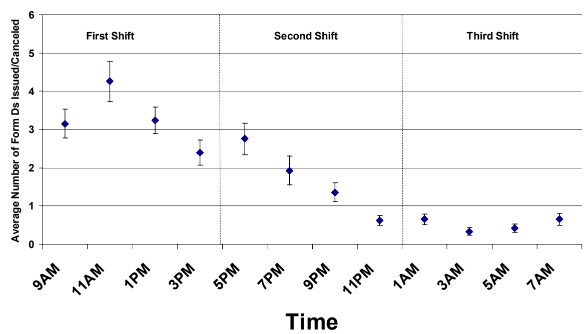
Possible Next Step

Team Cognitive Task Analysis

Thordsen & Klein (1989) have suggested "[one can] consider a team as an intelligent entity. Teams possess information, make decisions, solve problems, and develop plans"

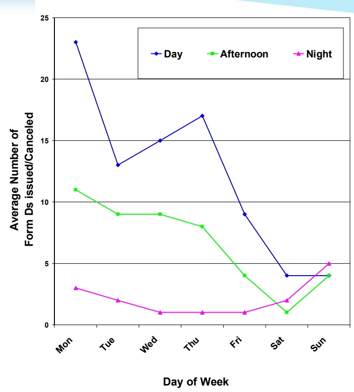
55

Freight Form Ds Across 24 Hours



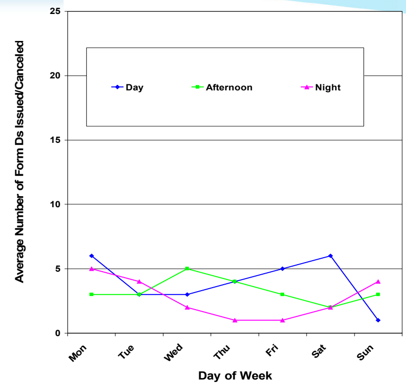
57

Freight Form Ds Across Week



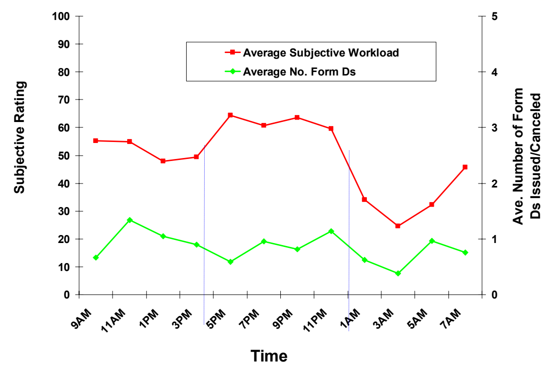
58

Passenger Form Ds Across Week



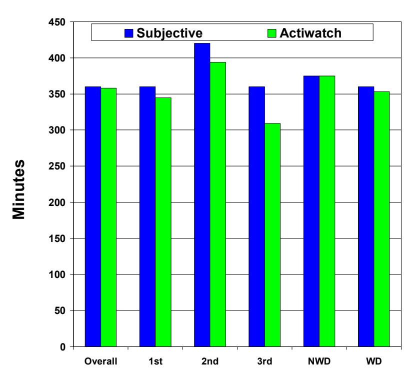
59

Passenger Form Ds and Subjective Workload Across 24 Hours

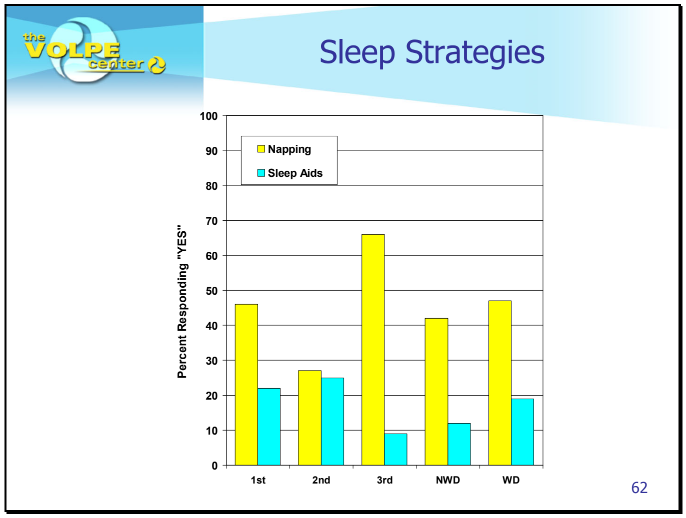


60

Sleep Length



61



Sleep Strategies
Napping
Sleep Aids
Percent Responding "YES"
100
90
80
70
60
50
40
30
20
10
0
1st
2nd
3rd
NWD
WD
62

Using Actigraphs to Improve Sleep Hygiene with Dispatchers

Patrick Sherry, Ph.D.
University of Denver
September 2004

1

- This research was supported by a grants from the FRA Office of Safety, the National Center for Intermodal Transportation, and the Burlington Northern Sante Fe.

2

Background

- Studying Dispatchers since 1990
- First Dispatcher Aptitude Tests (1991)
- Job Stress in Dispatchers (Weller, 1992)
- Fatigue in Dispatchers (Sherry, 1997)
- Self-efficacy & Job stress (Diem & Sherry, 2003)

3

The Experience

4

An email

- I am doing fine. I personally do not feel my fatigue level has changed. Mainly because my job has changed and being on a swing shift, 2 days 0700-1500, 2 days 1500-2300 and the third day either 1500-2300, or 2300-0700. It is difficult with that kind of schedule to get into any sleeping pattern. I fall asleep around seven or eight at night when I have to work the early shift, then try and stay up late my second day of early shift so I can work the evening shift the next day. If I don't stay up late, I get up at the crack of dawn, then too tired to work seconds. If I have to work the third shift my last day, I don't get much rest that day at all. I try to take a nap in the afternoon, but am seldom able to. Therefore, the first day of my days off, I spend sleeping. I am almost 60 years old now, and it is not natural to spend the night staying up all night. Therefore, on Saturday, after sleeping most of Friday, I feel drugged and am not able to accomplish anything at home. So, I don't ever feel like I have any days off. I am changing jobs again, going back to straight second shift with weekends off, so hopefully, I can get more rest.

5

Project Objectives

6

Objectives

- Continue developing ways to implement Actigraph technology as a fatigue countermeasures
- Provide an intervention tailored to personnel not in the road/train service
- Work more closely with management/supervisors in fatigue management
- Integrate coaching with feedback technology

7

Objective Measures

- Actigraphs enable an objective assessment of the hours of sleep obtained by individuals in a study.

8

Sample Characteristics

- Dispatchers volunteered for project
- Began with 4 women and 31 (88%) men
- Finished with 2 women and 18 men (90%)
- Several people from each shift
- Majority from third shift

Shift worked

		Frequency	Percent
Valid	First	8	22.9
	Second	5	14.3
	Third	12	34.3
	Variable	7	20.0
	Extra	3	8.6
	Total	35	100.0

9

Amount of Sleep

- Examining the statistics we can see that on the average
  - Day shift received 5.51 hours of sleep
  - Night shift received 6.48 hours of sleep
- People who volunteered for the study may have had more sleep issues than the average persons

10

Report

epp

Shift worked	Mean	N	Std. Deviation
First	10.8750	8	5.46253
Second	9.2000	5	4.91935
Third	9.7778	9	4.60374
Variable	10.2857	7	3.81725
Extra	9.0000	3	3.60555
Total	10.0000	32	4.40674

11

Report

epp

shift_3	Mean	N	Std. Deviation
1.00	10.8750	8	5.46253
2.00	9.2000	5	4.91935
3.00	9.7778	9	4.60374
4.00	10.2857	7	3.81725
Total	10.1034	29	4.52252

No difference between shifts on Eppworth at T1

12

Project Design

Feedback, identify goals, ask "How will you use the information?

Feedback, identify goals, ask "How will you continue to change?

T1

Baseline Wear Regular Actigraph Watch (30 days)

T2

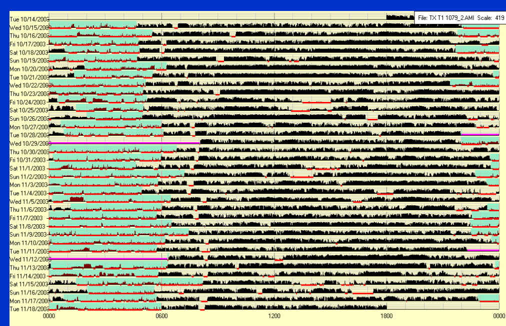
Wear Performance Feedback Watch (30 days)

T3

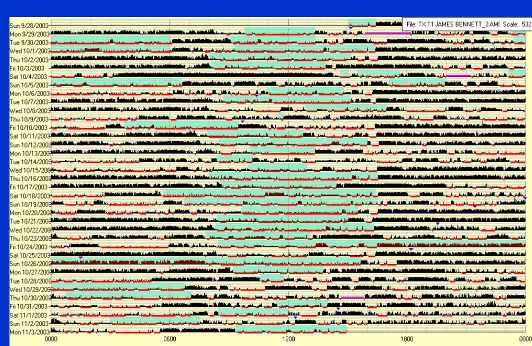
Wear Regular Actigraph Watch (30 days)

Coaching Protocol

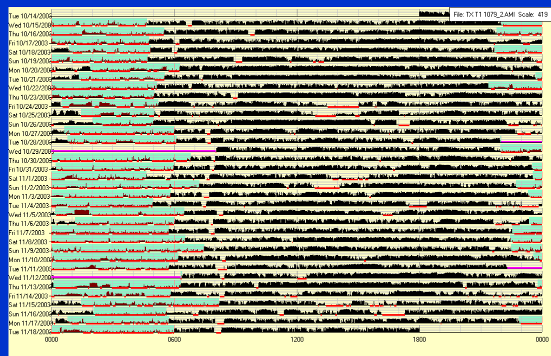
Provide Feedback from BASELINE Actigraphs



Third Shift Actigraph



Supervisor Actigraph



16

Coaching Intervention

- Identify areas in need of improvement
- Identify one goal to address
- Discuss ways to make changes
- Discuss how use the information from the watch

17

Evaluation

- Average amount of sleep for 30 day period
- Repeated measures analysis
- Self-report data
- Qualitative data - testimonials

18

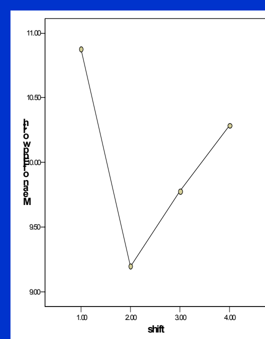
Drop Outs

- No differences in severity of sleep issues between initiators and completers at pre-test.
- People who stayed in the study were more likely to report that they had NOT had significant changes in their sleep habits recently. Drop outs reported more more recent changes in sleep habits.

