Project Title:
Individual Fatigue Countermeasures in Intermodal Passenger Transportation

Principal Investigator	Project Consultants	
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Project Objective:
The objective of this project is to test the application of feedback and knowledge of results, both key principles of behavior change established in many other studies of individual behavior change, as the essential ingredients of an individualized fatigue management program using Actigraph technology to a population of vehicle operators in the intermodal transportation industry.

Project objectives include the following:

- To test a procedure for altering individual behavior regarding fatigue management in the intermodal passenger transportation industry;
- To examine the application of feedback and knowledge of results through fatigue measurement technology, namely, Actigraph Devices, both key principles of behavior change established in many other studies of individual behavior change, as the essential ingredients of an individualized fatigue management program; and,
- To evaluate the effects of feedback on global measures of behavior change and activity (e.g. daily logs, performance indicators, and self-report measures) to determine the impact of the technology on desired outcomes.

Project Abstract:

Intermodal passenger transportation, defined as the utilization of more than two modes of transportation, is a system of transportation that is highly dependent upon the effective performance of individuals. Individual human performance is greatly affected by the level of fatigue currently experienced by the individual. Performance degradation occurs as a linear function of time and hours awake and the time in the circadian cycle. Consequently, the effective operation of a seamless intermodal passenger transportation system depends upon the effective management of human fatigue in the various modes.

In addition to the management of operations, hours of service regulations, and other approaches by managers of the intermodal passenger transportation systems, individuals also need to act responsibly and must learn to manage their own individual behavior. Unfortunately, considerable research exists to suggest that individuals are relatively poor judges of their own level of fatigue outside of the rather gross observations regarding number of hours awake. Consequently, it is not surprising that vehicular accidents and operational errors have been identified as critical causative factors in many accident investigations, and, in fact, the NTSB has singled out fatigue and the hours of service regulations as one of their primary targets for improvement in the transportation industry.

The recent collision of the New Jersey Transit line, the derailment of the Amtrak train outside of Chicago, and the Delta Airlines Little Rock crash landing have been attributed to errors most likely the result of excessive fatigue in operators of intermodal passenger transportation vehicles. Accordingly, the present research attempts to begin to develop aides to operators of vehicles in the intermodal passenger transportation system that will decrease the likelihood of fatigue-caused incidents through the utilization of fatigue management technologies and feedback mechanisms, designed to improve the effectiveness of an individual's ability to manage his/her own fatigue related behavior.

Task Descriptions:
In order to investigate the effects of feedback provided through technology on the behavior of intermodal transit personnel, a sample of 50 employees of transit (AMTRAK, METRA, American Airlines Flight Attendants) and air companies will be invited to participate in the study. These individuals will be asked to complete an Activity Survey to determine their fatigue management behaviors and to wear Actigraph wrist monitoring devices for 30 days.

During this 30-day time period, no feedback will be provided to them. Next, a 30-day period will begin that includes feedback provided by the Actigraph wrist monitoring devices. At the conclusion of the second 30-day feedback period, there will be an assessment of changes in behavior and activity that have occurred since the beginning of the project through the administration of the Activity Survey.

Project Milestones:

Task 1- Administer Activity Survey & Actigraphs.	1 June 2002
Task 2- Administer Activity Survey & Collect Actigraphs.	30 June2002
Task 3- Administer Feedback Actigraphs.	1 July 2002
Task 4- Administer Activity Survey & Collect Feedback Actigraphs.	30 July 2002
Task 5- Begin Data Analysis.	1 August 2002
Task 6- Preliminary Results.	30 August 2002

Task 7- Final Draft Report. 30 September 2002

Task 8- Final Report. 30 October 2002.

Project Budget:

NCIT	$30,000
Match	$30,000
Total Budget	$60,000

Matching funds will include the following:
Burlington Northern Santa Fe: Approximately $15,000 will be contributed by the BNSF to support this project. Approximately $10,000 will come from salaries and travel expenses that will be expended to support this project. In addition, a cash contribution of $5,000 will be contributed by BNSF.

Association of Professional Flight Attendants: Approximately $5,000 will come from salaries and travel expenses that will be expended to support this project. See support letter.

Amtrak, Inc.: Approximately $5,000 will be contributed by Amtrak to support this project. Approximately $2,500 will come from salaries and travel expenses that will be expended to support this project. In addition, a cash contribution of $2500 will be contributed. .

University of Denver: Approximately $5,000 will be contributed by the University of Denver to support this project. Approximately $5,000 will come from salaries and time contributed by Sherry and Szyliowicz that will be expended to support this project.

Student Involvement:
At least two students will be involved in the project as project assistants. These students would assist with data collection and analysis. In addition, they will have direct contact with the study participants in the form of interactions with the study participants from the different modes of transportation.

