VOLPE center Highlights

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Special Issue on Human Factors Research

For more information on the Volpe Center's human factors research, please visit *www.volpe.dot.gov/hf/index.html*

U.S. Department of Transportation
Research and Innovative Technology Administration
Volpe National Transportation Systems Center

Volpe Center subject pilot wearing head mounted eye-tracking device to record where the pilot is looking during human factors experiments. In the airplane, eye-tracking data has been central in the evaluation of the usability of airport surface markings, of moving map displays in flight, and while on the airport surface as well as in investigations of aircraft lighting as seen from final approach. (Photo by Andrew Kendra)

Human Factors Research

Making Transportation Solutions Personal

Human error is currently thought to contribute to between 60 and 80 percent of all transportation accidents. As a result, one of the greatest challenges in transportation is to design technology and procedures that reduce the probability of such error by taking human behavior and capability into account. As new technologies are introduced in the transportation enterprise, increased complexity places additional demands on individuals and fundamentally changes the role of those who work in these environments. This evolving role, as well as the human-system relationship, must be analyzed, understood, and acted upon.

This issue of *Highlights* presents an overview of the Volpe Center's Human Factors Division. Researchers in this Division analyze the relationship between human capability, behavior, transportation safety, and productivity using a systems approach. New developments in knowledge and procedures are successfully transferred across transportation modes to resolve a range of problems. The Division has a unique, multimodal perspective due to its long-term support of all the administrations within the Department of Transportation (DOT). (continued on page 3)

New Acting Director for the Volpe Center

"Bob Suda has the background and experience necessary to help the Volpe Center excel as an internationally recognized center of transportation innovation."

—Paul Brubaker, RITA Administrator

In January 2008, Mr. Robert Suda assumed the post of Acting Director of the Volpe Center, to oversee the operations and management of all the Center's programs. "Bob Suda has the background and experience necessary to help the Volpe Center excel as an internationally recognized center of transportation innovation," said RITA Administrator, Paul Brubaker; "Bob will ensure that the organization has the necessary support processes and is aligned to focus attention on national transportation priorities, such as using technology and innovation to achieve measurable improvements in safety and system performance."

Mr. Robert Suda, Acting Director of the Volpe Center

Bob Suda has had a distinguished federal career that spans nearly 30 years. He has held key positions at GSA in both the regional and headquarters offices. He has served as Assistant Commissioner for the Office of Information Technology Solutions at GSA and as the Chief Financial Officer of the Federal Technology Service (FTS). He managed the government-wide SmartBUY program, providing software licensing through enterprise agreements. He served as GSA's Director of Finance and the agency's first Deputy Chief Financial Officer. Before coming to the Volpe Center, Bob was the Associate Chief Information Officer for Integration and Operations for the U.S. Department of Agriculture. Bob served as past chair of the Executive Leadership Conference. He also serves as an advisory committee member for the Government Information Technology Executive Council.

The Center is fortunate to have Bob as its new leader. He understands the role of public service and its importance. He believes that making a difference in the transportation enterprise requires the collaborative effort of government and industry, and the Volpe Center is uniquely positioned to contribute innovative solutions to transportation challenges. Bob's extensive information technology background is particularly important to the Center's contribution to developing intelligent systems, such as vehicle infrastructure integration, which aims to link vehicles with roads through sensor technology. ■

Long-Term Experience in Human Factors Research

The Volpe Center has supported DOT in human factors research since its inception, and became a formal division in 1983. At that time, policymakers began to realize that not all national transportation problems could be solved through the hard sciences and engineering, alone; other disciplines were required, such as economics, environmental research, social sciences, psychology, information technology, operational analysis, and strategic planning, all of which can be linked with human factors. The Center continues to develop expertise in human factors, migrating toward a human systems integration framework in which users' requirements will be considered from project outset.

The combined experience of the Volpe Center's human factors research team amounts to several hundred years, and the team includes highly qualified experts who possess depth of experience in engineering psychology, industrial engineering, organizational development, operations research, and information technology. This broad range of expertise allows for creative team building—within the Division, across the Center, and with our project sponsors—to provide insights to help solve transportation problems.

Crossmodal Experience

The Human Factors Division executes projects for all DOT modes; its knowledge base permits efficiency in operation by leveraging ideas from one program or mode to another. Working with other experts, at the Volpe Center and elsewhere, its researchers are able to identify human factors issues early in the development cycle. They pinpoint areas in which their seminal work in one transportation mode is relevant to other modes and champion a human-systems integration approach. Following are examples of the division's cross-cutting research.

Information Communication and Display

Several Volpe Center projects address human factors considerations in the design and evaluation of communications and display technologies for aviation and rail operations.

Aviation: Electronic Flight Bags

Instead of traditional flight bags loaded with paper documents—such as checklists, operating manuals, and navigation publications—many pilots now use Electronic Flight Bags (EFBs), which may be installed on portable computers. EFBs are in use by a large number of corporate and private aircraft pilots as well as by several airlines. They are standard on new aircraft built by manufacturers such as Boeing and Airbus.