19

Pre-test

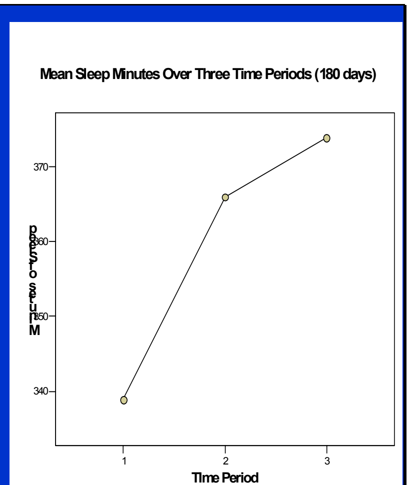
- No significant difference between groups on severity of sleep concerns



20

Results – Overall

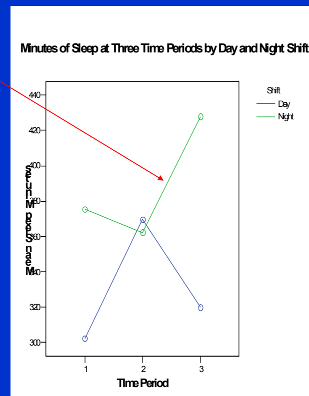
- For both shifts combined the average amount of sleep increased by 10% overall
- ns



Results-
for Minutes of Sleep

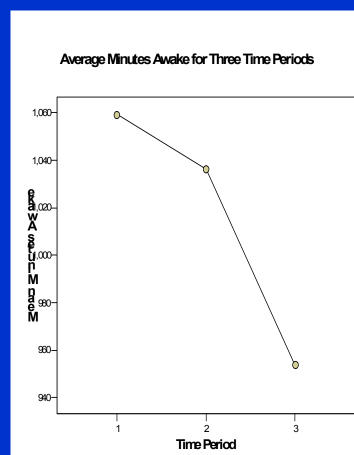
Night Shift

- Combined first and second shifts into DAY
- Looks like the day shift improved from T1 to T2 and then went back to T1 level
- Night shift seemed to change very little and then improve
- May be important to study habit change in different shifts



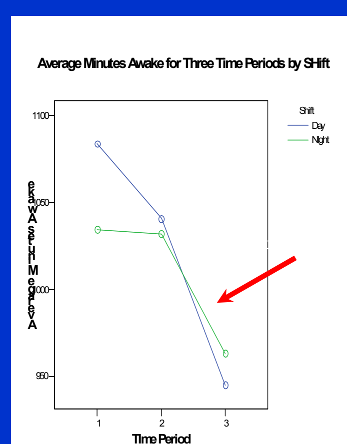
Results-
Wake Minutes

- Minutes awake decreased somewhat over the three time periods for all participants by 10%
- ns



Results –
Wake Minutes

- **Minutes of Wakefulness decreased (not statistically significant-univariate) after dispatchers wore the performance actigraphs and then again after wearing the non-performance actigraphs**



Third Shift Only

- A large but non significant improvement of over 12% in amount of sleep obtained.
- Variability is large due to small sample size.

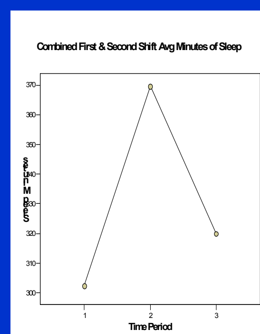
Descriptive Statistics (hrs)

	Mean	Std. Deviation
t1Sleep Minutes	6.26	.940
t2 Sleep Minutes	6.04	1.190
t3 Sleep Minutes	7.13	2.770

25

Combined First & Second Shifts

- Found a significant 22% increase in the amount of sleep from 5 hrs to 6.2 hrs of sleep between T1 and T2
- But returns to only 5% to 5.3 hrs at T3
- Only 6 people



26

Some Limitations

- Self-selection – drop outs initially more concerned with changes in sleep behavior
- Small sample size -> low power, high variability
- Night shift more interested – 3rd shift recognizes that they have sleep issues
- "never felt rested"
- Night more motivated to change (??)

27

Accuracy of the feedback numbers

- This question assessed whether the participants felt that the number on the performance feedback watches accurately reflected how tired or rested they felt.
  - 44.5% of participants felt that the numbers were accurate most of the time
  - 44.5% felt as though the numbers were not accurate most of the time
  - 11% felt as though the numbers were accurate some of the time

28

Liked Best

29

Best aspects of the watch

- 100% stated that they liked how the performance watches made them more aware and more conscious of their fatigue levels. When asked what additional effects an increased awareness had on their behavior, 60% stated that they were more apt to do things to counter their fatigue and get more rest.

30

Benefits

31

How helpful - One to five

32

Helpfulness Performance Watch

- Participants rated how helpful they felt the feedback information was in allowing them to manage their fatigue
- 56% felt as though it was somewhat to very helpful
- 44% felt as though it was not helpful
- Of the 56% who found it to be somewhat to very helpful, 60% worked third shift, 30% worked 1st shift, and 10% worked 2nd shift

33

Improvements

Needed Improvement

- 100% suggested making it more comfortable
- more stylish
- A beeper
- 50% suggested increasing accuracy and precision of performance numbers

35

Sleep Disorders

36

Main symptoms of Apnea

37

Benefits of CPAP

38

Summary

- when the participants felt as though the watch was accurate, they were more inclined to use the feedback number along with the fatigue countermeasures to manage their fatigue. For many this consisted of doing things that they previously were not doing and as a result they found the watch and coaching sessions to be helpful in alleviating fatigue.
- Others were already using various countermeasures to combat fatigue and for most of these individuals the performance watch did not provide any additional assistance in enhancing fatigue management. These were also individuals who reported fewer problems with fatigue in the first place.
- A third group of individuals likely felt some concerns about fatigue and the sleep watch was able to confirm or disconfirm their fears
- Seems to be useful for a little less than half the population

39

Lessons

- Improved the coaching and education
- Identified better measures
- Identified characteristics of likely candidates
- Watch issues
- Model issues

40

Next Steps

- Address higher risk population
- Increase power

41

American Rail Dispatching Center

"The 21st Century Short Line Dispatching Center"

AMERICAN RAIL DISPATCHING CENTER

Foster-Miller

ARDC – Why 21st Century?

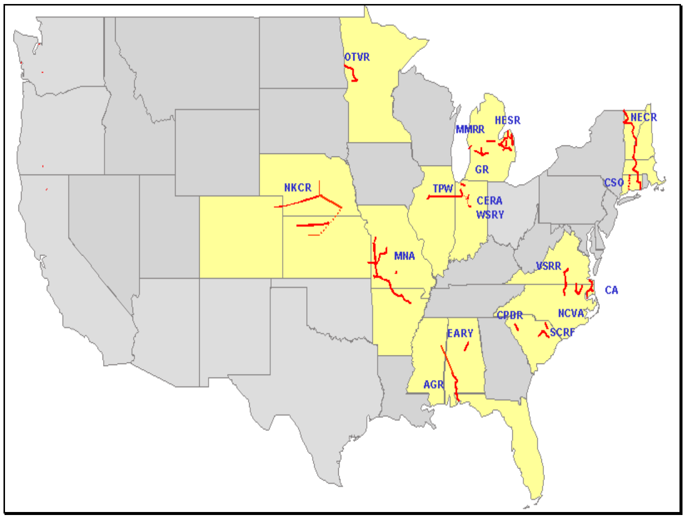
- ARDC "Who we are and what we do"
  - Stats - Continuity in procedures
- Safety
  - Emergency Response and Preparedness
- Control System – Dispatch Office Controller DOC®
- Weather Alertness – Advanced Warnings
- Radio & Telephonic Communication (recorded)
- ARDC Safety and Service Driven

ARDC "Who we are and what we do"

- ARDC Dispatches 17 railroads:

  NECR – TP&W – AGR – EARY – OTVR – C&A – NCVA – VSRR – SCRF – CPDR – CSO – MNA – WSRY – CERA – MMRR – HESR - NKCR

- Traffic Controlling for 3,000 miles
- In 19 separate U.S. States
- 500,563 Car Loads Annually
- 150 Crew Starts Per/Day
- Experienced Dispatchers – CTC, TWC, ABS, Yard Control



Our Class I Partners

- CSXT – Palmer, MA
- CN – East Alburg, VT
- CSXT – W.Springfield, MA
- CSXT, Boykins, VA
- CN/IC – Mobile, AL
- CSXT, Florence, SC
- CSXT – Laurens, SC
- CSXT – Talladega, AL
- NS – Sylacauga, AL
- BNSF – Fargo, ND
- BNSF – Sterling, CO
- BNSF – Holdrege, NE
- CSXT – Mobile, AL
- NS – Peoria, IL
- NS – Logansport, IN
- UP – Newport, AR
- UP - Kansas City, MO
- BNSF – Lamar, MO
- BNSF – Joplin, MO
- BNSF – Aurora, MO
- NS – Mobile, AL
- NS – Chesapeake, VA
- BNSF – Galesburg, IN
- NS – Burkeville, VA
- CSXT – Lafayette, IN
- NS – Marion, IL
- CSXT – Saginaw, MI
- CN – Durand, MI
- CSXT – Hybart, AL
- UP – Watseka, IL
- UP – East Peoria, IL
- NS – Kimbrough, AL
- KCS – Joplin, MO
- CN/IC – Gilman, IL
- CSXT – Atmore, AL
- NS – Demopolis, AL
- BNSF – Columbus, MS
- Short lines

ARDC in the News

B.C.D. 04-29

May 27, 2004

EMPLOYER STATUS DETERMINATION
American Rail Dispatching Center, Inc.

This is the determination of the Railroad Retirement Board concerning the status of American Rail Dispatching Center, Inc (ARDC) as an employer under the Railroad Retirement Act (45 U.S.C. § 231, et seq.) (RRA) and the Railroad Unemployment Insurance Act (45 U.S.C. § 351, et seq.) (RUIA).

Mr. Gary Laakso, Vice President and Regulatory Counsel, ARDC, advised that ARDC commenced service on January 1, 2004. He stated that ARDC is a wholly-owned subsidiary of RailAmerica Transportation Corp., a wholly-owned subsidiary of RailAmerica, Inc..[1] Neither RailAmerica Transportation Corp. nor RailAmerica, Inc. are employers covered under the RRA and RUIA. ARDC provides dispatching services to railroad customers, which services include emergency incident reporting, written records of train movements and issuance of track warrants to train crews. These services are provided to thirteen railroad employers, all except one of which are owned by RailAmerica, Inc.. ARDC has no Surface Transportation Board authorization.

Section 1(a)(1) of the Railroad Retirement Act (45 U.S.C. § 231(a)(1)), insofar as relevant here defines a covered employer as:

(i) any carrier by railroad subject to the jurisdiction of the Surface Transportation Board under part A of subtitle IV of title 49, United States Code;

(ii) any company which is directly or indirectly owned or controlled by, or under common control with, one or more employers as defined in paragraph (i) of this subdivision, and which operates any equipment or facility or performs any service (except trucking service, casual service, and the casual operation of equipment or facilities) in connection with the transportation of passengers or property by railroad * * *.

-2-

Sections 1(a) and 1(b) of the Railroad Unemployment Insurance Act (RUIA), 45 U.S.C. 351(a) and (b), contain substantially similar definitions, as does section 3231 of the Railroad Retirement Tax Act (RRTA), 26 U.S.C. 3231.

ARDC is clearly not a carrier by railroad. However, because ARDC is a wholly-owned subsidiary of RailAmerica Transportation Corp., which is a wholly-owned subsidiary of RailAmerica, Inc., and because RailAmerica, Inc. owns or controls almost all the railroads which ARDC services, ARDC is under common control with a railroad employer. The evidence demonstrates that the service

Michael S. Schwartz

V. M. Speakman, Jr.

ARDC Procedures

- Continuity in procedures and operating practices (short line vs. Class I resources):
  - Bulletins
  - Track warrants/Track and Time
  - Radio Communication
  - Rules compliance
    - For dispatchers and other short line employees
- CFR 228.17 – Ensure these standards are met
- Documentation and Reporting – short lines behind Class I industry
- Safety and Efficiency are a result

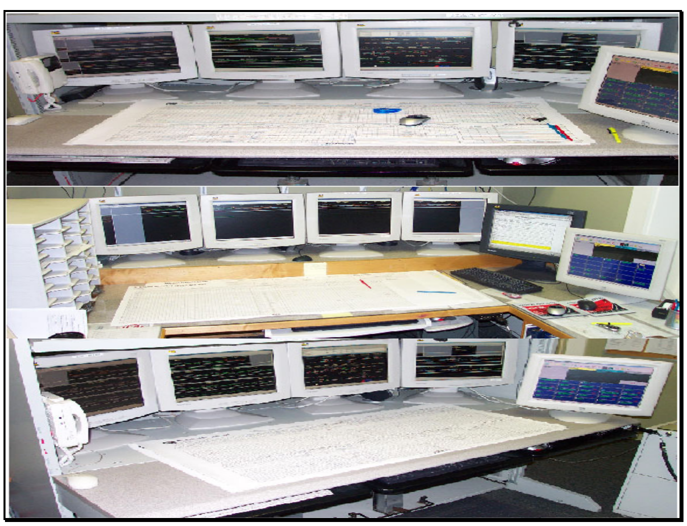
Safety – Emergency Response and Preparedness

- **ZERO** Reportable Injury (mentality)
- **ZERO** FRA Reportable Incidents
- 24-hour/365 Days a Year Emergency and Safety Coverage
- RA Hotline (50+ Railroads)
- AAR – ASLRRA
- First Response Program (Biannual)
- Emergency Training (OLI – GCCI – Continuing Education)
- Efficiency Testing (A.R.D.C.O.T.C.P.)
- Full Compliance and Strong Relationship with FRA (9-24-01)
  - "The ARDC is as professional as any Class I dispatching center today."