Relationship to Other Research Projects:
This project will continue the work of the ITI faculty in the area of safety and human factors issues. It is related to the general USDOT and NTSB interest in reducing the effects of fatigue on accident occurrence.

Technology Transfer Activities:
The potential for technology transfer with this project is considerable. The issue of fatigue in transportation is significant, affecting every vehicle operator in every major mode of transportation. Should this research demonstrate the effectiveness of a technological device for altering or at least affecting fatigue management behavior, this would be of considerable benefit to the average individual. It is conceivable that every operator could eventually buy a $50 wristwatch that would include fatigue as a display

screen, just like a watch that tells the time and also has a heart rate monitor. The potential for this type of distribution is very real.

Potential Benefits of the Project:

- The results of the study will have a direct impact on the likelihood of improving the individual management of behavior related to successful performance of jobs related to successful operation of a seamless transportation system;
- This research will, hopefully, have implications beyond the intermodal passenger transportation system alone, and if successful it will be applicable to both passenger and freight transportation systems;
- The successful demonstration project will show that the technology can be used by individuals;
- The project could have a direct impact on traffic and accident safety throughout the world. Fatigue is a major contributor to transportation related accidents. Improving individual's ability to manage fatigue is likely to lead to improved safety;

Project Deliverables:

- The project will deliver a report assessing the impact of the Actigraph Technology on individual fatigue management behavior;
- The project will deliver a series of recommendations on how such programs can be developed and implemented throughout the intermodal passenger transportation system.

Intent to Publish Research:

At the very least, the results of the research will be presented at a national conference and submitted to TRB. A published report of the final results will be available on the principle investigator's website. The final results will be submitted to an appropriate publication.

Qualifications of the Research Team:

Principal Investigator: Patrick Sherry, an Associate Professor at the University of Denver and a faculty member of the Intermodal Transportation Institute and the National Center for Intermodal Transportation, has a distinguished career in research with the transportation industry. Sherry has authored over 100 scientific publications and presentations. Recently, he authored a monograph entitled *Current Status of Fatigue Countermeasures in the Railroad Industry* (Sherry, 2000). Sherry has also been the principal investigator on a number of grants in the transportation industry. The most relevant have been "Perceptions of In-Vehicle Monitoring Devices in Transportation," sponsored by the American Trucking Association Foundation; "Identification of Best Practices in Critical Incident Debriefing in the Railroad Industry," sponsored by the FRA; and "Identification of Needed Skills and Training Experiences in the Transportation Industry," sponsored by the Canadian Ministry of Transportation and APEC. In addition, Sherry has served as a consultant for a number of national and international transportation companies assisting them in the evaluation of fatigue countermeasures. For further background information see: http://www.du.edu/~psherry/apa95aps.html.

Project Consultants:
Lesia Crumpton-Young will serve as a technical consultant in the area of fatigue assessment and modeling. Crumpton-Young received her BS, MS, and PhD in industrial engineering from Texas A&M University. Currently, she is Associate Dean, Research and Industrial Outreach, at Mississippi State University (MSU). She is the developer and director of the Ergonomics/Human Factors Program and Experimentation Laboratory at MSU. Her research interests include: fatigue assessment and modeling, use of virtual reality and computer simulation in ergonomics, design of displays and controls, workplace design; carpal tunnel syndrome prevention and control; and workplace redesign for disabled persons. She has published over 75 scholarly publications and has worked on several industrial research projects with companies, such as UPS, IBM, Caterpillar, Intel, Garan Manufacturing, and Southwest Airlines. Crumpton-Young received the 1997 Black Engineer of the Year Education Award.

Joseph S. Szyliowicz is a Professor in the Graduate School of International Studies at the University of Denver and is an international expert on transportation policy, technology, and development. He is the recipient of the 1997 International Award for Transportation and Ethics from the Alliance for Transportation Research Institute and the Outstanding Scholar Award from the Burlington Northern Foundation in 1986. He is author or co-author of a half-dozen books on transportation, energy, technology, and the Middle East, including *Denver International Airport: Lessons Learned* (New York: McGraw-Hill, 1997). He has written more than two dozen articles and op-ed pieces that have appeared in *Transportation Research, Transportation Quarterly, Transportation Law Journal, Trends 2000, Policy Sciences, The Middle Eastern Journal, World Politics, the Chicago Tribune,* and *Engineering-News Record.* Szyliowicz received a BA from the University of Denver, MA from Johns Hopkins, and Ph.D. from Columbia University. *See*: http://www.du.edu/~jszyliow/academic_bio.html

Diversity:
Project consultant (Dr. Young) and students (J. Buhain) have minority status and will be active contributors to the project.

TRB Keywords:
Intermodal, fatigue, human factors, stress, labor, personnel.