Since 1999, the Volpe Center has worked with FAA and industry to:

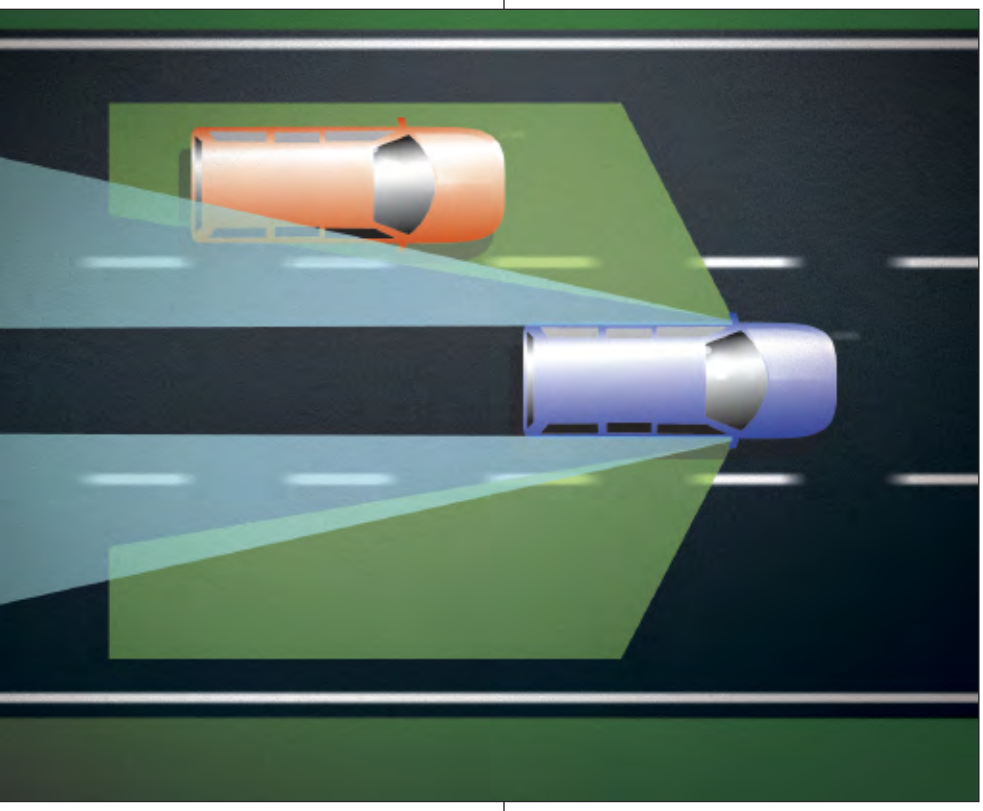
- Improve the safety of EFBs by identifying human factors considerations for their design and evaluation
- Help streamline and standardize EFB assessments
- Coordinate information about industry and policy trends related to EFBs

Examples of Early Human Factors Transportation Research

For National Highway Traffic Safety Administration (NHTSA): The Center evaluated sudden-acceleration incidents in certain automobiles, determining that most of these occurrences were due to poor design and driver error.

For Federal Railroad Administration (FRA): Grade-crossing research included a human factors component, such as examining the effectiveness of making trains more conspicuous.

For Federal Aviation Administration (FAA): A Volpe Center team developed several alternatives for the redesign of aviation approach charts. These alternatives were then compared with existing charts in extensive laboratory experiments and flight tests. The resulting redesigned charts were adopted as the industry standard, and new approach charts became available to pilots, incrementally, starting in 1997.



Schematic showing the coverage provided by lateral sensors on trucks to detect lane change threats. The Volpe Center is evaluating this technology as part of the IVBSS initiative.

What Is Human Factors Research?

"Human Factors refers to the study of human capabilities and interactions within systems and the application of that knowledge to optimize safety, well-being, and system performance. In transportation systems, humans may be studied in relation to equipment, procedures, jobs, environments, training, or personnel management."

—USDOT Human Factors Coordinating Committee

The Volpe Center's research on EFBs has been referenced by FAA in various, widely used guidance documents. This research has also contributed to the development of international guidance. As a result, the Volpe Center hasmade a significant impact on the whole EFB-user community.

Integrated Vehicle-Based Safety Systems Evaluation

The Integrated Vehicle-Based Safety Systems (IVBSS) initiative is a safety research program, sponsored by DOT and aimed at accelerating the introduction of integrated crash-warning systems in vehicles. These warning systems will assist drivers and reduce the number and severity of injuries resulting from rear-end, roadway departure, and lane-change crashes.

The Volpe Center is conducting an independent evaluation of IVBSS. This evaluation will include estimation of potential safety benefits, driver and fleet acceptance, and characterization of the integrated system capability. The Center's human factors specialists provide technical support to determine driver and fleet acceptance. This work is being conducted in support of the Advanced Safety Technology Division.

High-Speed Rail: Automation in Locomotive Cabs

As the United States moves toward high-speed passenger rail service, questions have emerged regarding the appropriate configuration of automation in the locomotive cab. These questions are also relevant to freight and conventional passenger operations. Recent advances in technology hold the promise of achieving gains in safety and productivity through in-cab automation and minimal reliance on trackside infrastructure. However, FRA wants to better understand the implications of cab automation on human operator performance. By leveraging its previous experience with display automation for EFBs in aircraft cockpits [see above], Volpe Center researchers have been able to address automation issues related to locomotive cabs. The key questions are similar; for each mode, it must be determined which tasks are appropriate for humans to perform, which tasks are appropriate for computers, and which tasks should be shared. These determinations may have significant safety implications. Volpe Center researchers have emphasized the need for human-centered design of new technologies; that is, a technology should be designed on the basis of the needs and limitations of the operator rather than forcing the operator to adapt to the technology. FRA is placing its new simulator—the Cab Technology Integration Laboratory (CTIL)—at the Center's Human Factors Laboratory in support of this effort.

The Volpe Center Human Factors Laboratory: Training Simulators

The Volpe Center's on-site human factors laboratory, the Center for Human Factors Research in Transportation, operates partially under a Cooperative Research and Development Agreement with the Massachusetts Institute of Technology (MIT). The laboratory includes several research simulators aimed at replicating the experience of flying, driving, or operating as closely and realistically as needed to serve our sponsors. There are enough commonalities among the various simulator environments such that research topics, equipment programming, and data analysis in one transportation mode often have validity for simulator research in other modes. Facilities and equipment include a railroad dispatcher simulator, a high-fidelity locomotive simulator, three flight simulators, an electronic display development laboratory, an air-traffic-control communications laboratory, a sound attenuation room, and a navigation/workload room. In addition, there will be the new FRA modular technology simulator, and the Center has access to a Cessna 402B aircraft equipped for in-flight experimentation and eye tracking. For the FAA, Volpe Center researchers have developed a ground vehicle simulators for airport driver training to increase vehicle operator awareness of the measures required to prevent runway incursions by ground vehicles.

