

## **Ergonomics– rok 2016, ročník 59**

### **Číslo 3**



#### **Isabel Neumann & Josef F. Krems. *Battery electric vehicles – implications for the driver interface.* Pages 331-343.**

The current study examines the human-machine interface of a battery electric vehicle (BEV) from a user-perspective, focussing on the evaluation of BEV-specific displays, the relevance of provided information and challenges for drivers due to the concept of electricity in a road vehicle. A sample of 40 users drove a BEV for 6 months. Data were gathered at three points of data collection. Participants perceived the BEV-specific displays as only moderately reliable and helpful for estimating the displayed parameters. This was even less the case after driving the BEV for 3 months. A taxonomy of user requirements was compiled revealing the need for improved and additional information, especially regarding energy consumption and efficiency. Drivers had difficulty understanding electrical units and the energy consumption of the BEV. On the background of general principles for display design, results provide implications how to display relevant information and how to facilitate drivers' understanding of energy consumption in BEVs. **Practitioner Summary:** Battery electric vehicle (BEV) displays need to incorporate new information. A taxonomy of user requirements was compiled revealing the need for improved and additional information in the BEV interface. Furthermore, drivers had trouble understanding electrical units and energy consumption; therefore, appropriate assistance is required. Design principles which are specifically important in the BEV context are discussed.

- **Keywords:** Human-machine interface, battery electric vehicle, energy consumption, user-centred design

#### **Bruce Mehler, David Kidd, Bryan Reimer, Ian Reagan, Jonathan Dobres & Anne McCartt. *Multi-modal assessment of on-road demand of voice and manual phone calling and voice navigation entry across two embedded vehicle systems.* Pages 344-367.**

One purpose of integrating voice interfaces into embedded vehicle systems is to reduce drivers' visual and manual distractions with 'infotainment' technologies. However, there is scant research on actual benefits in production vehicles or how different interface designs affect attentional demands. Driving performance, visual engagement, and indices of

workload (heart rate, skin conductance, subjective ratings) were assessed in 80 drivers randomly assigned to drive a 2013 Chevrolet Equinox or Volvo XC60. The Chevrolet MyLink system allowed completing tasks with one voice command, while the Volvo Sensus required multiple commands to navigate the menu structure. When calling a phone contact, both voice systems reduced visual demand relative to the visual-manual interfaces, with reductions for drivers in the Equinox being greater. The Equinox 'one-shot' voice command showed advantages during contact calling but had significantly higher error rates than Sensus during destination address entry. For both secondary tasks, neither voice interface entirely eliminated visual demand. **Practitioner Summary:** The findings reinforce the observation that most, if not all, automotive auditory-vocal interfaces are multi-modal interfaces in which the full range of potential demands (auditory, vocal, visual, manipulative, cognitive, tactile, etc.) need to be considered in developing optimal implementations and evaluating drivers' interaction with the systems. **Social Media:** In-vehicle voice-interfaces can reduce visual demand but do not eliminate it and all types of demand need to be taken into account in a comprehensive evaluation.

- **Keywords:** Voice interface, visual demand, distraction, workload, human-machine interface

**Tao Liu, Matthew Pelowski, Changle Pang, Yuanji Zhou & Jianfeng Cai. *Near-infrared spectroscopy as a tool for driving research. Pages 368-379.***

Driving a motor vehicle requires various cognitive functions to process surrounding information, to guide appropriate actions, and especially to respond to or integrate with numerous contextual and perceptual hindrances or risks. It is, thus, imperative to examine driving performance and road safety from a perspective of cognitive neuroscience, which considers both the behaviour and the functioning of the brain. However, because of technical limitations of current brain imaging approaches, studies have primarily adopted driving games or simulators to present participants with simulated driving environments that may have less ecological validity. Near-infrared spectroscopy (NIRS) is a relatively new, non-invasive brain-imaging technique allowing measurement of brain activations in more realistic settings, even within real motor vehicles. This study reviews current NIRS driving research and explores NIRS' potential as a new tool to examine driving behaviour, along with various risk factors in natural situations, promoting our understanding about neural mechanisms of driving safety.

**Practitioner Summary:** Driving a vehicle is dependent on a range of neurocognitive processing abilities. Near-infrared spectroscopy (NIRS) is a non-invasive brain-imaging technique allowing measurement of brain activation even in on-road studies within real motor vehicles. This study reviews current NIRS driving research and explores the potential of NIRS as a new tool to examine driving behaviour.