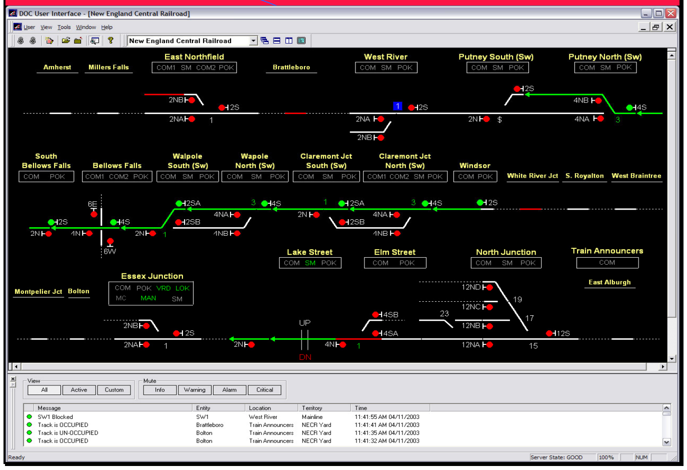
Control System

- ARDC had specific criteria
  - Redundant Back-up (duel servers)
  - Full Conflict Checking and Validation Logic (mission critical)
  - TWC – CTC (and mixed territory) – Yard Control – Single system
  - GCOR (including track bulletins A-B-C)
  - Additional modules:
    - Train Sheets (CFR228.17) – TSR – OOS – AMWDM/OOS – Etc…
  - Supports minimum of 5 workstations
  - Microsoft Windows Operating System

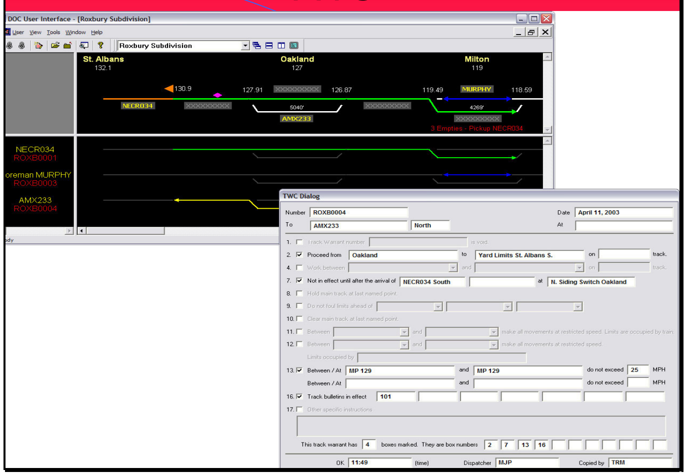
- **Scaleable platform** - full-featured desktop applications, and complex networked system applications
- **Extensible platform** - supports future application growth without re-designing core
- **Expandable platform** - supports increasing network size without compromising performance
- **COTS** - utilizes commercially available hardware components, no proprietary equipment
- **Open Standards** - supports database,3rd party integration through open architecture (ie. SQL)
- **Graphical Designer Tools** - ability to modify applications without specialized training
- **System Administration Tools** - System Administrator may configure application functionality including security settings, user interface attributes, logic and rules (non-safety)
- **Seamless Expansion** – Must be expandable internally TWC / CTC / SCADA /Yard system



CTC



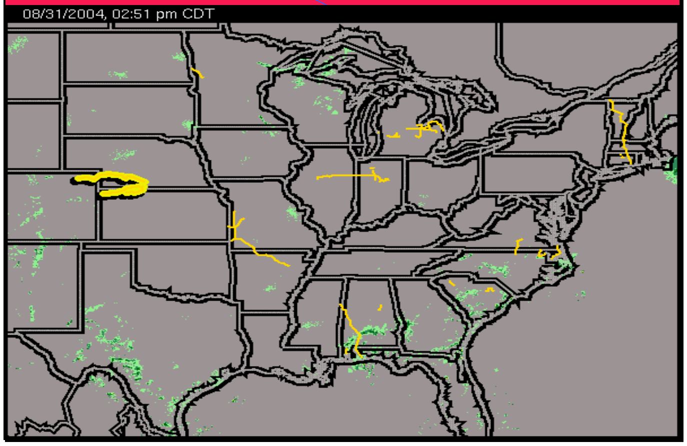
TWC



Weather Alertness – WeatherData

- Weather Warnings are track specific:
  - WeatherData has track file (latitude and longitude)
  - These warnings do not repackage NWS warnings,WeatherData warnings are original content tailored to the railroads specific needs to enhance safety (MNA pinpoints TT).
  - National Weather Service (NWS) (county wide).
    - Stopping or slowing trains cost $$.
- Weather Warnings are time specific.
  - 20 minutes prior.
- 24/7 Consulting Privileges.
  - ARDC call and talk to a meteorologist any time, day or night.
  - Alert not acknowledged: Expect within 2-minute to get a call from professional meteorologist
- Weather Warnings are tailored to railroads needs.
  - Thresholds: tornadoes – heavy rain – flash flooding – 4 or more inches of snow in 12 hours blizzard – trace or more of ice – tropical storms or hurricanes – Temperature changes of 50 degrees or more in 24 hours or less – temperatures 90 degrees F or higher.

WeatherData Alert



WeatherData.
Weather risk management solutions since 1981

True Stories. Real Results.

ARDC stops trains short of flooded tracks in Missouri

WeatherData® SkyGuard® service helps ARDC avoid a disastrous derailment

Photo courtesy Rail America

"In May, WeatherData's proactive warning system prompted us to go out and inspect our track, even though the weather did not appear threatening at the time. We found more than 600 feet of track washed out by severe flooding with two trains scheduled to go through the area within the hour. Thanks to WeatherData's team and the SkyGuard® system we were able to avoid serious damage to the MNA trains and our equipment."
—Thomas Murphy, Manager, ARDC

The Story

Thunderstorms were pounding the Lone Tree area in Cass County, Missouri on May 18, 2004. Meanwhile, flood waters were rising quickly as almost eight inches of rain fell overnight. Early the next morning, two trains on the Missouri & Northern Arkansas (MNA) line were headed for disaster. A flash flood was about to wash out almost 800 feet of track. Using WeatherData's SkyGuard® system and an early warning from WeatherData's business savvy meteorologists, the American Rail Dispatch Center (ARDC) canvassed the area and stopped the trains before they reached the damaged track. Here is the story of how WeatherData helped ARDC save those trains from a tragic derailment.

- **10:05 pm CDT:** WeatherData's 24x7 North American Operations Center tracks persistent thunderstorms moving over Cass County, Missouri, just south of Kansas City.
- **10:20 pm:** WeatherData issues a customized track-specific flash flood warning to ARDC for a section of railway passing through Lone Tree, Missouri. WeatherData's on-duty meteorologists determine that the flood threat will be greatest overnight and continue into the early morning hours.
- **12:54 am:** Cass County Police report that 4 to 5 inches of rain have fallen in less than 3 hours causing severe flooding across the area. Heavy rains continue to fall. Several emergency water rescues are performed and a foot of water covers sections of US-71, the main north-south artery through western Missouri.
- **1:18 am:** WeatherData predicts, based on data from several sources, that the South Grand River will rise above flood stage around dawn with worsening flood conditions through the day. WeatherData contacts ARDC to update them on the situation and the rising waters.
- **Morning of May 19:** MNA Roadmasters, called out because of WeatherData's warning, find almost 800 feet of railroad track washed out on the MNA line where WeatherData predicted the flooding. Two trains, including a 132-car empty coal train are held in place while crews begin the cleanup.

Flood waters covering the MNA track. Photo courtesy of NOAA.

Lone Tree

Radar estimated total precipitation early May 19: From 6 to 8 inches of rain fell.

The Results

Prompted into action by WeatherData's SkyGuard® system, the MNA Roadmaster deployed a track patrol that discovered the flooded and washed out tracks. The timely and accurate data provided by WeatherData meteorologists allowed ARDC to stop two separate trains that were within one hour of hitting the damaged area. Thomas Murphy of ARDC sums up WeatherData's capabilities in this way, "We decided to work with WeatherData because we wanted to ensure the safety of our trains and our customer's cargo," he said. "We have not been disappointed."

For more information please call 316-265-9127 or visit www.weatherdata.com

Put WeatherData to work for you!

© 2004 WeatherData, Inc.

WeatherData, Inc. | 245 N. Waco St., Suite 310 | 316-265-9127 | www.weatherdata.com

Communication – Penta

- Redundant Back-up (duel servers)
- Touch screen technology
- Radio and telephones in one system (2 & 4 wire)
  - Stacking ability
  - Auto answer – Auto hold
- Record all calls and radios (email)
- Secure network
- Microsoft Windows Operating System
- Expandable – Supports multiple workstations

ARDC – Safety Driven; Designed for Service

- We believe the savings are immeasurable (Safety)
- Individual Relationships with each railroad
  - Our Customers
  - Rail Traffic Control Services Without Discrimination
  - Dispatcher of the past is the transportation planner of the future
- Afford even the smallest railroad greater safety and Professional Service
- Class I partnership and greater efficiency on both sides

Testimonial

- **General Manager of the New England Central, Mike Olmstead says** "the dispatching service from the ARDC is as good as you will get on **ANY CLASS ONE** railroad. The ARDC's training and efficiency testing programs are something that most other short lines would like to emulate, and this is clearly evident in their end product."

- **General Manager of the Alabama Gulf Coast Railroad, Mike Brigham says**, "Centralizing the Dispatching function of the AGR in Vermont has provided a safer atmosphere for our train crews, our mechanical group and our maintenance of way crews. They are assured that track warrants are issued via computer which has a fail safe option built in and dispatchers issuing the warrant are knowledgeable in their field. By centralizing this function, it is under a true Dispatching Center and not with personnel who perform more daily functions than just Dispatching."

EUROPEAN DISPATCHING OPERATIONS

Joern Pachl

Technical University Braunschweig, Germany
Institute of Railway Systems Engineering

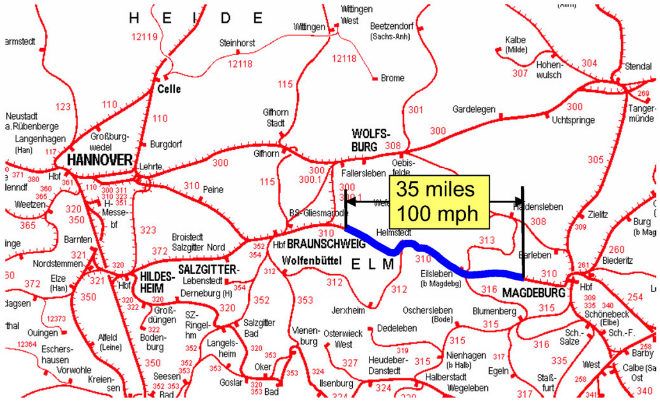
CONTENTS

Characteristic Features of European Railroad Operation

- Passenger operation is the backbone of the system. (about 75 - 80% of all train miles)
- Freight trains are much shorter (and often faster) than in North America.
- Average traffic density is about five times higher than in North America => most lines are double track.
- All train operations are entirely scheduled, passenger trains often with clockface schedules.
- All mainline operation is entirely signal-controlled, even on lines with old technology. Track warrants are only used on a very few branches.