Train simulator at the Volpe Center human factors laboratory. The simulator is used to study human-factors problems in freight-railroad operations. (Photo by John K. Pollard)

Human Factors Training Evaluation

Airline-Pilot Training and Evaluation: Simulator Fidelity

The Volpe Center is engaged in a long-term initiative to study the requirements for effective training simulators for FAA. In the 1990s, there was an effort to address the fact that accident rates for commuter airlines were higher than those for domestic commercial airlines. The "Commuter Rule," which became final in 1995, required "one level of safety" for all airlines and included 17 safety recommendations. Recommendations for pilot training included providing access to simulators for all airlines and ensuring that simulator requirements added training value.

Early research showed that motion simulation of FAA-qualified simulators may be insufficient; the Notice of Proposed Rule Making for FAR Part 60 on flight simulator requirements contains stringent motion requirements. In response, the air transport community questioned whether added training value would result from the higher minimum requirements that were proposed. A key component of Volpe Center's research included assessing whether motion is required for flight-simulator fidelity in air pilot training, focusing on the effect of platform motion on pilot training and

The Volpe Center received a letter of thanks and appreciation from Jimmy Mynatt, Airport Operations Supervisor of the Charlotte-Douglas International Airport, for installing a ground vehicle simulator at this airport. As a result, 120 personnel received training that led to the airport's compliance with FAA's training regulations for movement area drivers.

Lights on at Takeoff. Volpe Center researchers investigated how pilots were interpreting FAA advisory circular AC 120-74A-Flightcrew Procedures during Taxi Operations. One section of the circular advised flightcrews about procedures for the use of exterior aircraft lights to make the aircraft more conspicuous when taxiing into position for takeoff or taking off. Photograph shows a sampling of planes taking off. (Video capture by Andrew Kendra)

evaluation. The research confirmed that motion is a factor, but concluded that pilots do not need to be trained on how to use motion cues. This result is contrary to popular belief but is supported by rigorous research. As a result, the Aviation Rule Making Committee (consisting of FAA and industry) removed the added motion specifications from its recommended final rule language for revising FAR Part 60.

This finding has the potential to save large amounts of money. For example, the Volpe Center's research coincided with, and supported, the European commuter airplane manufacturer ATR's decision to develop a fixed-base, high-level simulator with dynamic seat, intended for pilot licensing. This was done with the concurrence of the French government. ATR and others are pushing for consideration of such devices in the revision of the International Civil Aviation Organization's flight simulator requirements document, which would greatly improve access to simulator training internationally. The Volpe Center is participating in this revision.

Safety Metrics in Human Factors Research

The importance of collecting data to quantify the effectiveness of safety measures is evident across the transportation enterprise.

Aviation Safety Performance Metrics

The Volpe Center provides international leadership in the area of aviation safety performance metrics. Measuring the performance of the system is critical for identifying areas of concern, developing mitigation strategies, and tracking progress. Volpe Center has been instrumental in developing strategies to measure the severity of adverse events on the ground (surface incidents) and in the air (airborne losses of standard separation).

An aircraft or ground vehicle that enters a runway without authorization can present a serious hazard to aircraft that are taking off or landing. Runway incursions have been responsible for several accidents and numerous serious incidents. Both FAA and the National Transportation Safety Board (NTSB) have identified the prevention of such incidents as among their highest priorities.

The Volpe Center supports FAA in several technical efforts to improve runway safety. In addition to supporting improvements in equipment provided to pilots and controllers, a key task is the ongoing analysis of runway safety data. Human factors specialists routinely analyze runway incursions and other surface incidents to:

- Identify areas in which error mitigation strategies are needed for pilots, controllers, airport vehicle drivers, and airport operators
- Develop strategies to reduce the frequency and severity of runway incursions
- Evaluate the effectiveness of error mitigation strategies

One measure of risk is the frequency and severity of adverse events. Therefore, one of the keys to runway safety is a reliable measurement of the severity of runway incursions. Volpe Center experts designed a tool, the Runway Incursion Severity Classification (RISC) model, to provide a consistent assessment of the outcome of runway incursions. The model is in the final stages of validation by FAA and is currently offered by the International Civil Aviation Organization (ICAO) to its member states.

Measuring the severity of an adverse event is also important when two airborne aircraft have less than the required separation. Volpe Center experts have revised the way the FAA classifies such events with respect to the severity of the outcome. While the previous FAA measure (the "Severity Index") combined subjective and objective measures of both the outcome and the process that resulted in the event, the new metric is a purely objective measure of the outcome. This "Separation Conformance Metric" measures the severity of the outcome by comparing vertical and horizontal distance between the aircraft to the separation intervals required. While the absolute standards for required separation vary by environment, the separation conformance metric can be used in all radar environments, since the computation is the percentage of required separation that was maintained. The Separation Conformance Metric is now the official FAA measure for the outcome of losses of standard separation in the radar environments and is likely to be accepted as an international standard within the global aviation community.

FAA Staffed Virtual Tower prototype.
(Photo by Jonathan Lee)

Considering Human Factors Early in the Project Cycle

Transportation researchers have learned that it is critical to apply human factors principles and methods early in a project so as to obtain the greatest benefit. By teaming human factors specialists with engineers and potential system users, possible problems can be identified early, when they are easier and less costly to fix.

FAA Staffed Virtual Tower (SVT)

Under the leadership of the Advanced Surveillance and Communications Division, Volpe Center researchers are supporting FAA's NextGen program and have identified a need for developing and implementing staffed virtual towers (SVTs) for controlling air traffic at airports. In the future, air traffic control (ATC) services similar to those provided by existing control towers may originate from alternate locations,

potentially away from the airport. The SVT concept utilizes two-dimensional displays of traffic information to eliminate the need for direct, out-the-window observation of aircraft. Benefits may include reduced capital investment in tower construction costs and retention of operational efficiency during poor visual conditions.