- **Keywords:** Driving, road safety, brain imaging, ecological validity, near-infrared spectroscopy (NIRS)

**Floor Richters, Jan Maarten Schraagen & Hans Heerkens. *Assessing the structure of non-routine decision processes in Airline Operations Control. Pages 380-392.***

Unfamiliar severe disruptions challenge Airline Operations Control professionals most, as their expertise is stretched to its limits. This study has elicited the structure of Airline Operations Control professionals' decision process during unfamiliar disruptions by mapping three macrocognitive activities on the decision ladder: sensemaking, option evaluation and action planning. The relationship between this structure and decision quality was measured. A simulated task was staged, based on which think-aloud protocols were obtained. Results show that the general decision process structure

resembles the structure of experts working under routine conditions, in terms of the general structure of the macrocognitive activities, and the rule-based approach used to identify options and actions. Surprisingly, high quality of decision outcomes was found to relate to the use of rule-based strategies. This implies that successful professionals are capable of dealing with unfamiliar problems by reframing them into familiar ones, rather than to engage in knowledge-based processing. **Practitioner Summary:** We examined the macrocognitive structure of Airline Operations Control professionals' decision process during a simulated unfamiliar disruption in relation to decision quality. Results suggest that successful professionals are capable of dealing with unfamiliar problems by reframing them into familiar ones, rather than to engage in knowledge-based processing.

- **Keywords:** Decision-making, Airline Operations Control, fractionated expertise, macrocognitive activities

**Nathan Lau, Greg A. Jamieson & Gyrd Skraaning Jr. *Empirical evaluation of the Process Overview Measure for assessing situation awareness in process plants. Pages 393-408.***

The Process Overview Measure is a query-based measure developed to assess operator situation awareness (SA) from monitoring process plants. A companion paper describes how the measure has been developed according to process plant properties and operator cognitive work. The Process Overview Measure demonstrated practicality, sensitivity, validity and reliability in two full-scope simulator experiments investigating dramatically different operational concepts. Practicality was assessed based on qualitative feedback of participants and researchers. The Process Overview Measure demonstrated sensitivity and validity by revealing significant effects of experimental manipulations that corroborated with other empirical results. The measure also demonstrated adequate inter-rater reliability and practicality for measuring SA in full-scope simulator settings based on data collected on process experts. Thus, full-scope simulator studies can employ the Process Overview Measure to reveal the impact of new control room technology and operational concepts on monitoring process plants. **Practitioner Summary:** The Process Overview Measure is a query-based measure that demonstrated practicality, sensitivity, validity and reliability for assessing operator situation awareness (SA) from monitoring process plants in representative settings.

- **Keywords:** Full-scope simulator, experiments, process control, nuclear

**Maria Mikela Chatzimichailidou & Ioannis M. Dokas. *Introducing RiskSOAP to communicate the distributed situation awareness of a system about safety issues: an application to a robotic system. Pages 409-422.***

This paper introduces the *RiskSOAP* ('RiskSOAP' is the abbreviation for **Risk Situation Awareness Provision**.) indicator to measure the capability of a complex socio-technical system to provide its agents with situation awareness (SA) about the presence of its threats and vulnerabilities and enables analysts to assess distributed SA. The RiskSOAP methodology adopts a comparative approach between two design versions of a system differing in the elements and characteristics that can enhance or cause the degradation of the awareness provision capability. The methodology uniquely combines three methods: (1) the STPA hazard analysis, (2) the EWaSAP early warning sign identification approach, and (3) a dissimilarity measure for calculating the distance between binary sets. In this paper, the *RiskSOAP* methodology was applied to a robotic system and the findings show that the indicator is an objective measure for the system's capability to provide its agents with SA about its threats and vulnerabilities. **Practitioner Summary:** This paper suggests a novel methodology for assessing distributed situation awareness (DSA) regarding safety issues. Given that systems consist of specifications and

components possible to be mapped, the risk SA provision capability (RiskSOAP) methodology demonstrates the feasibility of measuring to what extent systems' elements contribute to the emergence of DSA.

- **Keywords:** Distributed situation awareness, safety, STPA, EWaSAP, risk SA provision capability indicator

**Jonas Rybing, Heléne Nilsson, Carl-Oscar Jonson & Magnus Bang. *Studying distributed cognition of simulation-based team training with DiCoT. Pages 423-434.***

Health care organizations employ *simulation-based team training* (SBTT) to improve skill, communication and coordination in a broad range of critical care contexts. Quantitative approaches, such as team performance measurements, are predominantly used to measure SBTTs effectiveness. However, a practical evaluation method that examines how this approach supports cognition and teamwork is missing. We have applied *Distributed Cognition for Teamwork* (DiCoT), a method for analysing cognition and collaboration aspects of work settings, with the purpose of assessing the methodology's usefulness for evaluating SBTTs. In a case study, we observed and analysed four Emergo Train System® simulation exercises where medical professionals trained emergency response routines. The study suggests that DiCoT is an applicable and learnable tool for determining key distributed cognition attributes of SBTTs that are of importance for the simulation validity of training environments. Moreover, we discuss and exemplify how DiCoT supports design of SBTTs with a focus on transfer and validity characteristics.