Video Clip of Typical Double Track Operation

(click on map to start video)



Scheduled Operation

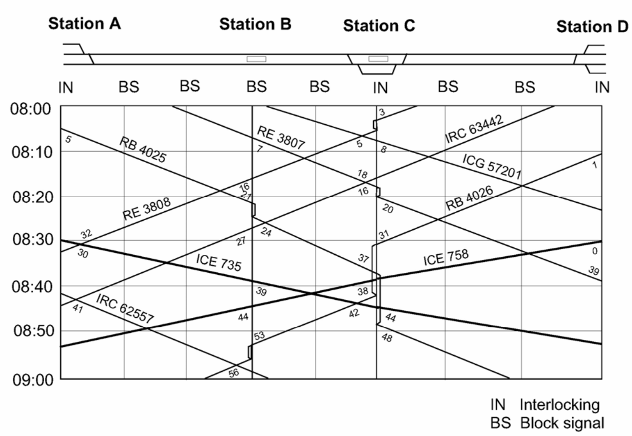
TRAINS SCHEDULED LONG TIME IN ADVANCE (MONTHS)

- Most passenger trains
- Only a part of freight trains

TRAINS SCHEDULED SHORT TIME IN ADVANCE (HOURS)

- Increasing share of freight trains

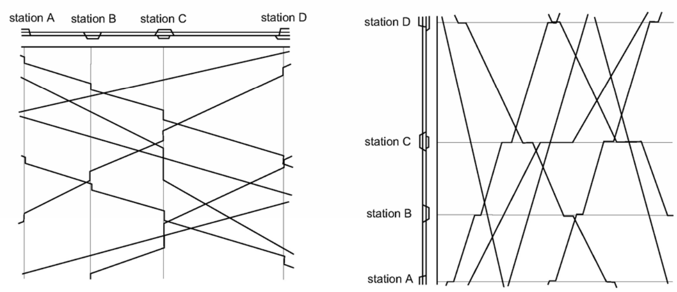
Principle of a Traffic Diagram



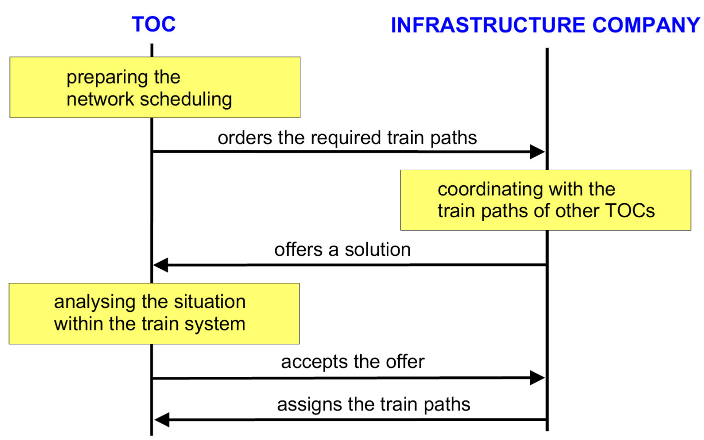
Different Types of Stringline Diagrams

a) Horizontal station axis
example: Germany

b) Vertical station axis
example: France

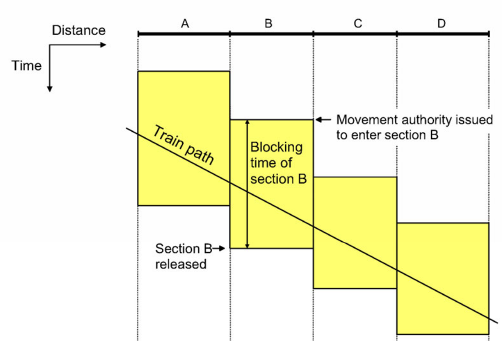


Scheduling Procedure on an Open Access Railroad

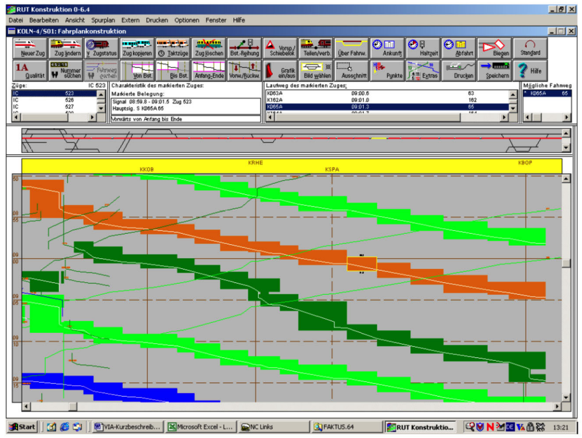


Computer-based Scheduling with Blocking Times

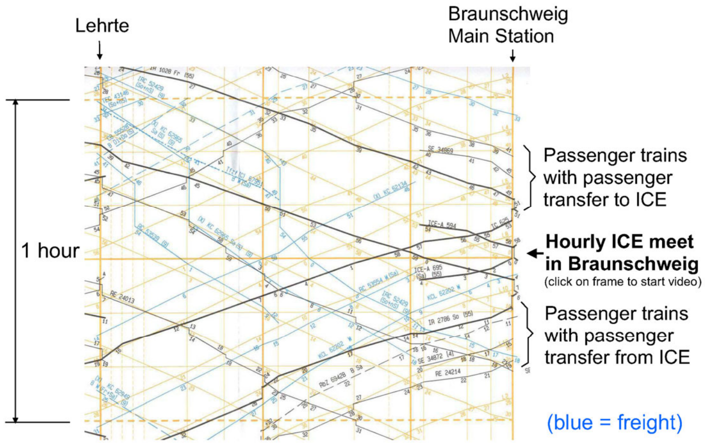
=> The total elapsed time a section of track (e.g. a block section, an interlocked route) is exclusively allocated to a train and therefore blocked for other trains



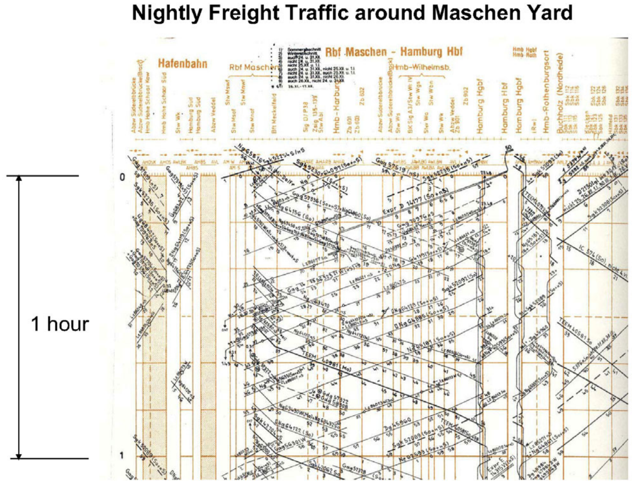
Screenshot of the Scheduling Program RUT
(Standard Scheduling Software of German Railways)



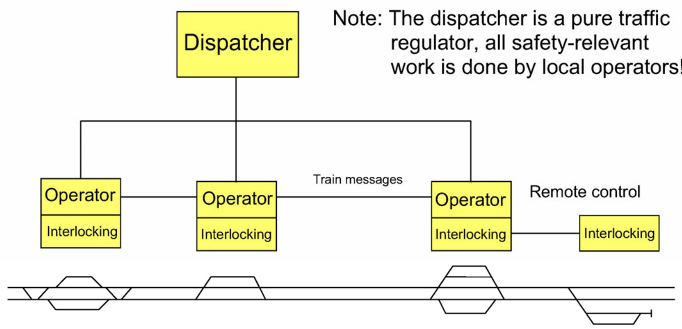
Cutout of Traffic Diagram Braunschweig - Hannover



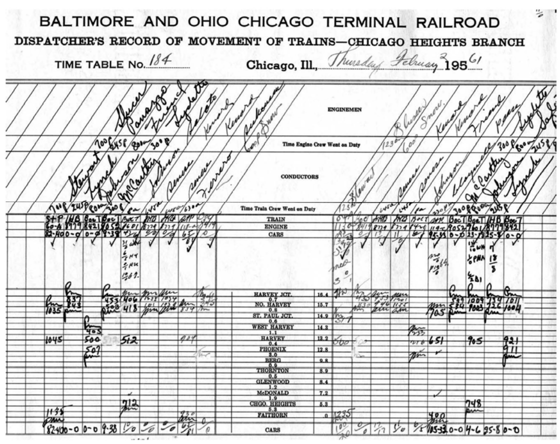
Nightly Freight Traffic around Maschen Yard



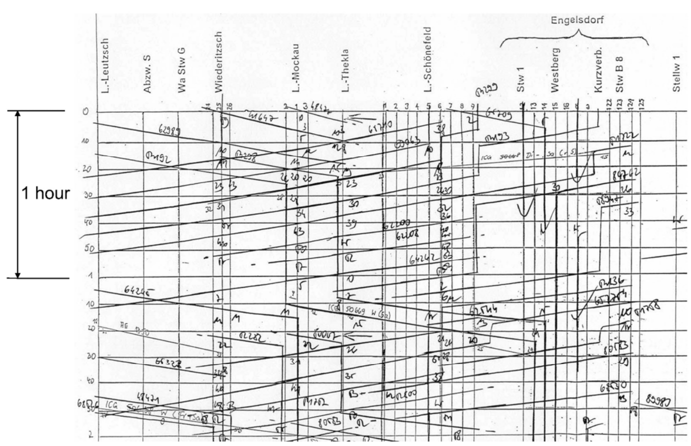
Traditional Traffic Control with Local Operators



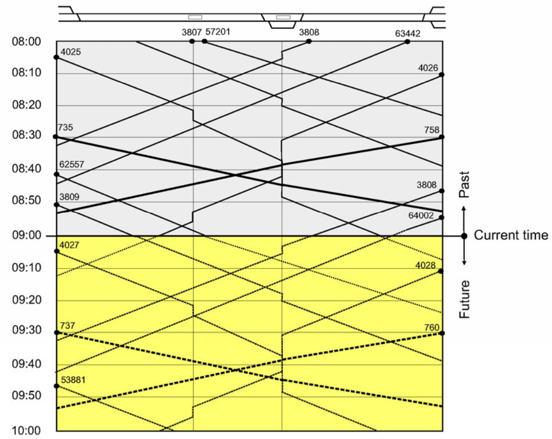
Cutout from a North American Trainsheet



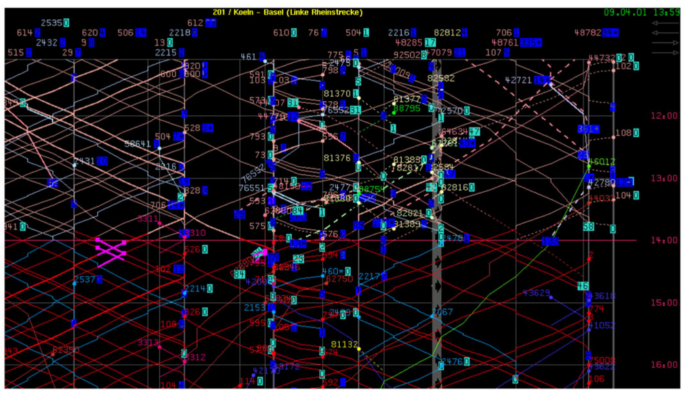
Cutout from a German Trainsheet



Principle of Online Traffic Diagrams on a Dispatcher Screen



Cutout from an Online Traffic Diagram (Cologne - Basel)



Operating Modes of European Railroads

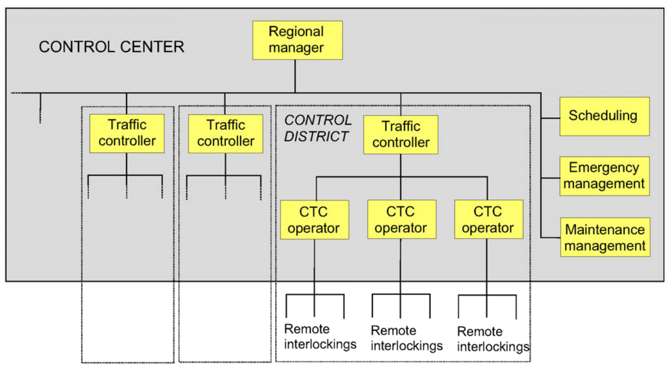
Trains governed by signal indication	Trains governed by written/verbal authority
• Operation with local towers	• Unsignaled operation
• Traditional CTC (CTC towers or offices)	• Simplified signaling for branchlines
• Control centers	

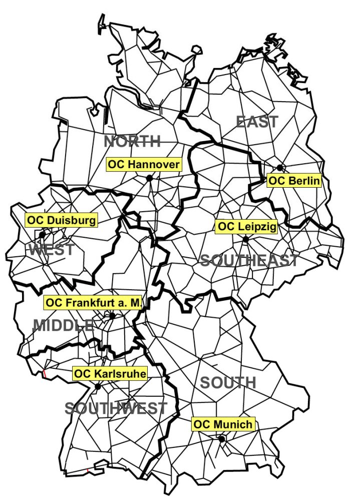
Now Centralization is in Progress ...