The Volpe Center produced a working prototype for managing terminal area air traffic based on existing tower display systems. The electronic systems that functionally replace the out-the-window view must be as accurate, reliable, and intuitive as the visual depiction currently available. Human factors specialists, working with a team of engineers and air traffic controllers, were able to incorporate human systems integration best practices in developing this prototype display. The resulting system was proven to be effective and easy to use in simulations, and controllers preferred it to the conventional tower cab view.

Traffic research vehicle for gathering information on vehicles approaching grade crossings; trailer design features solar charging batteries and secure tool storage. (Photo by Brian Gilleran, FRA)

Driver Behavior at Grade Crossings

Highway-rail grade crossings represent a significant portion of the overall risk from railroad operations, and the Volpe Center supports FRA in all aspects of grade crossing research, from technical to behavioral. Volpe Center researchers have worked to develop a more precise understanding of risks to highway and rail users at grade crossings and determine how best to decrease or eliminate various risk elements. It has been shown that a significant portion of grade-crossing collisions can be directly attributed to human behavior. Research on driver behavior at grade crossings and evaluation of measures designed to reduce risky behavior require fine-grained data regarding the timing of drivers' decisions (to either brake or proceed through the crossing when a train is approaching).

For FRA, Volpe Center researchers from both the Rail and Transit System Division and the Human Factors Division are conducting an independent evaluation of a mobile, solar-powered device. The device gathers and automatically records the speed profile and size of each vehicle approaching a grade crossing during the interval immediately preceding and following the passage of a train through the crossing. This evaluation, which takes place early in this project cycle, combines the Center's engineering expertise in evaluating technology with its expertise in human factors and provides a more robust data-gathering system.

Improving Operational Safety

Center human factors staff are also involved in analyzing operational safety and developing methods and tools to help operators better identify and manage human error.

Analyzing Close Calls

Reliable, accurate, and timely data are critical to safety improvement efforts. Safety data analysis enables researchers to identify and anticipate where safety problems may arise. Accidents are often preceded by "close calls," which can act as warnings about unsafe conditions. Studying close calls can help in identifying safety hazards and developing

solutions that prevent accidents. This proactive approach enables transportation safety specialists to better manage risk and save lives.

The Center's work in this area for FRA demonstrates the value of implementing a reporting system that encourages employees to disclose safety-critical information. The Volpe Center is supporting FRA in the development, implementation, and evaluation of a first-of-its-kind confidential, voluntary system for reporting and analyzing close calls in the U.S. railroad industry—the Confidential Close Call Reporting System (C3RS). It requires a sense of trust by the employees who are required to submit reports. This system is being systematically measured and evaluated. Information that is collected will be shared with participating stakeholders to evaluate the effectiveness of the system for improving safety and managing risk. Developing the system required careful coordination with labor leaders, senior railroad managers, government management, and staff from different agencies. To date, several hundred events have been reported.

The system is helping FRA to meet its goal of significantly improving operational safety and was identified as an important element in the DOT Secretary's Action List for 2007.

Human Factors Experts Guide Government, Industry, and the General Public

Volpe Center human factors researchers have been called upon to provide technical opinion and to deliver expert evidence to groups representing government, industry, and the general public. As impartial advisors, they can provide these groups with informed comments and explanations that, in turn, can help these entities to establish their own policies and determine a course of action.

Technology to Prevent Alcohol-Impaired Crashes

Alcohol-impaired drivers contribute to a substantial portion of crash fatalities and injuries. Recent advances in unobtrusive, miniaturized detection technologies offer the potential for vehicle-based monitoring of a motorist's blood alcohol concentration and driving performance, to detect signs of impairment and (if necessary) take action, such as preventing impaired drivers from starting a vehicle by disabling the ignition to prevent a crash.

NHTSA asked the Volpe Center to identify detection technologies and to assess their practicability and effectiveness. Conducting its examination on an international scale, Center researchers focused on technologies that seemed most promising in terms of feasibility, public acceptance, and issues pertaining to privacy and legality.

Center researchers have been called upon as specialists to make presentations at public forums. These have included a keynote presentation at the first meeting of the newly formed Blue Ribbon Panel for the Development of Advanced Alcohol Detection Technology (comprising leaders from NHTSA, the Insurance Institute for Highway Safety, and the automotive and insurance industries) and the annual meeting of the International Council on Alcohol, Drugs, and Traffic (continued on page 12)

Volpe Center Human Factors Program Managers

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Stephen Popkin is an engineering psychologist who serves as chief of the Volpe Center's Human Factors Division. Prior to joining the Volpe Center, he was a senior engineer at Foster-Miller, Inc., specializing in human-fatigue-related projects for FRA and NASA. His other previous work experience has included conducting visual performance and fatigue research for the U.S. Navy and studying the effects of partial sleep deprivation on work-related performance at the Finnish Institute of Occupational Health. He founded the Fatigue Monitoring and Countermeasures Research Team in exploring multimodal fatigue and alertness issues, including the testing, development, and validation of fatigue-monitoring technologies and countermeasures. He sits on DOT's Human Factors Coordinating Committee. He is also an elected member to the International Commission on Occupational Health's Working Time Society, a group dedicated to understanding the effects of shiftwork on workers' health and performance. He has a doctorate in industrial and organizational psychology.

Judith Bürki-Cohen, PhD
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Judith Bürki-Cohen manages the Cockpit and Human Factors program, which supports FAA, providing improved pilot training with use of simulators and enhancing pilot performance by ensuring appropriate information display and interface design. She has also managed a research program focusing on air traffic control (ATC) communication and high-speed rail. Dr. Bürki-Cohen has consulted on air traffic automation projects and served as a member of several FAA system evaluation teams. She has a doctorate in experimental psychology.