**Practitioner Summary:** In this study, we have evaluated a method to assess simulation-based team training environments from a cognitive ergonomics perspective. Using a case study, we analysed Distributed Cognition for Teamwork (DiCoT) by applying it to the Emergo Train System®. We conclude that DiCoT is useful for SBTT evaluation and simulator (re)design.

- **Keywords:** Simulation, team training, distributed cognition, prehospital medicine, methodology

**Heljä Franssila, Jussi Okkonen & Reijo Savolainen. *Developing measures for information ergonomics in knowledge work. Pages 435-448.***

Information ergonomics is an evolving application domain of ergonomics focusing on the management of workload in the real-world contexts of information-intensive tasks. This study introduces a method for the evaluation of information ergonomics in knowledge work. To this end, five key dimensions of information ergonomics were identified: contextual factors of knowledge work, multitasking, interruptions at work, practices for managing information load, and perceived job control and productivity. In total, 24 measures focusing on the above dimensions were constructed. The measures include, for example, the number of fragmented work tasks per work day. The measures were preliminarily tested in two Finnish organisations, making use of empirical data gathered by interviews, electronic questionnaires and log data applications tracking work processes on personal computers. The measures are applicable to the evaluation of information ergonomics, even though individual measures vary with regard to the amount of work and time needed for data analysis. **Practitioner Summary:** The study introduces a method for the evaluation of information ergonomics in knowledge work. To this end, 24 measures were constructed and tested empirically. The measures focus on contextual factors of knowledge work, multitasking, interruptions at work, practices for managing information load, and perceived job control and productivity.

- **Keywords:** Information ergonomics, knowledge work, measurement, mental workload

**Juliane Botter, Rolf P. Ellegast, Eva-Maria Burford, Britta Weber, Reinier Könemann & Dianne A. C. M. Commissaris. *Comparison of the postural and physiological effects of two dynamic workstations to conventional sitting and standing workstations. Pages 449-463.***

Increasing evidence is being found for the association of health risk factors with work-related physical inactivity. An increasing number of people are being exposed to this form of inactivity, and as a result, various interventions aimed at increasing physical activity during working hours are being developed. This study aims to investigate the differences in postural, muscular and physical activities resulting from two dynamic workstations, namely an elliptical trainer and a treadmill workstation, compared with a conventional sitting and standing workstation. Twelve participants completed five standardised office tasks in a laboratory setting at all workstations. No significant effect was found regarding changes in posture and the muscular activity was only significantly higher for the trapezius muscle (50th percentile: 8.1 %MVC) at the dynamic workstations. For the dynamic workstations, physical activity ranged from 4.0 to 14.9 × 10<sup>-2</sup> g, heart rate from 14.3 to 27.5 %HRR and energy expenditure from 1.8 to 3.1 METs. **Practitioner Summary:** Work-related physical inactivity is associated with health risk factors. In this study, physiological and postural effects of dynamic workstations were assessed in comparison to conventional workstations. No significant effects were found regarding changes in posture and muscular activity. Physical activity, heart rate and energy expenditure increased for the dynamic workstations.

- **Keywords:** Dynamic workstations, postural analysis, muscular activity, physical activity

**E. H. C. Woo, P. White & C. W. K. Lai. *Ergonomics standards and guidelines for computer workstation design and the impact on users' health – a review. Pages 464-475.***

This paper presents an overview of global ergonomics standards and guidelines for design of computer workstations, with particular focus on their inconsistency and associated health risk impact. Overall, considerable disagreements were found in the design specifications of computer workstations globally, particularly in relation to the results from previous ergonomics research and the outcomes from current ergonomics standards and guidelines. To cope with the rapid advancement in computer technology, this article provides justifications and suggestions for modifications in the current ergonomics standards and guidelines for the design of computer workstations. **Practitioner Summary:** A research gap exists in ergonomics standards and guidelines for computer workstations. We explore the validity and generalisability of ergonomics recommendations by comparing previous ergonomics research through to recommendations and outcomes from current ergonomics standards and guidelines.

- **Keywords:** Computer workstation, ergonomics, standards and guidelines, visual display terminal