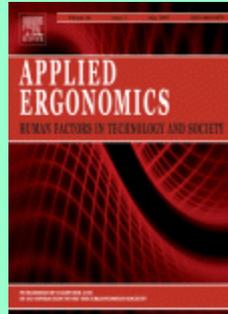


Applied Ergonomics - rok 2011, ročník 42

Číslo 4 (May 2011)



Mark S. Young, Stewart A. Birrell, Neville A. Stanton. *Safe driving in a green World : a review of driver performance benchmarks and technologies to support 'smart' driving.* Pages 533-539.

Road transport is a significant source of both safety and environmental concerns. With climate change and fuel prices increasingly prominent on social and political agendas, many drivers are turning their thoughts to fuel efficient or 'green' (i.e., environmentally friendly) driving practices. Many vehicle manufacturers are satisfying this demand by offering green driving feedback or advice tools. However, there is a legitimate concern regarding the effects of such devices on road safety – both from the point of view of change in driving styles, as well as potential distraction caused by the in-vehicle feedback. In this paper, we appraise the benchmarks for safe and green driving, concluding that whilst they largely overlap, there are some specific circumstances in which the goals are in conflict. We go on to review current and emerging in-vehicle information systems which purport to affect safe and/or green driving, and discuss some fundamental ergonomics principles for the design of such devices. The results of the review are being used in the Foot-LITE project, aimed at developing a system to encourage 'smart' – that is safe and green – driving.

- **Keywords:** Safety; Environment; Driving; IVIS; Interface design

Nobuyuki Uchida, Dick de Waard, Karel A. Brookhuis. *Countermeasures to prevent detection failure of a vehicle approaching on collision course.* Pages 540-547.

Objective: This study investigated causal factor of perceptual failure and possible countermeasure of crossing path crashes at clear-sighted unsignalised intersections. **Background:** Crossing path crashes involving two vehicles at intersections are a common and serious problem, and perceptual failure has been identified as a predominant causal factor. Previous studies have showed that late detection of a crossing vehicle frequently occurs even when there are no visual obstructions, at such as rural intersections. **Method:** With using a fixed-based driving simulator, three experiments were performed to investigate a driver's ability to detect a periphery presented cross traffic while approaching an intersection. In Experiment 1, drivers' ability to detect crossing vehicles in their peripheral field of view was studied, both in conditions of vehicles following a collision and a non-collision trajectory. In Experiment 2, we examined whether abrupt appearance of a vehicle on collision course would improve detection performance. In Experiment 3, we tested potential of collision warning, if it

affects voluntary visual scanning, improving the detection performance regarding hazards cross traffic. **Results:** The results of Experiment 1 showed that vehicles on collision course vehicles were detected late. This suggested that the late detection could be related to the lack of motion visible in the peripheral view. In Experiment 2, it was found that abrupt appearance effect ("pop-up" from road side occluding furniture) improves detection performance of a crossing vehicle. The results of Experiment 3 demonstrated that cross traffic collision warnings were beneficial for preventing late detection responses by means of encouraging voluntary visual scanning. **Conclusion:** Less attention attractive visual properties of hazardous cross traffic attributed to mutual approaching course can cause recognition failure. Drivers' gaze shift to potential conflicting direction, either reflective or voluntary manner, is crucially important for preventing crossing path crashes at such as rural intersections.

- **Keywords:** Collision course; Rural intersection; Intersection accident

Michael G. Lenné, Christina M. Rudin-Brown, Jordan Navarro, Jessica Edquist, Margaret Trotter, Nebojsa. *Driver behaviour at rail level crossings : responses to flashing lights, traffic signals and stop signs in simulated rural driving. Pages 548-554.*

Australian road and railway authorities have made a concerted effort to reduce the number of rail level crossings, particularly the higher risk passive crossings that are protected by devices such as 'give way' or 'stop' signs. To improve this situation, passive level crossings are often upgraded with active controls such as flashing red lights. Traffic signals may provide good safety outcomes at level crossings but remain untested. The primary purpose of this research was to compare driver behaviour at two railway level crossings with active controls, flashing red lights and traffic signals, to behaviour at the current standard passive level crossing control, a stop sign. Participants drove the MUARC advanced driving simulator for 30 min. During the simulated drive, participants were exposed to three level crossing scenarios. Each scenario consisted of one of three level crossing control types, and was associated with an oncoming train. Mean vehicle speed on approach to the level crossings decreased more rapidly in response to flashing lights than to traffic signals. While speed on approach was lowest for the stop-sign condition, the number of non-compliant drivers (i.e., those who did not stop) at the crossing was highest for this condition. While results indicate that traffic signals at rail level crossings do not appear to offer any safety benefits over and above flashing red lights, further avenues of research are proposed to reach more definitive conclusions. Compliance was lowest for the passive crossing control which provides further support for the ongoing passive crossing upgrades in Australia.