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Kim Cardosi is a national expert in aviation human factors at the Volpe Center. Her research has focused on flight-deck and ATC considerations. She has conducted extensive research on controller-pilot voice communications and has supported many FAA and international aviation safety programs. Dr. Cardosi's recent research has been aimed at identifying, classifying, and developing mitigation strategies for factors that contribute to pilot and controller error associated with runway incursions. She has a doctorate in experimental psychology and a private pilot's license.

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Divya Chandra is an aviation human factors specialist who serves as the lead for the Volpe Center's Electronic Flight Bag (EFB) project. She has worked extensively with airlines and EFB vendors through the Air Transport Association (ATA), compiling a comprehensive document on human factors considerations for EFBs. She also leads an FAA-sponsored project on flight symbology. Before joining the Volpe Center, Dr. Chandra worked on the design and evaluation of traffic and weather data-link services for general aviation and on the design of the computer-human interface for the Center-TRACON Automation System (CTAS). She has a doctorate in psychology and a private pilot's certificate.

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Stephanie Chase is an engineering psychologist specializing in safety in aviation and railroad operation. Her research for FAA has focused on understanding necessary requirements for the development of a driving simulator for vehicle operator training and investigating the factors involved in runway incursions and surface incidents. Her research on rail safety includes program evaluation, the impact of traumatic events on railroad employees, and subsequent prevalence of Post Traumatic Stress Disorder (PTSD) within the workforce, and railroad sign human factors. Her previous research experience includes work in social cognition, particularly studies on perception, memory, and recall. She has a doctorate in experimental psychology.

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Daniel Hannon is an engineering psychologist whose research is focused on flight-deck and ATC human factors as well as the labeling of hazardous materials. He has studied the perception of color as well as cognitive neuroscience and aging. Currently, he is involved in projects related to runway safety and railroad-signal human factors. He has a doctorate in experimental psychology.

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Heidi Howarth is an engineering psychologist specializing in ergonomic work systems and transportation operator fatigue. She serves as co-lead of the Fatigue Monitoring and Countermeasures Research Team, which investigates multimodal fatigue and alertness issues, including fatigue management and the validation of fatigue-monitoring technologies. She is also involved in research on drivers' acceptance of emerging and new in-vehicle technologies

for passenger automobiles and commercial trucks. She has a doctorate in industrial and organizational psychology.

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Gina Melnik is a human factors engineer with a background in research psychology. She is involved in FRA-sponsored research focusing on ways to improve the effectiveness of locomotive train horns as warning devices at grade crossings. She has also peformed aviation research, including exploration of memory-aid usage in ATC, and was a member of a team that evaluated runway incursions. She has a doctorate in experimental psychology.

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Jordan Multer is a human factors engineer and is currently the principal investigator of the Human Factors Support Program, which assists FRA in its efforts to create safer rail transportation systems. His current focus is directed toward implementing a close call reporting system for the U.S. railroad industry. He has supervised projects focusing on the use of warning devices at highway-railroad grade crossings, including devices for making locomotives more conspicuous, retroreflective markings for making railcars more visible, and wayside audible horns. He also managed a project to develop human factors guidelines for the evaluation of locomotive cabs and supervised projects examining the role of automation and communications technology on safety in train control. Dr. Multer worked with FAA to improve the design of aeronautical charts used by pilots and studied ATC communications for the purpose of reducing errors. For FTA, he evaluated design specifications for detectable warning surfaces to assist visually impaired users of public transportation. He has a doctorate in experimental psychology.

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John Pollard is an operations research analyst whose major projects have included on-road testing of the effectiveness of radar-based collision-warning devices, an investigation into the causes of sudden acceleration in automobiles, and research on the causes of fatigue among merchant mariners and locomotive crews. For FRA, he is evaluating new technologies to warn operators of loss of alertness, consulting on studies to assess the effectiveness of fatigue countermeasures, evaluating new technologies for surveillance of driver behavior at grade crossings as well as acoustic-warning devices, and investigating the design of motorcoach and rail-passenger equipment as it affects riders' ability to escape in emergency situations. He has an MBA.

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Thomas Sheridan is a senior transportation fellow at the Volpe Center, where he supports projects in aviation, highway, and rail safety. He is also Ford Professor of Engineering and Applied Psychology Emeritus in both the Department of Mechanical Engineering and the Department of Aeronautics and Astronautics at MIT. As director of the MIT Human-Machine Systems Laboratory, his research focused on enhancements to human performance and safety for air, space, and undersea robotics; nuclear power, medical, and virtual reality systems; and arms control. Dr. Sheridan has authored over 200 technical papers and five books and has served on numerous advisory committees. He is a fellow and past president of both the Human Factors and Ergonomics Society and IEEE's Systems, Man, and Cybernetics Society. He received many prestigious awards, including the IEEE Centennial Medal, a Third Millennium Medal, and the National Engineering Award of the American Association of Engineering Societies. He is a member of the National Academy of Engineerng..

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Mary Stearns is a program manager who leads research that supports NHTSA's Office of Vehicle Safety Research in monitoring the high-priority, multiyear Safety Vehicle Using Adaptive Interface Technology (SAVE-IT) program, aimed at developing a prototype system to minimize driver distraction. She has designed and conducted evaluations of user acceptance of automotive collision avoidance and roadway-departure warning systems, specifically addressing the issues of older drivers. Dr. Stearns has performed extensive human factors research for FAA, leading a team that developed a PC-based tool to assess human factors considerations for equipment and that provided the human factors plan for a proposed ATC tower upgrade. She has a doctorate in sociology.

Michelle Yeh, PhD
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Michelle Yeh is an engineering psychologist. Since coming to the Volpe Center from Mitre Corporation, where she conducted research on display technology, she has led and supported projects on identifying human factors guidelines for new flight deck technologies, understanding driver behavior and compliance to driving rules, and program evaluation for FAA, FMCSA, and FRA. She has a doctorate in experimental psychology.