Closed Old Tower in CTC Territory (Berlin 2002)

Photo: J. Pachl

Typical Structure of an Operation Control Center





1 Nationwide Operation Management Center

7 Regional Operation Control Centers (OC)

Final state (planned):
- 75 Control Districts
- about 400 Control Desks

Today in operation:
- all Traffic Controller's desks
- about 30% of CTC desks

Rest follows within the next years

Control Regions of DB's Operation Control Centers

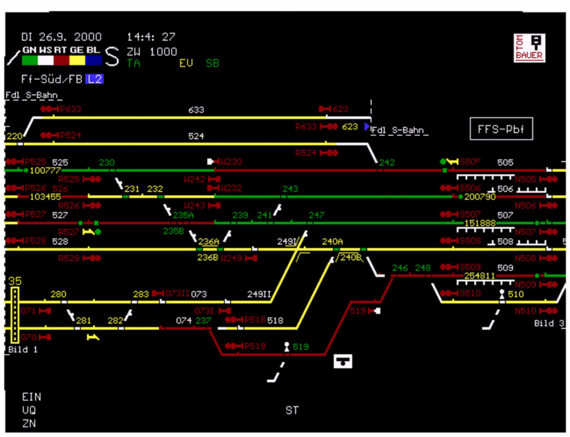
Typical Dispatcher Workstation

Photo: Deutsche Bahn

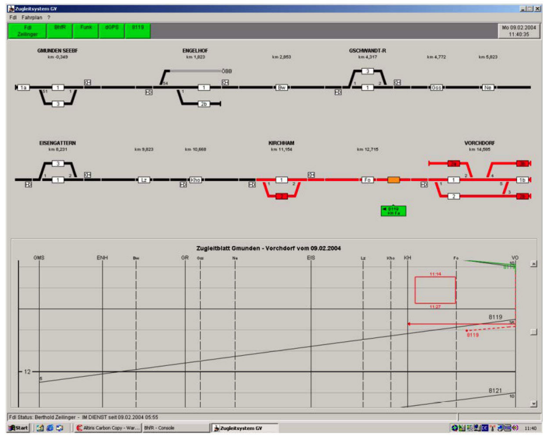
Control Desks in the Leipzig Operation Control Center

Photo: Alcatel

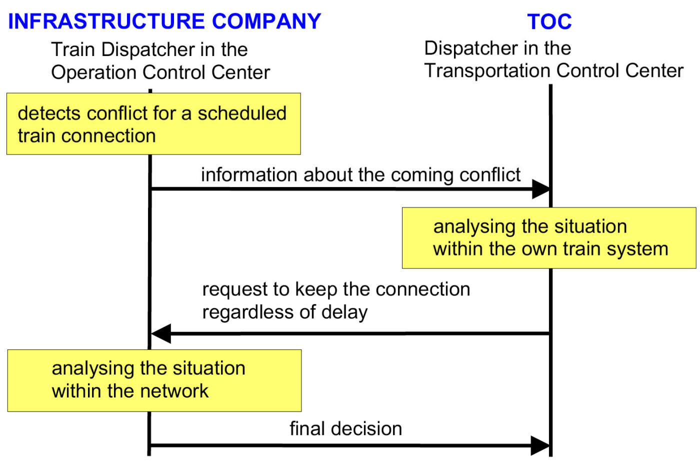
German Interlocking Screen



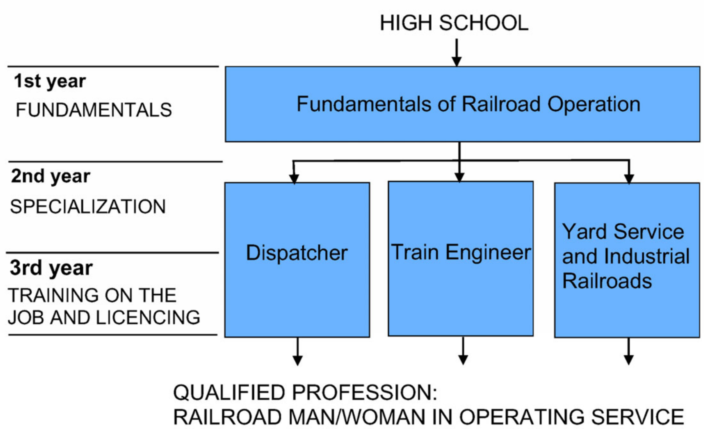
Screenshot of a TWC Workstation (Austrian Railways)



Conflict Resolution on an Open Access Railroad



Qualification and Training at Railroad Trade Schools



Office of Vessel Traffic Management

Providing navigation safety information for America's ports and waterways

Ed Wendlandt

Commander, United States Coast Guard

Overview

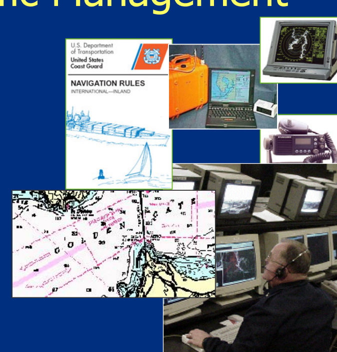
- Vessel Traffic Management
- History and Background of Vessel Traffic Services
- Responsibilities of a VTS operator
- Technology and training available to VTS Operator
- Work hours and schedule.

Homeland Security

United States Coast Guard

Vessel Traffic Management

- NAVRULES / COLREGS
- Ship's Routing Measures
  - Port Access Route Studies
  - TSS / Fairways
  - Navigation Regulations
- IMO & IALA Membership
  - Nav & VTS IALA Committees
- Equipment Carriage
  - Bridge-to-Bridge Radio
  - Navigation Equipment
    - Radar, ARPA, GPS, AIS
- Vessel Traffic Services
  - VTS's and Cooperative Partnerships
  - Ports & Waterways Safety Assessments
  - Ports & Waterways Safety System



Homeland Security

United States Coast Guard

Vessel Traffic Service

"…a service implemented by a Competent Authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment.

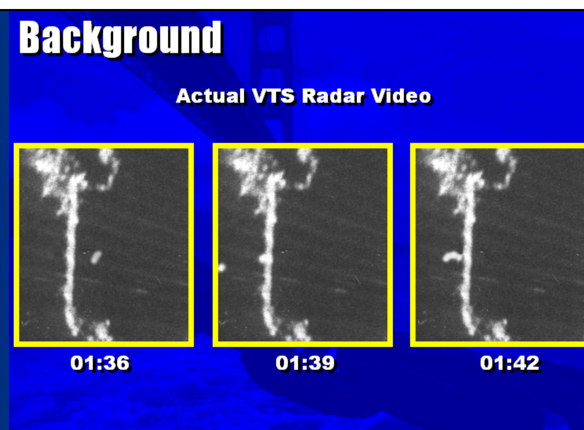
- The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area."
- IMO "GUIDELINES FOR VTS"

Homeland Security

United States Coast Guard

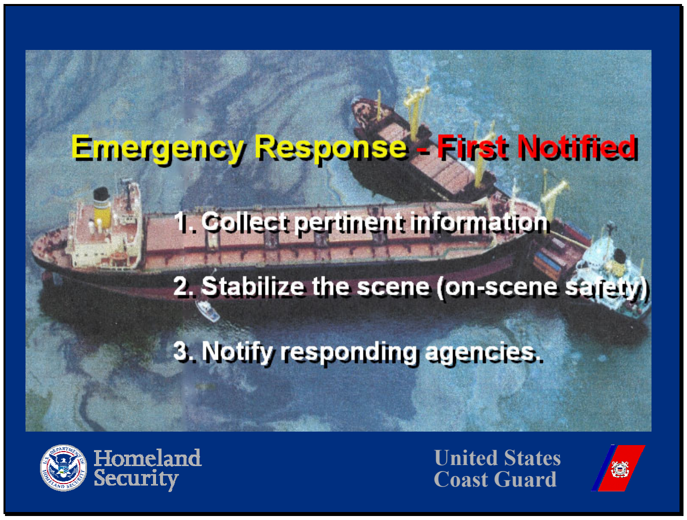
Homeland Security

United States Coast Guard

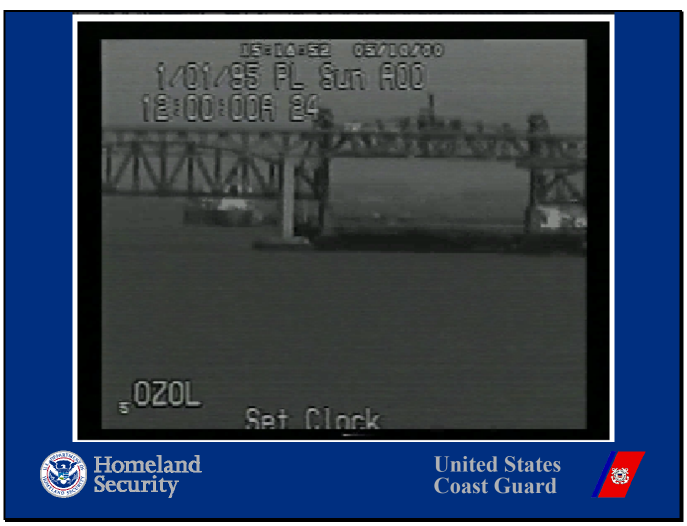


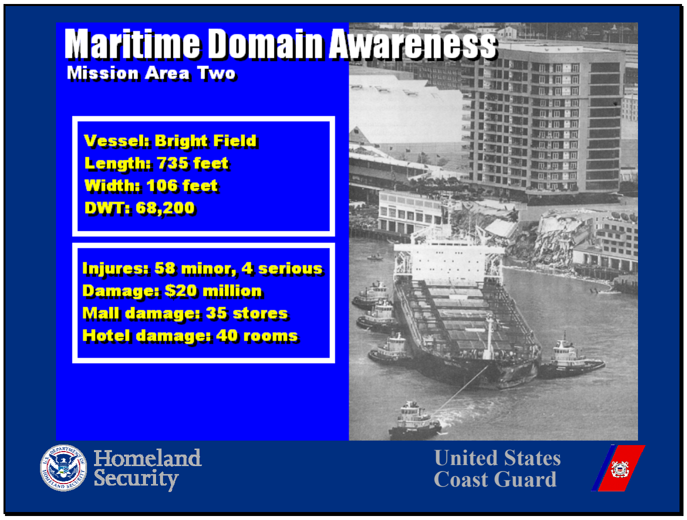
Homeland Security

United States Coast Guard

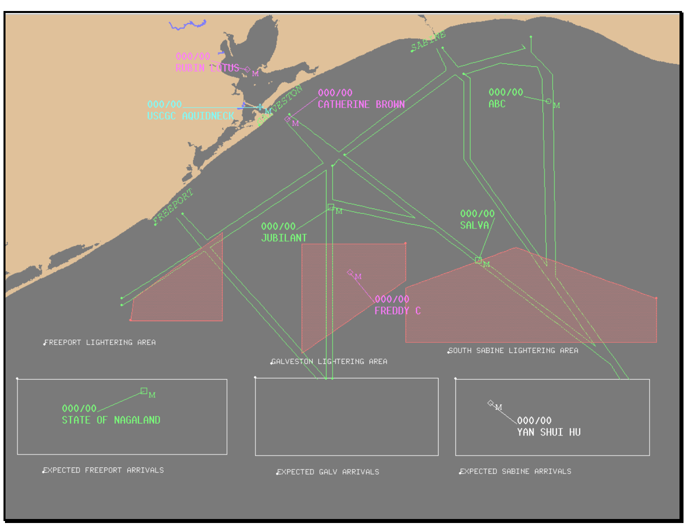

Emergency Response - First Notified
1. Collect pertinent information
2. Stabilize the scene (on-scene safety)
3. Notify responding agencies.
Homeland Security
United States Coast Guard