- **Keywords:** Passive level crossings; Active crossing controls; Driving simulator; Driver behaviour; Compliance

Eckardt Johanning. *Vibration and shock exposure of maintenance-of-way vehicles in the railroad industry. Pages 555-562.*

The aim of this study is to investigate and compare vibration and shock measurements of maintenance-of-way vehicles used in the railroad industry for track maintenance and construction. Following international standards (i.e., ISO 2631-1: 1997) and professional guidelines the frequency weighted root-mean-square (r.m.s.) acceleration for each measurement axis, the vector sum, the seat effective amplitude transmissibility (SEAT), the crest factor (CF), the maximum transient vibration value (MTVV), the vibration dose value (VDV), the ratio and the newly proposed shock risk estimation factor 'R' for spinal injury according to ISO 2631-5:2004 were measured and calculated for seven different maintenance-of-way vehicles during revenue service. Furthermore, a proposed alternative spinal injury prediction method, the VibRisk model, which incorporates different typical driver postures and operator physical characteristics was included for

comparison with the ISO 2631-5 risk prediction. The results of the vibration exposure measurements depended on vehicle type, track/surface conditions and seat properties, with the tamper and bulldozer showing the highest r.m.s. vibration values. The vector sum (a_v) results ranged from 0.37 to 0.99 (m/s^2). Five of seven track maintenance vehicles would exceed the current Whole-body Vibration ACGIH-TLV[®] guideline for an 8 h exposure duration in the vertical axis recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). The measured CF, $MTVV/a_w$ and $VDV/(a_w \cdot T^{1/4})$ ratios were at or above the critical ratios in the majority of measurements given by the ISO 2631-1 (1997) and American industry guidelines by the American Conference of Governmental Industrial Hygienists (ACGIH-TLV). Comparing both prediction models for vibration shock risk for parts of the lumbar spine, different risk predictions and inconsistencies were found. The VibRisk model generally suggests different and higher risk of vertebral endplate failure for individual lumbar levels, whereas the ISO 2631-5 model indicated generally lower risks and did not differentiate between different disk levels and driver posture. Epidemiological studies validating the different shock risk models are lacking. Work modifications and adequate suspension seats would be beneficial for prevention of harmful exposure to vibration and shocks.

- **Keywords:** Vibration; Shock; Railroad; Risk assessment

Catherine Harvey, Neville A. Stanton, Carl A. Pickering, Mike McDonald, Pengjun Zheng. *A usability evaluation toolkit for In-Vehicle Information Systems (IVISs)*. Pages 563-574.

Usability must be defined specifically for the context of use of the particular system under investigation. This specific context of use should also be used to guide the definition of specific usability criteria and the selection of appropriate evaluation methods. There are four principles which can guide the selection of evaluation methods, relating to the information required in the evaluation, the stage at which to apply methods, the resources required and the people involved in the evaluation. This paper presents a framework for the evaluation of usability in the context of In-Vehicle Information Systems (IVISs). This framework guides designers through defining usability criteria for an evaluation, selecting appropriate evaluation methods and applying those methods. These stages form an iterative process of design–evaluation–redesign with the overall aim of improving the usability of IVISs and enhancing the driving experience, without compromising the safety of the driver.

- **Keywords:** Usability; Evaluation; In-Vehicle Information Systems

Robert Broström, Peter Bengtsson, Jakob Axelsson. *Correlation between safety assessments in the driver–car interaction design process*. Pages 575-582.

With the functional revolution in modern cars, evaluation methods to be used in all phases of driver–car interaction design have gained importance. It is crucial for car manufacturers to discover and solve safety issues early in the interaction design process. A current problem is thus to find a correlation between the formative methods that are used during development and the summative methods that are used when the product has reached the customer. This paper investigates the correlation between efficiency metrics from summative and formative evaluations, where the results of two studies on sound and navigation system tasks are compared. The first, an analysis of the J.D. Power and Associates APEAL survey, consists of answers given by about two thousand customers. The second, an expert evaluation study, was done by six evaluators who assessed the layouts by task completion time, TLX and Nielsen heuristics. The results show a high degree of correlation between the studies in terms of task efficiency, i.e. between customer ratings and task completion time, and customer ratings and TLX. However, no correlation was observed between Nielsen heuristics and customer ratings,

task completion time or TLX. The results of the studies introduce a possibility to develop a usability evaluation framework that includes both formative and summative approaches, as the results show a high degree of consistency between the different methodologies. Hence, combining a quantitative approach with the expert evaluation method, such as task completion time, should be more useful for driver-car interaction design.

Keywords: Safety; Usability; IVIS; UEM

Eve Mitsopoulos-Rubens, Margaret J. Trotter, Michael G. Lenné. *Effects on driving performance of interacting with an in-vehicle music player : a comparison of three interface layout concepts for information presentation.* Pages 583-591.