(continued from page 9) Safety (ICADTS). Center staff also helped prepare a presentation given by NHTSA to a Mothers Against Drunk Driving (MADD) symposium on anti-drunk driving technology.

Volpe Center researchers serve on Railway Safety Advisory committees that support the collaborative development of rail emergency evacuation regulations. The U.S. DOT Rollover Rig research and rescue training simulator, shown here, is designed to train emergency responders to deal with accidents, to enhance passenger rail safety, and to demonstrate the need for safety features. Here the rig is being used to develop and compare emergency lighting and egress signage alternatives. This photograph shows the difficulty of egression from a railcar following an accident. (Photo by John K. Pollard)

Standards for Emergency Egress

In a transportation emergency, it is often necessary to evacuate passengers and crew. Volpe Center experts have provided guidance to the transportation community on human factors and engineering considerations as they relate to the evacuation of trains, buses, and motorcoaches. Center staff members have provided extensive research support and recommendations to FRA's Railroad Safety Advisory Committee (RSAC) Emergency Preparedness Task Force and the Passenger Systems and Electrical Committees of the American Public Transportation Association/Passenger Rail Equipment Safety Standards (APTA/PRESS) Task Force regarding standards for emergency lighting, emergency signs, and low-location exit path marking. As a result of the Wilmer, Texas, motorcoach fire that killed 23 nursing home residents being evacuated from Hurricane Rita, the NTSB recommended that NHTSA investigate human factors issues in the evacuation of buses and motorcoaches and recommend revisions to existing NHTSA regulations. NHTSA asked for Volpe Center's support based on its experience working with FRA in studying passenger railcar emergency evacuation issues. This task is being performed by staff from the Rail and Transit Systems Division, the Structures and Dynamics Division, and the Human Factors Division.

The Future

The Center's broad experience in human factors and transportation is evident from the examples given in this article. They reflect the ability to apply a systems approach to complex issues, utilizing various areas of human factors expertise and transferring and translating that information and experience from one mode or project to others. The Center has one of the largest, if not the largest, multi-modal staff of highly skilled transportation human factors specialists in the country. They have a strong commitment to understanding the ways people process information, make decisions, and function within the human and machine systems, and they are creative in applying this knowledge to get the job done well.

Volpe Center researchers are actively conceptualizing how to incorporate HSI into the Center's developing work portfolio. Volpe Center human factors specialists have contributed to a National Research Council report, *Human Systems Integration (HSI) in the System Development Process*. This report examines the consequences of the disconnect between people and technology in the large-scale development process and the importance of considering human capabilities throughout the development process. It also describes the need for seamless integration of humans into the design process from various perspectives: human factors engineering, manpower, personnel, training, safety and health, and (in the military) habitability and survivability. The process known as human systems integration will provide guidance for system designers and developers and help prevent large-scale system accidents. The broad range of overall research activities that the Center conducts provides an opportunity to integrate the human factors viewpoint into many transportation research endeavors. ■

PUBLISHED AND PRESENTED

Overview of Intrusion and Obstacle Detection. In support of the Federal Railroad Administration, Mr. Marco daSilva of the Advanced Safety Technology Division and Mr. William Baron of the Infrastructure Protection and Operations Division wrote *State-of-the-Art Technologies for Intrusion and Obstacle Detection for Railroad Operations,* DOT-VNTSC-FRA-07-04; DOT/FRA/ORD-07/06, to provide an updated review of the state-of-the-art technology, including systems currently available and potential technology concepts for future field testing. Application of such detection capabilities can improve the safety of railroad rights of way (ROW) and crossings. *http://www.fra.dot.gov/downloads/Research/ord0706.pdf*

Four-Quadrant Gate/Obstruction Detection System. In support of the Federal Railroad Administration, Volpe Center researchers published a final report, *Evaluation of the School Street Four-Quadrant Gate/In-Cab Signaling Grade Crossing System,* DOT-VNTSC-FRA-03-04; DOT/FRA/ORD-07/09. The objectives of the study were to assess the safety benefits and document the operational performance of this novel technology. The results of the investigation, performed by the Volpe Center during a three-year evalation, were extremely favorable. The report, co-authored by Mr. Adrian Hellman and Ms. Anya Carroll of the Rail and Transit Systems Division and Ms. Debra Chappell of the Federal Highway Administration, documents the results of the research. *http://www.fra.dot.gov/downloads/Research/ord0709.pdf*

Crash Avoidance Research. Dr. Wassim Najm, Mr. John D. Smith, and Mr. Mikio Yanagisawa of the Advanced Safety Technology Division recently completed a final report, *Pre-Crash Scenario Typology for Crash Avoidance Research,* DOT-VNTSC-NHTSA-06-02; DOT-HS 810 767. A number of crash typologies, which provide an understanding of distinct crash types and scenarios, have been developed over the years in support of the National Highway Traffic Safety Administration's (NHTSA) vehicle safety research. The report defines a new typology, which will help researchers determine which traffic safety issues should be of priority to investigate and to develop concomitant crash avoidance systems. *http://www.nrd.nhtsa.dot.gov/departments/nrd-12/pubs_rev.html*

Electronic Flight Bag Industry. An Electronic Flight Bag (EFB) is a small, customizable information-management display system that helps pilots conduct flights more efficiently and safely. Dr. Michelle Yeh and Dr. Divya Chandra, both of the Human Factors Division, published *Electronic Flight Bag (EFB): 2007 Industry Review,* DOT-VNTSC-FAA-07-04. The report provides information about 19 providers of integrated (hardware plus software) EFB systems. *http://www.volpe.dot.gov/hf/aviation/efb/vreppub.html*