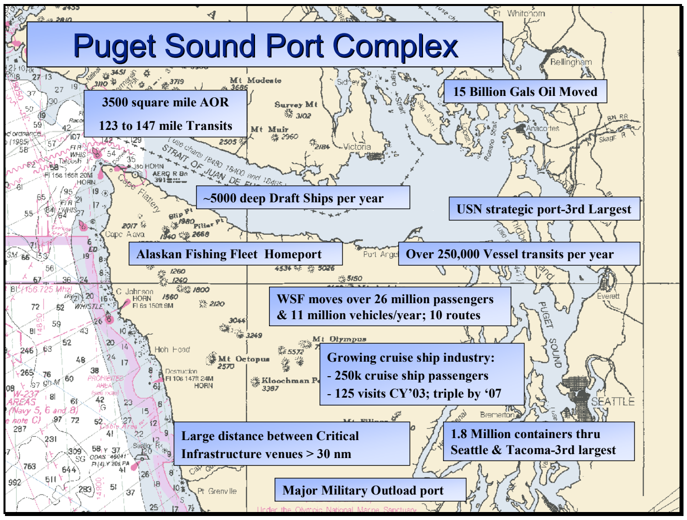

Homeland Security
United States Coast Guard


1/01/95 PL Sun A00
12:00:00A 24
Set Clock
Homeland Security
United States Coast Guard


Maritime Domain Awareness
Mission Area Two
Vessel: Bright Field
Length: 735 feet
Width: 106 feet
DWT: 68,200
Injures: 58 minor, 4 serious
Damage: $20 million
Mall damage: 35 stores
Hotel damage: 40 rooms
Homeland Security
United States Coast Guard


Where the VTS operator works
Puget Sound
Sault Ste. Marie
Louisville*
New York
San Francisco
Los Angeles
Houston
Berwick Bay
Prince William Sound
Lower Mississippi River
Homeland Security
United States Coast Guard


000/00
RUBIN LOTUS
000/00
USCGC AQUIDNECK
000/00
CATHERINE BROWN
SABINE
000/00
ABC
FREEPORT
000/00
JUBILANT
000/00
SALVA
000/00
FREDDY C
FREEPORT LIGHTERING AREA
GALVESTON LIGHTERING AREA
SOUTH SABINE LIGHTERING AREA
000/00
STATE OF NAGALAND
000/00
YAN SHUI HU
EXPECTED FREEPORT ARRIVALS
EXPECTED GALV ARRIVALS
EXPECTED SABINE ARRIVALS



Ferry Routes

* Nations Largest System
* 520+ Transits per day
* 40 Transit per day with >500 passengers
* 26 million passengers per year
* 11 million vehicles per year

United States Coast Guard

Responsibilities of a VTS Operator

- Ensure safe, efficient movement of vessels in a prescribed area by creating good order and predictability
- Communicate with vessels over the radio
- Monitor vessel movements using sensor suite
- Respond to calls for assistance
- Collect, sort and analyze information for future use to make recommendations or direct ship movements

Homeland Security

United States Coast Guard

Responsibilities of a VTS operator

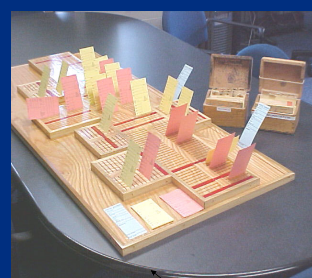
- Provide clear, concise, accurate, timely and purposeful information
  - Provide Information
  - Provide Navigation Assistance
  - Traffic Organization

Homeland Security

United States Coast Guard

Manual Board Tracking System

- Board/Card tracking system
- Each card represents vessel
- Each slot represents segment of waterway
- Used in case of catastrophic failure



Homeland Security

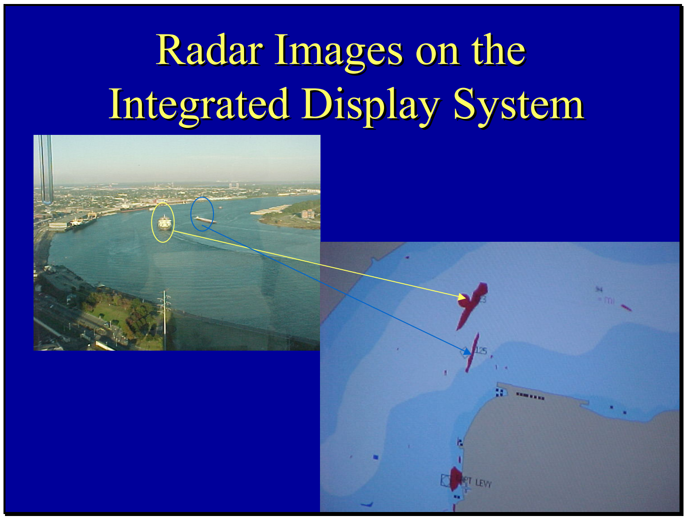
United States Coast Guard

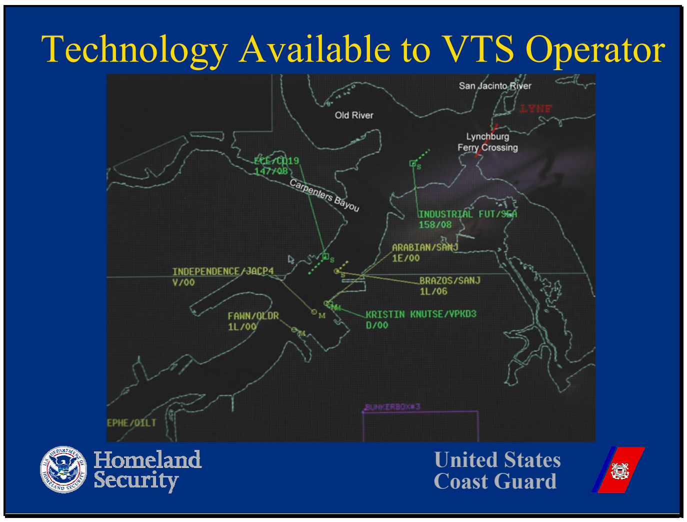
Technology Available to VTS Operator

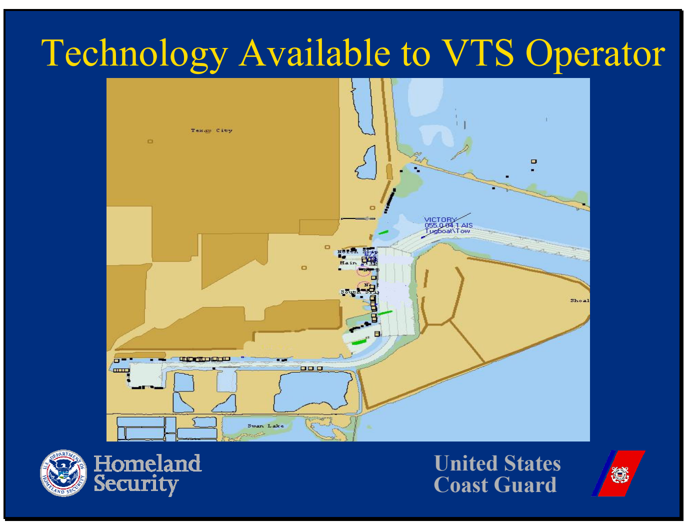
- Vessel Transit Management Systems
  - CGVTS
  - MTM-200

Homeland Security

United States Coast Guard


Radar Images on the
Integrated Display System


Technology Available to VTS Operator
San Jacinto River
Old River
Lynchburg
Ferry Crossing
Carpenters Bayou
INDUSTRIAL FUT/96A
158/08
ARABIAN/SANJ
1E/00
INDEPENDENCE/3BCP4
V/00
BRAZOS/SANJ
1L/06
FAWN/OLDR
1L/00
KRISTIN KNUTSE/VPKD3
D/00
Homeland
Security
United States
Coast Guard

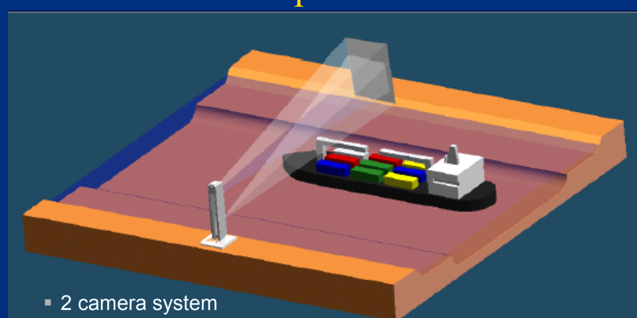

Technology Available to VTS Operator
Homeland
Security
United States
Coast Guard

Technology Available to VTS Operator

- Remote Sensors
  - Radar, VHF-FM radio, Camera, Automatic Identification System, Trip line

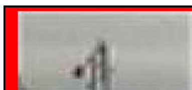
Homeland Security | United States Coast Guard

Trip Line



- 2 camera system
- Located on tower in area with sufficient time to stop

Homeland Security | United States Coast Guard



Zoom

Height: 135 ft **Speed: 3.5**

- Sensor alerts Opcen-vessel at 132 ft (Orange)
- Sensor alerts Opcen-vessel at 135ft (Red)
- Video captures picture of vessel's highest point

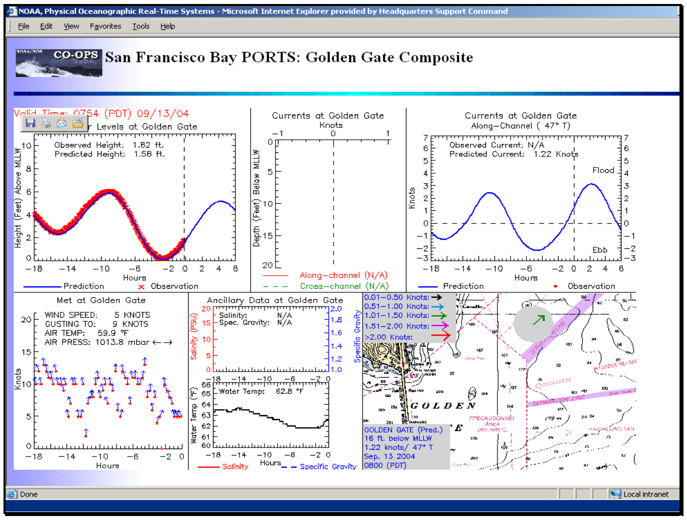
Homeland Security | United States Coast Guard

Technology Available to VTS Operator

- PORTS - Physical Oceanographic Real-Time System
  - Provides real-time information on height of tides and current speed and direction.
  - Available on the internet.
  - Often relayed to Mariner.
  - A factor in Vessel Movement decisions and directions.

Homeland Security

United States Coast Guard



Training

- Two Key Components – National and Local
- National VTS school
  - Certification course
  - Provides history of program including authorities
  - Teaches basic Vessel Traffic Management
  - Employs state of the market simulators
  - Used to ensure national policies are understood and carried forward in a standard manner

Homeland Security

United States Coast Guard

Training (cont'd)

- Local Training provides
  - Indoctrination to local port complex and vessel transit history
  - "Knobology" - equipment operation training
  - Ship Ride Program - form of outreach to local mariners who periodically carry VTS operators on transits of the Vessel Traffic Service Area
  - Regulations

Homeland Security

United States Coast Guard

Work Hours and Schedule

- Work hours and schedule.
  - Varies by location –
  - Most Common:
    - 12 hours on/12 hours off – 3 days on/3 days off
      - With small adjustments allows 80 hours every 2 weeks
      - Either all day shifts or all night shifts
      - 6 AM to 6 PM
    - 8 hour sliding shifts
  - On Watch:
    - 1 hour on board then break with rotation

Homeland Security

United States Coast Guard

Thank you!

Websites:
U. S. Coast Guard:
http://www.uscg.mil
Vessel Traffic Services:
http://www.navcen.uscg.gov/mwv/vts/vts_home.htm
National Boating Safety:
http://www.uscgboating.org

CDR Ed Wendlandt
ewendlandt@comdt.uscg.mil

2100 2nd Street SW
Washington, DC 20593

Foster-Miller, Inc.

Development of a Dispatcher Taskload Assessment Tool

Stephen Reinach
Foster-Miller, Inc.

