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Traveling to the future: human factors and ergonomics integration, simulation, field testing and strategic partners in support of heavy vehicle research

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Abstract

The proliferation of inexpensive sensors and devices capable of inter-device communication is hastening the implementation of smart technology for current and future generations of vehicles nationwide.The introduction of this technology promises to enhance safety, reduce accidents, increase fuel efficiency, and perhaps enhance traveler experience. The challenge associated with transitioning to and implementing various smart technologies is to ensure that driver, passenger, and pedestrian safety are not compromised. At Idaho National Laboratory (INL), human factors engineering (HFE) staff participates in the evaluation of technology for fleet operations, including review of fuel efficiency, enhancement and driver performance, and assists in the testing of prototype buses with advanced systems.One of the potential applications of smart technology lies in the development of an interoperable wireless communications network among vehicles.INL uses HFE expertise in conjunction with fleet operations and Mission Support Services expertise to guide the introduction and implementation of vehicle to vehicle and vehicle to infrastructure communications and to support interactions with stakeholders including Cooperative Research and Development Agreement partners.To our knowledge, our approach integrating HFE and fleet operations is unique within the Department of Energy complex.The Heavy Vehicle Simulator, located at the Center for Advanced Energy Studies, is used for design evaluation, and HFE supports the conduct of field tests involving bus drivers and supervisors. INL's HFE group and fleet operations are partners involved in a number of collaborative initiatives to segue the Department of Energy's largest motor coach fleet to the next generation of smart vehicles.This presentation reviews our approach, findings, and successes from two of the focus areas (predictive driver efficiency display prompting and vehicle prototype testing); discusses how HFE has been integrated in the planning and design review process for INL fleet operations; and highlights progress on connected vehicle research initiatives.

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1. Introduction and background

Idaho National Laboratory (INL) has a strong focus on engineering and applied science. This focus has been used over the past 65 years to help reduce risks associated with research, design, development, and deployment of new concepts of national importance. With this legacy in mind, INL's Mission Support Services Division deploys more than $150 million of transportation-related federal assets in partnership with industry and academia to ensure the United States' energy security and improve the safety and reliability of America's transportation infrastructure.

On March 22, 2015, the President signed an executive order calling for further reduction in greenhouse gas emissions for all Federal Agencies to extend nationwide [1].However, during the last decade, the U.S. Department of Transportation (USDOT), Department of Energy, and the automotive industry have been enacting initiatives to reduce fossil fuel emissions, enhance safety, and optimize transportation data collection with the objective to reduce commute time, decrease traffic congestion, increase road report accuracy and response time, identify commuter-route information interaction strategies, and reduce accidents [2].

Complementary industry practices have sought to reduce fuel consumption through improved transmissions, advanced engine tuning, better aerodynamics, improved maintenance practices, use of light composite materials, and driver assist technology.These efforts have a payback in terms of better safety, reduced greenhouse gas emissions, and reduced carbon.Industry and USDOT have achieved communications advances in safety warning, collision mitigation, lane deviation, parking assist, signal phasing, animal-highway warning systems, and traffic notification.As a relatively large fleet owner/operator, INL is concerned with continually improving safety and performance and is working on complementary strategies involving smart technology and advances in communication.

1.1. Background to INL fleet operations

INL maintains the largest motor coach fleet in the U.S.Department of Energy National Laboratory system comprised of over 100 coaches, 75 professional drivers, and a large number of miscellaneous heavy vehicles. Each day,over 3,000 employees are transported to and from the desert site and city locations. This daily transportation results in 2.8 million miles per year logged under mild to extreme weather conditions.INL maintains its own workshop with skilled technicians capable of making all bus repairs and installing and calibrating a wide variety ofsystems. With this infrastructure already in place, INL is using human factors engineering (HFE) in an integrated fashion to evaluate changes in technology and driver behavior that could be translated into fuel savings and attaining safety goals.

1.2. HFE integration

Driving to and from work is work performed within a sociotechnical system comprised of the technology, traveler/driver, environment, and rules of the road.Improper performance can result in any number of consequences from delayed arrival- to having an accident. For fleet operations, being fuel efficient or punctualat the expense of safety is simply not permitted. The bus driver is responsible for decisions and actions in real time, including strategies on how to respond to changes in elevation, road conditions, visibility, and wind.

HFE is integrated in fleet operations in the following way.HFE staff attend bi-weekly Mission Support Services operations meetings and work with fleet supervisors and shop supervisors in developing and instrumenting the large Heavy Vehicle Simulator (HVS), in the design of prototype bus studies, in the debrief of drivers, in display design, in data collection, and in the design of simulator studies.HFE experiments and ideas are expected to be relevant to fleet operations, and training and working with fleet schedulers and supervisors gives INL HFE staff access to end users (drivers) and the fleet that many researchers simply don't have.

1.3. Background to connected vehicle research

The emphasis on HFE research has been accelerated by USDOT and auto industry interest in connected vehicles (CVs) as a means of enhancing national safety and fuel efficiency while reducing corridor congestion and emissions.