Volpe Center Continues Tank Car Impact Testing. Research for the final report, *Analysis of Accelerations Measured During Full-Scale Tank Car Impact Tests,* DOT-VNTSC-FRA-07-03, DOT/FRA/ORD-07/08, was performed as part of the Tank Car Structural Integrity Program sponsored by the Federal Railroad Administration. Written by Mr. Matthew Lyons of the Structures and Dynamics Division with Dr. William Riddell (formerly of the Structures and Dynamics Division) and Mr. Kevin Koch (of the Transportation Technology Center, Inc), results of the project may help modify tank car standards, design specifications, and operating practices. *http://www.fra.dot.gov/downloads/Research/ord0708.pdf*

Volpe Center Contributes to Wheel/Rail Interaction Seminar. Mr. Brian Marquis of the Structures and Dynamics Division presented "Safety Studies in Support of Higher Cant Deficiency Operations" at the 13th Annual Wheel/Rail Interaction Seminar in Chicago, Illinois, on May 9, 2007. Sponsored by Advanced Rail Management Corp. and the *Interface Journal,* the seminar is devoted to examining wheel/rail, vehicle/track interaction on rail freight and shared-track passenger systems and presenting the latest information on the ways in which technology is being used to improve wheel/rail interaction.

Intrusion and obstacle detection technology can help prevent the kind of trespass depicted here.

Railroad tank cars are designed to carry liquefied loads, petroleum products, liquid chemicals, and gasses. The Volpe Center supported rigorous testing of tank car impact responses as part of FRA's effort to ensure railroad tank car safety.

Intelligent Assembly and Disassembly Workshop. Dr. Seamus M. McGovern of the Terminal and Surface Systems Division presented "Benchmark Data Set for Evaluation of Line Balancing Algorithms," co-authored with Dr. Surendra Gupta of Northeastern University, on May 24, 2007, in Alicante, Spain. The technical paper will be published in the Proceedings of the IFAC Workshop on Intelligent Assembly and Disassembly (IAD'07), pp 54–59, 2007. This conference deals with how rapid development in modern production is tied to the development of new assembly and disassembly systems.

Risk Analysis Briefing at World Conference. The United Kingdom (UK) Ministry of Defence (MOD) Logistics Team of Dr. Alexander Blumenstiel of the Safety Information Systems Division, Mr. Kenneth McGillvary and Mr. John Krumm, both of the Integrated Transportation Business Enterprise Division, and Mr. David Clark (of DACAR Inc, a Volpe Center contractor) developed and presented "A Methodology for Providing a Quantifiable Comparative Risk Analysis for Evaluating Business Alternatives" to the 11th World Conference on Transport Research, held at the University of California, Berkeley, California, on June 25, 2007. The Volpe Center presentation was one of five papers at the "Cost and Investment Valuation" session.

B757 Wake Vortex Report. Dr. James Hallock of the Office of Demonstration and Deployment Programs and Ms. Melanie Soares of the Advanced Communication, Navigation, and Surveillance (CNS) Technologies Division completed the report, *Comparison of the Wake Vortices of Heavy and non-Heavy B757,* DOT-VNTSC-FA27-PM-07-06. Using data collected by the Volpe Center at the San Francisco Airport, it was shown that the decay of the vortices from the B757-200 and B757-300 is virtually identical. Thus, the classification of the B757-300 as a Heavy aircraft by the FAA Air Traffic organization (thus necessitating increased separations on approach and landing for aircraft) may not be necessary.

Disassembly Line Balancing Research. Dr. Seamus McGovern of the Terminal and Surface Systems Division co-authored (with Dr. Surendra Gupta of Northeastern University) the peer-reviewed research paper, *A Balancing Method and Genetic Algorithm for Disasembly Line Balancing,* which was published in *European Journal of Operational Research* (EJOR), Elsevier Science Publishers, North-Holland, Amsterdam, Vol. 179, No. 3, pp. 692–708, June 2007. (DOI:10.1016/j.ejor.2005.03.055)

Human Factors in Use of Railroad Control Systems. For the Federal Railroad Administration (FRA), Dr. Jordan Multer of the Human Factors Division with Mr. John Wreathall (of John Wreathall & Co), Dr. Emilie Roth (of Roth Cognitive Engineering), Dr. Dennis Bley (of Buttonwood Consulting) produced the final report, *Human Factors Considerations in the Evaluation of Processor-Based Signal and Train Control Systems: Human Factors in Railroad Operations,* DOT-VNTSC-FRA-07-05; DOT/FRA/ORD-07/07. This report attempts to fill the gap provided by the lack of knowledge about the kinds of human performance challenges and safety risks that will occur with positive train control (PTC) systems.
http://www.fra.dot.gov/downloads/Research/ord0707.pdf

Highway Congestion. Dr. Douglass Lee of the Economic and Industry Analysis Division presented "Expectations and Results from Congestion Pricing of Highways" at the session on congestion management in highway systems at the Allocation and Exchange of Airport Access Rights Workshop. The workshop ran from June 6–8, 2007, was hosted by the National Center of Excellence for Aviation Operations Research (NEXTOR), and was held in Queenstown, Maryland.
http://www.isr.umd.edu/NEXTOR/Conferences/200706_Airport_Access_Rights/Lee.pdf

Volpe Center at Vehicle Safety Conference. The 20th International Technical Conference on the Enhanced Safety of Vehicles (ESV) was in Lyon, France, from June 18–21, 2007. The Volpe Center was well represented and co-authored four papers with National Highway Traffic Safety Administration

The Volpe Center's research supports U.S. DOT's National Strategy to Reduce Congestion on America's Transportation Network, known as the U.S. DOT Congestion Initiative. (© iStockphoto.com)

colleagues. Papers are listed below and available in the conference proceedings *(http://www.nrd.nhtsa.dot.gov/pdf/nrd-01/esv/esv20/TOC.pdf):*

- Ms. Linda McCray, Dr. Santokh Singh (both of NHTSA), and Dr. John Brewer of the Advanced Safety Technology Division. "The Effect of Restraint Use and Crash Mode on Injury Severity Risks for Children."
- Ms. Linda McCray, Mr. Mark Scarboro (both of NHTSA), and Dr. John Brewer of the Advanced Safety Technology Division. "Injuries to Children One to Three Years Old in Side Impact Crashes."
- Dr. Wassim Najm of the Advanced Safety Technology Division, Mr. Jack Ference of NHTSA, and Mr. Sandor Szabo of National Institute of Standards and Technology.
- "Objective Test Scenarios for Integrated Vehicle-Based Safety Systems." Dr. Wassim Najm of the Advanced Safety Technology Division and Dr. David L. Smith of NHTSA. "Definition of a Pre-Crash Scenario Typology for Vehicle Safety Research."