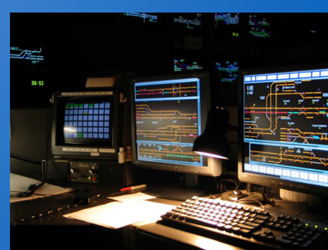
September 30, 2004

4006-1

Foster-Miller, Inc.

Overview

- Background
- Methods
- Results
- Discussion

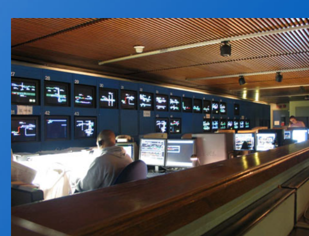


4006-2

Foster-Miller, Inc.

Background

- Dispatchers
  - Shoulder more responsibilities than ever before
  - Integral to rail safety



4006-3

Foster-Miller, Inc.

Background (continued)

- FRA system safety audits
  - Found evidence of periodic work overloads
  - Collected data on dispatcher activities
  - FRA felt method was imprecise
- FRA Office of Research and Development dispatcher R&D program

4006-4

Foster-Miller, Inc.

Background (continued)

- FRA Class I safety audit of dispatch center
  - FRA developed dispatcher taskload assessment method
  - Railroad-specific
  - Time-consuming
  - Required numerous personnel
- No tool currently exists to reliably and quickly measure dispatcher activity

4006-5

Foster-Miller, Inc.

Concept

- Idea: Take original method developed by Office of Safety and…
  - Make it widely applicable to railroads
  - Make it quick, easy and unobtrusive to implement
- Tool:
  - Support future dispatcher research
  - Support internal railroad dispatcher desk studies
  - Ensure even distribution of taskload across desks
  - Support FRA Office of Safety dispatch audits

4006-6

Foster-Miller, Inc.

Approach

- Step one:
  - Identify comprehensive set of observable dispatcher tasks
  - Discern factors that affect dispatcher taskload
  - Determine how data can be collected
- Step two:
  - Develop taskload calculation methodology
  - Convert into portable software application

4006-7

Foster-Miller, Inc.

Taskload

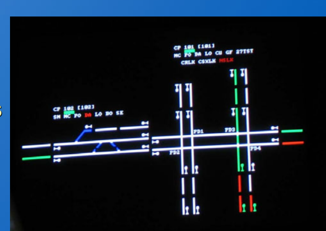
- ***Definition***: The average time demanded of a dispatcher in carrying out all job-related tasks at a particular desk, over a specified period of time (e.g., one shift)
  - Time = common denominator
  - Allows for collection of different tasks at different railroads
- Tasks
  - Observable
  - Quantifiable
  - Quick and unobtrusive to collect

4006-8

Foster-Miller, Inc.

Methods

- Develop initial set of dispatcher tasks
- Develop and distribute two rounds of questionnaires to FRA, railroads and ATDA
  1. Expand upon initial tasks
  2. Identify data collection methods



4006-9

Foster-Miller, Inc.

Results

- Initial set of dispatcher tasks
  - Literature review
  - SME input
  - Naturalistic observation
- Questionnaire #1: 11 respondents
- Questionnaire #2: 10 respondents

4006-10

Foster-Miller, Inc.

Results (continued)

- 67 dispatcher tasks organized into six categories
  1. Actuation of signals, switches, blocking devices and bridge controls via CTC/CAD
  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. General record-keeping tasks
  6. Review of reference materials

4006-11

Foster-Miller, Inc.

Relative *Time* Required to Route Track Vehicles

	Passenger/ Commuter Train	Local Freight Train	Work Train	Hi-Rail Vehicle
Less Time	2	0	0	0
Equal Time	6 (55%)	5 (45%)	3	2
More Time	1	4	6 (55%)	7 (64%)

4006-12

Foster-Miller, Inc.

Relative *Effort* Required to Route Track Vehicles

	Passenger/ Commuter Train	Local Freight Train	Work Train	Hi-Rail Vehicle
Less Effort	2	0	0	0
Equal Effort	5 (45%)	4	2	0
More Effort	2	5 (45%)	7 (64%)	9 (82%)

4006-13

Foster-Miller, Inc.

Dispatcher Task Data Collection Methods

- CAD report
- Other computer report
- Paper train sheet
- Other paper record
- Audio tape
- Direct observation
- Other
- Cannot be collected

4006-14

Foster-Miller, Inc.

Dispatcher Task Data Collection Methods (continued)

- CAD report
  - CAD/CTC activity (10)
  - Mandatory directives (8)
  - General record-keeping* (8)
- Audio tape
  - Track-related permissions, protections and clearances (9)
- Direct observation
  - Non-movement authority and non permission/protection/clearance communications (9)
  - General record-keeping* (8)
  - Review of reference material (6)

4006-15

Foster-Miller, Inc.

Median Level of Time, Effort and Obtrusiveness to Collect Taskload Data

	CAD/CTC Activity	Mandatory Directives	Track-related Permissions, Protections, Clearances	Other Communi-cations	General Record-keeping	Review Reference Materials
Time	4	4	7	7	6	4
Effort	4	4	6.5	7	5.5	3
Obtrusiveness	3	3	4.5	6	4	4

4006-16

Foster-Miller, Inc.

Percentage of Time Dispatchers Spend on Each Task Category During a Typical Shift

Task	Avg Percentage of Time
CAD/CTC activity	29.3
Mandatory directives	28.5
Track-related permissions, protections, clearances	17.4
Other communications	10.0
General record-keeping	10.9
Review reference materials	3.9

4006-17

Foster-Miller, Inc.

Discussion
Questionnaire Results

- 67 observable dispatcher tasks were identified and organized into six top-level task categories
- Not all trains are created equal
- No one method is effective at collecting data on all six dispatcher activities

4006-18

Foster-Miller, Inc.

Discussion (continued)

Questionnaire Results

- Data on track-related permissions, protections, clearances; other communications; and general record-keeping appear to be the most time-consuming, effortful and obtrusive to collect
- Over 50 percent of a dispatcher's work-related time was estimated to be spent actuating signals and switches via CAD/CTC and issuing and canceling mandatory directives to track occupants

4006-19

Foster-Miller, Inc.

Discussion (continued)

Cognitive Nature of Dispatching

- Railroad dispatching is heavily cognitive in nature
- Relationship between observable taskload and unobservable cognitive workload unknown
- Development of a taskload assessment tool based only on observable task activity may not be the most appropriate approach to characterizing railroad dispatching

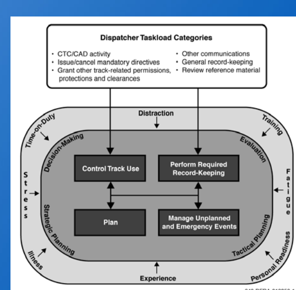
4006-20

Foster-Miller, Inc.

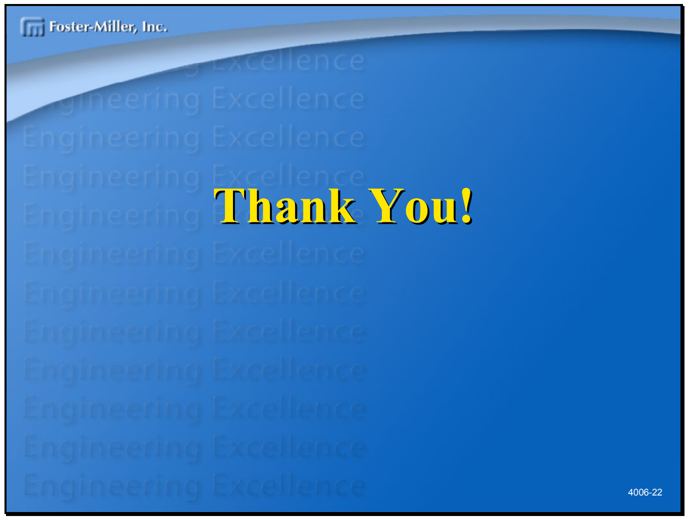
Discussion

Preliminary Model of Dispatcher Performance

- Data on observable dispatcher tasks can serve as the building blocks to a preliminary model of dispatcher performance and safety that incorporates both the physical and cognitive aspects of a dispatcher's job



4006-21


Foster-Miller, Inc.
Thank You!
4006-22

Understanding How Train Dispatchers Manage and Control Trains

Emilie M. Roth
Roth Cognitive Engineering

Roth Cognitive Engineering 1

Changing Cognitive Landscape of U. S. Railroad Industry

- Advanced train control technology
- New display and communication technology
- Introduction of high-speed trains
- Changes in hiring practice

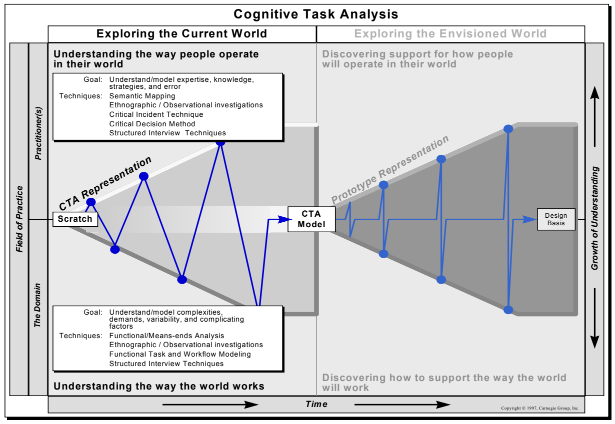
Roth Cognitive Engineering 2

Examining Train Dispatching in Today's Environment

Cognitive Task Analysis (CTA):

- Examine how experienced dispatchers schedule trains and manage track use
- Identify cognitive activities that could be more effectively supported
- Identify features of existing environment that contribute to effective performance and should be preserved when transitioning to new technologies

Roth Cognitive Engineering 3



4

CTA Approach

Iterative 'bootstrap' approach:

- ❖ Preliminary field observations in a dispatch center:
  - ➢ multiple dispatchers
  - ➢ multiple shifts (including shift turn-overs)
- ❖ Structured Interviews
- ❖ Follow-up field observations
  - ➢ observations at a second dispatch center
  - ➢ additional observations at original center

Roth Cognitive Engineering

5

Guiding Framework

- ❖ Identify and document:
  - ➢ Sources of task complexity
  - ➢ Skills and strategies that experienced practitioners have developed to cope with task demands
  - ➢ Opportunities for performance improvement:
    - ❑ training
    - ❑ new technologies
- ❖ Look for:
  - ➢ Illustrative incidents
  - ➢ Deviations from 'canonical'

Roth Cognitive Engineering

6

7

The Train Dispatching Environment

- ❖ Train dispatchers are responsible for:
  - ➢ Managing track use
  - ➢ Insuring that trains are routed safely and efficiently
  - ➢ Insuring the safety of personnel working on and around railroad track
- ❖ An example of a distributed planning task
  - ➢ Multiple train dispatchers handling adjoining territories
  - ➢ Train engineers
  - ➢ Maintenance of way workers

Roth Cognitive Engineering 8

What Makes Train Dispatching Difficult?

- ❖ Need to dynamically re-compute train routes and meets:
  - ➢ train delays and track outages
  - ➢ unplanned demands on track usage
- ❖ Need to satisfy multiple demands placed on track usage
- ❖ High knowledge requirements and memory load
- ❖ Heavy attention and communication demands (particularly over the radio)

Roth Cognitive Engineering 9

Examples of Dispatcher Decisions

- How to route a train?
- Where to have meets and passes?
- How long will it take a train to get from point A to point B?
- Which train to let through first?
- How to help a train make-up time?
- Whether there is enough time to give permission to MOW personnel to work on track?
- Whether there is enough time to allow another train through?

These decisions require extensive knowledge and skill built up from experience.