Interface design is an important factor in assessing the potential effects on safety of interacting with an in-vehicle information system while driving. In the current study, the layout of information on a visual display was manipulated to explore its effect on driving performance in the context of music selection. The comparative effects of an auditory-verbal (cognitive) task were also explored. The driving performance of 30 participants was assessed under both baseline and dual task conditions using the Lane Change Test. Concurrent completion of the music selection task with driving resulted in significant impairment to lateral driving performance (mean lane deviation and percentage of correct lane changes) relative to the baseline, and significantly greater mean lane deviation relative to the combined driving and the cognitive task condition. The magnitude of these effects on driving performance was independent of layout concept, although significant differences in subjective workload estimates and performance on the music selection task across layout concepts highlights that potential uncertainty regarding design use as conveyed through layout concept could be disadvantageous. The implications of these results for interface design and safety are discussed.

- **Keywords:** Driving performance; Safety; Interface design; Information layout; Music player; In-vehicle information systems

Neville A. Stanton, Alain Dunoyer, Adam Leatherland. *Detection of new in-path targets by drivers using Stop & Go Adaptive Cruise Control.* Pages 592-601.

This paper reports on the design and evaluation of in-car displays used to support Stop & Go Adaptive Cruise Control. Stop & Go Adaptive Cruise Control is an extension of Adaptive Cruise Control, as it is able to bring the vehicle to a complete stop. Previous versions of Adaptive Cruise Control have only operated above 26 kph. The greatest concern for these technologies is the appropriateness of the driver's response in any given scenario. Three different driver interfaces were proposed to support the detection of modal, spatial and temporal changes of the system: an iconic display, a flashing iconic display, and a representation of the radar. The results show that drivers correctly identified more changes detected by the system with the radar display than with the other displays, but higher levels of workload accompanied this increased detection.

- **Keywords:** Automation; Driving; Cruise control; Driver; Situation awareness; Workload

Paul M. Salmon, Kristie L. Young, Michael A. Regan. *Distraction 'on the buses' : a novel framework of ergonomics methods for identifying sources and effects of bus driver distraction.* Pages 602-610.

Driver distraction represents a significant problem in the public transport sector. Various methods exist for investigating distraction; however, the majority are difficult to apply within the context of naturalistic bus driving. This article investigates the nature of bus driver distraction at a major Australian public transport company, including the sources of distraction present, and their effects on driver performance, through the application of a novel framework of ergonomics methods. The framework represents a novel approach for assessing distraction in a real world context. The findings suggest that there are a number of sources of distraction that could potentially distract bus drivers while driving, including those that derive from the driving task itself, and those that derive from the additional requirements associated with bus operation, such as passenger and ticketing-related distractions. A taxonomy of the sources of bus driver distraction identified is presented, along with a discussion of proposed countermeasures designed to remove the sources identified or mitigate their effects on driver performance.

- **Keywords:** Distraction; Bus drivers; Ergonomics methods; Task analysis

Kristie L. Young, Michael G. Lenné, Amy R. Williamson. *Sensitivity of the lane change test as a measure of in-vehicle system demand. Pages 611-618.*

The Lane Change Test (LCT) is one of the growing number of methods developed to quantify driving performance degradation brought about by the use of in-vehicle devices. Beyond its validity and reliability, for such a test to be of practical use, it must also be sensitive to the varied demands of individual tasks. The current study evaluated the ability of several recent LCT lateral control and event detection parameters to discriminate between visual-manual and cognitive surrogate In-Vehicle Information System tasks with different levels of demand. Twenty-seven participants (mean age 24.4 years) completed a PC version of the LCT while performing visual search and math problem solving tasks. A number of the lateral control metrics were found to be sensitive to task differences, but the event detection metrics were less able to discriminate between tasks. The mean deviation and lane excursion measures were able to distinguish between the visual and cognitive tasks, but were less sensitive to the different levels of task demand. The other LCT metrics examined were less sensitive to task differences. A major factor influencing the sensitivity of at least some of the LCT metrics could be the type of lane change instructions given to participants. The provision of clear and explicit lane change instructions and further refinement of its metrics will be essential for increasing the utility of the LCT as an evaluation tool.

- **Keywords:** Driver distraction; Lane change test; In-vehicle information systems; Evaluation methods

Jessica Edquist, Tim Horberry, Simon Hosking, Ian Johnston. *Effects of advertising billboards during simulated driving. Pages 619-626.*

There is currently a great deal of interest in the problem of driver distraction. Most research focuses on distractions from inside the vehicle, but drivers can also be distracted by objects outside the vehicle. Major roads are increasingly becoming sites for advertising billboards, and there is little research on the potential effects of this advertising on driving performance. The driving simulator experiment presented here examines the effects of billboards on drivers, including older and inexperienced drivers who may be more vulnerable to distractions. The presence of billboards changed drivers' patterns of visual attention, increased the amount of time needed for drivers to respond to road signs, and increased the number of errors in this driving task.

- **Keywords:** Distraction; Roadside advertising; Driving simulation; Lane change test; Response time; Eye movements