Conference on Environment. Air and Waste Management Association's 100th Annual Conference and Exhibition in Pittsburgh, Pennsylvania, from June 26–28, 2007. The conference celebrated the technological and public policy advances that have shaped the Association's role in environmental stewardship.

- Dr. Roger Wayson of the Environmental Measurement and Modeling Division. "Evaluation of Noise Impacts from Landfills."
- Dr. Roger Wayson and Mr. Gregg Fleming, both of the Environmental Measurement and Modeling Division. "FOA (First order Approximation) Version 3.0: Documentation of Model Development."
- Dr. Roger Wayson of the Environmental Measurement and Modeling Division. "Particulate Matter at Two Large North American Airports."

Information Technology Conference. Volpe Center experts attended ITS America's 2007 Annual Meeting and Exposition, Palm Springs, California, from June 4–6, 2007.

- Dr. Bruce Wilson and Mr. Jonathan Koopmann, both of the Advanced Safety Technology Division. "Performance and Capability of a Road Departure Crash Warning System."
- Dr. Wassim Najm of the Advanced Safety Technology Division. "Independent Evaluation Concept for Integrated Vehicle-Based Safety Systems," presented by Dr. Bruce Wilson of the Advanced Safety Technology Division.
- Ms. Suzanne Sloan of the Service and Operations Planning Division. "Meeting the Just-In-Time Need for Learning with ITS Solutions Center."

Effects of Diesel Exhaust on Driver Safety. For the Federal Motor Carrier Safety Administration, the Volpe Center published *Emissions Impact on Driver Safety* (FMCSA-RRA-07-012/ DOT-VNTSC-FMCSA-07-02). The report compiles existing research as to whether exposure to diesel exhaust at levels found in cabs affects safety performance by affecting driver sleep, alertness, reaction time, fatigue levels, or judgment-making abilities. The report is authored by Dr. Michelle Yeh and Mr. John K. Pollard of the Human Factors Division with support from Mr. Paul Zebe and Mr. Jose Mantilla of the Environmental Engineering Division.

Wake Vortex Sound Emissions. A paper written by Dr. Frank Wang, Mr. Hadi Wassaf (both of the Advanced Communication, Navigation, and Surveillance (CNS) Technologies Division), Dr. Z.C. Zheng, and Dr. Wenhua Li (both of Kansas State University), *Influence of Vortex Core on Wake Vortex Sound Emission,* was published in *Journal of Aircraft,* v. 44, n. 4, July-August 2007, pp. 1369–1377. The paper was also presented (as Paper 2538) at the 12th AIAA/CEAS Aeroacoustics Conference, in Cambridge, Massachusetts, from May 8–10, 2006. ■

Volpe Center Highlights

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Human Systems Integration (HSI) in Complex Transportation Systems

Imagine being an air traffic controller at Boston Logan airport on a weekday morning, where you and your fellow controllers are responsible for ensuring the timely takeoffs and landings of 60 aircraft per hour. You are well trained and can normally handle such a workload without any problems. But today a thick fog has rolled in, making your out-the-window view useless for directing ground traffic. Under current Standard Operating Procedures, a ground-delay program for inbound traffic is initiated—with flight delay effects rippling across the day and the country—causing inconvenience for all involved. This scenario may one day have less impact on ATC through the integration of good engineering practice with human factors principles, a process known as Human Systems Integration.

Human factors and ergonomics are critical for the design and development of technology used by people in many contexts to improve both safety and efficiency. Although the terms are sometimes used interchangeably, human factors means the application of cognitive science to equipment displays, controls, and task performance, while ergonomics refers to workplace layout, biomechanics, and physiological considerations. The term human systems integration refers to the process of applying human factors and ergonomics to designing and developing systems that involve technologies, human operators, and organizations.

HSI is particularly important in transportation. Transportation systems tend to be large, complex human-machine systems involving and serving many different users and needs. Regardless of operating mode, the capital costs of transportation are high, and the public expects the highest level of safety feasible. Transportation systems affect the economies, politics, and lifestyles of the urban and/or rural communities and nations they serve. The success of HSI is dependent on how well human factors and ergonomics professionals communicate and collaborate with each other and with engineers and other disciplines, to satisfy the needs of multiple competing interests. Before installing, maintaining, and managing a system in the real world, they need to help identify opportunities, specify requirements, evolve designs, perform simulations and evaluations, and train the operators. To design an efficient system, not only must the human factors of the system and its users be considered but also those of its design process. This requires an eclectic team of professionals to communicate and collaborate via shared representations of goals and constraints.

The system concept that will likely bring relief from current ground-delay programs, by eventually replacing the out-the-window view with virtual displays, is an example of the Center's move toward HSI. The SVT project, under the Advanced Surveillance and Communications Division, integrates understanding of human perception and information processing with electrical, systems, and software engineering to develop a novel air-traffic display. Such application of HSI principles promises to address not only air traffic but also congestion on U.S. highways. The increasing demands on our transportation system make acting upon the transportation enterprise with knowledge of human capability and decision making (and thus HSI) even more imperative. ■