Roth Cognitive Engineering 10

Expert Strategies for Coping with Task Demands

- Off-load memory requirements
- Anticipate and plan ahead
- Act proactively
- Level workload

Roth Cognitive Engineering 11

Off-Loading Memory Requirements (Compensating for Interface Limitations)

- Cheat Sheet:
  - inter-lockings and train stations and when the trains are scheduled to arrive
  - track sidings and corresponding mileposts
  - streets with crossing gates and corresponding mileposts
- Desk File:
  - supplemental bulletin orders in effect
  - temporary speed restrictions
  - handwritten notes alerting to problems and providing tips
- Personal street maps

Roth Cognitive Engineering 12

Anticipating and Planning Ahead

- Maintain 'Big Picture'/Monitor Activity Beyond Own Territory:
  - Wall Panel
  - Other dispatchers
  - PC to access Information Reservation and Ticket System
  - Radio Communication
- Plan cooperatively across dispatch territories
- Take advantage of the radio 'party line' feature:
  - Identify when a train has left a station
  - Identify equipment problems
  - Listen for/head off potential conflicts
  - Listen for mistakes
- Consider what can go wrong and plan for contingencies

Roth Cognitive Engineering 13

Expert Dispatch Strategies

- Acting Proactively
  - Strategies to take advantage of windows of opportunity
  - Cooperative strategies between dispatchers and engineers
- Leveling Workload
  - Clearing routes/setting blocks in anticipation of needs
  - Giving authorization for track usage 'until further notice'

Roth Cognitive Engineering 14

Summary: Insights from CTA

- Dispatchers have developed a variety of strategies that:
  - smooth the way for trains to pass safety and efficiently
  - satisfy the multiple demands placed on track use
- These strategies depend heavily on communication and coordination among individuals distributed across time and space

Roth Cognitive Engineering 15

Implications of CTA Results for Improving Train Dispatch Operations

- Advanced Displays and Decision Aids
- Introduction of Data Link Technology
- Improvements to Training

Roth Cognitive Engineering 16

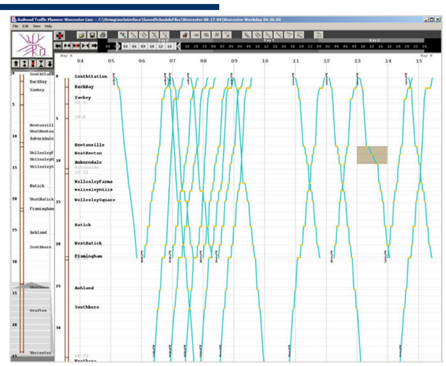
Advanced Displays and Decision Aids

- **Enhance ability to track train progress and anticipate delays: precise train location**
- **Facilitate access to information affecting train routing and track usage decisions:**
  - ***Shift paper resources to electronic media***
  - **Provide visualizations of physical track and surrounding geography (*Electronic track charts with street maps overlaid)***
- **Provide train routing aids**

Roth Cognitive Engineering 17

Dispatcher Planning

Stringline display that supports both preliminary planning and reacting to unexpected events



Roth Cognitive Engineering 18

Implications for Introduction of 'Data Link' Technology

- CTA confirmed the need to off-load some radio channel communication and suggested opportunities for data link technology:
  - electronic transmission of movement authorization forms
  - track visualization displays to promote shared understanding of location information.
- Revealed the importance of preserving the 'broadcast/party-line' characteristic for some types of communication.
  - Exploring ways to implement data link systems that have 'broadcast' capabilities.

Roth Cognitive Engineering 19

Datalink Communications

- Problem Statement
- Phase I
- Phase II
- Further steps

Railroad Worker PDQ Screen

Train and territory information

Train status

Form D / Foul Time

Request Line 4

Request Lines 2,3	Request Foul Time
Cancel/Fulfill	Clear
My Form Ds	My Foul Time

Roth Cognitive Engineering 20

Training

- The CTA revealed important cognitive skills that underlie expert dispatcher performance:
  - Maintain 'Big Picture'/Monitor Activity Beyond Own Territory:
  - Plan cooperatively across dispatch territories
  - Take advantage of the radio 'party line' feature
  - Take advantage of windows of opportunity
  - Consider what can go wrong and plan for contingencies
  - manage workload
- Currently these skills are learned in apprenticeship mode
- These cognitive skills can be more efficiently learned through practice on challenging scenarios in a dynamic simulator

Roth Cognitive Engineering 21

General Conclusions

This study provides an illustrative case of the potential value of CTA.

- Can reveal the sources of task complexity
- Can reveal the knowledge and skills that underlie expert performance
- Can reveal opportunities to improve performance
- Can reveal features of the current environment that facilitate effective performance and should be preserved as new technologies are introduced.

Roth Cognitive Engineering 22

References

- Roth, E. M., Malsch, N. and Multer, J. (2001). Understanding how train dispatchers manage and control trains: Results of a cognitive task analysis. Washington, D. C.: U. S. Department of Transportation/Federal Railroad Administration. (DOT/FRA/ORD-01/02) Available online at: http://www.fra.dot.gov/downloads/Research/ord0102.pdf
- Wreathall, J. Roth, E., Bley, D. and Multer, J. (2003). Human Reliability Analysis in Support of Risk Assessment for Positive Train Control. U. S. Department of Transportation, Federal Railroad Administration, Office of Research and Development: Washington, D. C. (DOT/FRA/ORD-03/15) Available online at: http://www.fra.dot.gov/downloads/Research/ord0315.pdf

Roth Cognitive Engineering 23

Appendix E.
Bibliography of Dispatcher Research

Aguirre, A., & J. Foret (1994). Irregularity of working hours in railway workers and types of complaints. *International Archives of Occupational and Environmental Health, 65,* 367-371.

Davis, D. R. (1958). Human error in transport accidents. *Ergonomics, 2,* 24-33.

Devoe, D.B. (1974). *An Analysis of the Job of Railroad Train Dispatcher*. (Report No. FRA-PRD&D-74-37). Springfield, VA: National Technical Information Service.

Edkins, G. D., & Pollock, C.M. (1997). The influence of sustained attention on railway accidents. *Accident Analysis and Prevention, 29(4),* 533-539.

Federal Railroad Administration. (1990). *National Train Dispatching Safety Assessment*. Washington, D.C.: U.S. Department of Transportation.

Federal Railroad Administration. (1995). *National Train Dispatcher's Follow-up Review.* Washington, D.C.: U.S. Department of Transportation.

Gertler, J., & Acton, S. (2003). *Railroad Dispatcher Communications Training Materials*. (Report No. DOT/FRA/ORD-03/12). Springfield, VA: National Technical Information Service.

Gertler, J. (2003). *Selection of Railroad Dispatcher Candidates*. (Report No. DOT/FRA/ORD-03-09). Springfield, VA: National Technical Information Service.

Gertler, J., & Nash, D. (2004). *Optimizing Staffing Levels and Schedules for Railroad Dispatching Centers.* (Report No. DOT/FRA/ORD-04/01). Springfield, VA: National Technical Information Service.

Grant, J. S. (1971). Concepts of fatigue and vigilance in relation to railway operations. *Ergonomics, 14(1),* 111-118.

Hak, A. &. Kampman, R. (1981). Working irregular hours: Complaints and state of fitness of railway personnel. In A. Reinberg, N. Vieux & P. Andlauer (Eds.) *Night and Shift Work: Biological and Social Aspects* (pp. 229-236). Rouen: Pergamon Press.

Kolmodin-Hedman, B., & Swensson, A. (1975). Problems related to shift work: A field study of Swedish railroad workers with irregular work hours. *Scandinavian Journal of Work, Environment and Health, 1*, 254-262.

Komaya, K., & Asuka, M. (2001). Rail traffic control under disrupted conditions. *Control in Transportation Systems 2000: A Proceedings Volume from the 9th IFAC Symposium*, Braunschweig, Germany, 13-15 June 2000.

Kvist, T., Hellstrom, P., Sandclad, B., & Bystrom, J. (2002). Decision support in the train dispatching process. *Eight International Conference on Computers in Railways VIII*. Lemnos, Greece, 12-14 June 2002.

Lambropoulos, T. (2002). Genetic algorithm application for the solution of the optimal dispatching problem. *Eight International Conference on Computers in Railways VIII*. Lemnos, Greece, 12-14 June 2002.

Lauber, J. K. & Kayten, P. J. (1988). Sleepiness, circadian dysrhythmia, and fatigue in transportation system accidents. *Sleep, 11(6),* 503-512.

Lenior, T. M. J. (1993). Analysis of cognitive processes in train traffic control. *Ergonomics, 36 (11*), 1361-1368.

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

Pickup, L., Wilson, J.R., & Clarke, T. Mental workload of the railway signaller. In Paul T. McCabe (ed) Contemporary Ergonomics 2003. Proceedings from the Ergonomics Society Conference. Edinburgh: Taylor & Francis, 397-402, 2003.

Popkin, S., Gertler, J., & Reinach, S. (2001). *A Preliminary Examination of Railroad Dispatcher Workload, Stress, and Fatigue*. (Report No. DOT/FRA/ORD-01-08). Springfield, VA: National Technical Information Service.

Reinach, S., Gertler, J., & Kuehn, G. (1998). *Training Requirements for Railroad Dispatchers: Objectives, Syllabi, and Test Design*. (Report No. DOT/FRA/ORD-98-08). Springfield, VA: National Technical Information Service.

Rondon, M., & Gomide, F. (2001). Line block analysis in railway dispatch and simulation systems. *Control in Transportation Systems 2000: A Proceedings Volume from the 9th IFAC Symposium*, Braunschweig, Germany, 13-15 June 2000.

Roth, E., Malsch, N., & Multer, J. (2001). *Understanding How Train Dispatchers Manage and Control Trains: Results of a Cognitive Task Analysis*. (Report No. DOT/FRA/ORD-01/02). Springfield, VA: National Technical Information Service.

Sandblad, B., Andersson, A., Jonsson, K. E., Hellstrom, P., Lindstrom, P., Rudolf, J., Storck, J., & Wahlborg, M. (2000). A train traffic operation and planning simulator. *Seventh International Conference on Computers in Railways. Computers in Railways VII.* Bologna, Italy 11-13 September 2000.

Skjerve, A. B., Ludvigsen, J., & Neset, T. (2002) *Identification of qualifications for train-dispatcher trainees*. Halden, Norway: Institute for Energy Technology.

Vanderhorst, J. (1990). *A comparison of voice and data link communication: Railroad dispatcher's perspective.* (Report No. PB91-130021INZ). Springfield, VA: National Technical Information Service.

Abbreviations

ARDC	American Rail Dispatching Center
BNSF	Burlington Northern Santa Fe Railway
CAD	computer-aided dispatching
COLREG	collision regulations
CTA	cognitive task analysis
CTC	centralized traffic control
FRA	Federal Railroad Administration
GCOR	General Code of Operating Rules
GPS	global positioning system
HDC	Harriman Dispatching Center
HR	Human Resources
ICE	Inter City Express
IHB	Indiana Harbor Belt Railroad
IMO	International Maritime Organization
ISO	International Standards Organization
KSAO	knowledge, skills, abilities, and other characteristics
mTAWL	modified task analysis workload
NIOSH	National Institute for Occupational Safety and Health
OCC	Operations Control Center
OJT	on-the-job training
P&W	Portland & Western Railroad
PAQ	Position Analysis Questionnaire
PTC	positive train control
RSAC	Railroad Safety Advisory Committee
RTC	rail traffic controller
SACP	Safety Assurance and Compliance Program
TGV	Train à Grande Vitesse
TOC	train operating company
TWC	track warrant control

UP	Union Pacific Railroad
VTS	Vessel Traffic Services

Glossary

adverse impact: A substantially different rate of selection in hiring, promotion, or other employment decision, which works to the disadvantage of members of a race, sex, or ethnic group. (29 C.F.R. §1607.16, *Uniform Guidelines on Employee Selection Procedures*)

cognitive task analysis: A set of methods used to understand the mental processes and strategies of operators in carrying out job-related tasks to achieve a work-related goal.

job analysis: A set of methods to identify and prioritize job duties and the requirements necessary to complete these duties.

PAQ: The PAQ is a systematic methodology for conducting a job analysis.

realistic job preview: An approach used in the employee selection process to give a job applicant a clear, unambiguous depiction of the job, including its requirements, demands, and organizational culture.

task analysis: A set of techniques and methodologies to identify or break down operator requirements to accomplish a work-related goal. Requirements are often defined in terms of actions and processes.

taskload: A measure of work burden, typically measured through the identification and quantification of various work tasks and activities.

workload: A measurement of an individual's ability to manage tasks and activities. Workload is usually distinguished from taskload in that two individuals with different amounts of training or experience, for example, may manage the same exact set of tasks in a completely different manner.