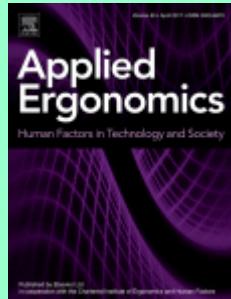


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Joana Vieira, Joana Maria A. Osório, Sandra Mouta, Pedro Delgado, Aníbal Portinha, José Filipe Meireles, Jorge Almeida Santos. Kansei engineering as a tool for the design of in-vehicle rubber keypads. Pages 1-11.

Manufacturers are currently adopting a consumer-centered philosophy which poses the challenge of developing differentiating products in a context of constant innovation and competitiveness. To merge both function and experience in a product, it is necessary to understand customers' experience when interacting with interfaces. This paper describes the use of Kansei methodology as a tool to evaluate the subjective perception of rubber keypads. Participants evaluated eleven rubber keys with different values of force, stroke and snap ratio, according to seven Kansei words ranging from "pleasantness" to "clickiness". Evaluation data was collected using the semantic differential technique and compared with data from the physical properties of the keys. Kansei proved to be a robust method to evaluate the qualitative traits of products, and a new physical parameter for the tactile feel of "clickiness" is suggested, having obtained better results than the commonly used Snap Ratio. It was possible to establish very strong relations between Kansei words and all physical properties. This approach will result in guidance to the industry for the design of in-vehicle rubber keypads with user-centered concerns.

- **Keywords:** Kansei engineering; Rubber keypads; Automotive HMI; Snap ratio

Junfeng Peng, Xuguang Wang, Lisa Denninger. Ranges of the least uncomfortable joint angles for assessing automotive driving posture. Pages 12-21.

Few investigations have been performed on how the ranges of preferred angles should be used for vehicle interior discomfort evaluation. This study investigated the ranges of the least uncomfortable joint angles considering both inter-individual and intra-individual variability. The driving postures of sixty-one subjects were collected using two multi-adjustable vehicle mock-ups under four test conditions by gradually adding the number of control parameters (constraints), from the "least-constrained" driving condition to the configurations close to currently existing vehicles. With help of subjective discomfort evaluation, the intra-and inter-individual variation ranges of least uncomfortable postural angles were quantified. Results show that intra-individual variation ranges of postural angles were much smaller than those of inter-individual variation as expected. An individual may not feel comfortable throughout the whole range of comfortable angles from all participants. Possible relationships between perceived discomfort and ranges of

inter and inter individual variations in least uncomfortable angles were explored, suggesting that the inter ranges could be used to detect potential problems of postural discomfort and the intra ranges could be considered as optimum ranges. A three color model, based on the intra-and inter-individual variability ranges of comfortable driving postures, was proposed for ergonomics assessment of a vehicle configuration.

- **Keywords:** Driving posture; Discomfort; Digital human modeling; Vehicle packaging

J. Regente, J. de Zeeuw, F. Bes, C. Nowozin, S. Appelhoff, A. Wahnschaffe, M. Münch, D. Kunz. *Can short-wavelength depleted bright light during single simulated night shifts prevent circadian phase shifts?* Pages 22-30.

In single night shifts, extending habitual wake episodes leads to sleep deprivation induced decrements of performance during the shift and re-adaptation effects the next day. We investigated whether short-wavelength depleted (=filtered) bright light (FBL) during a simulated night shift would counteract such effects. Twenty-four participants underwent a simulated night shift in dim light (DL) and in FBL. Reaction times, subjective sleepiness and salivary melatonin concentrations were assessed during both nights. Daytime sleep was recorded after both simulated night shifts. During FBL, we found no melatonin suppression compared to DL, but slightly faster reaction times in the second half of the night. Daytime sleep was not statistically different between both lighting conditions ($n = 24$) and there was no significant phase shift after FBL ($n = 11$). To conclude, our results showed positive effects from FBL during simulated single night shifts which need to be further tested with larger groups, in more applied studies and compared to standard lighting.

- **Keywords:** Shift work; Circadian; Blue-light depletion

Tobias Heine, Gustavo Lenis, Patrick Reichensperger, Tobias Beran, Olaf Doessel, Barbara Deml. *Electrocardiographic features for the measurement of drivers' mental workload.* Pages 31-43.

This study examines the effect of mental workload on the electrocardiogram (ECG) of participants driving the Lane Change Task (LCT). Different levels of mental workload were induced by a secondary task (n-back task) with three levels of difficulty. Subjective data showed a significant increase of the experienced workload over all three levels. An exploratory approach was chosen to extract a large number of rhythmical and morphological features from the ECG signal thereby identifying those which differentiated best between the levels of mental workload. No single rhythmical or morphological feature was able to differentiate between all three levels. A group of parameters were extracted which were at least able to discriminate between two levels. For future research, a combination of features is recommended to achieve best diagnosticity for different levels of mental workload.

- **Keywords:** Mental workload; Driving; Electrocardiogram; Feature comparison; Heart rate variability; Wave morphology

Ilse M. Harms, Karel A. Brookhuis. *Traffic management: Assessing various countermeasures to improve detection failure of changes in speed limit signals.* Pages 44-52.

Under certain circumstances, drivers fail to notice changes in electronic speed limits. A video-based study was performed to reveal which countermeasures would improve drivers' ability to detect changes in electronic speed limits. Countermeasures included

leaving electronic signs blank prior to a speed limit change and adding motion signals by means of flashing amber lights or a wave. A video representing a motorway was shown repeatedly to 255 participants. They were instructed to press the space bar when detecting a change. The video was viewed 13 times before the speed limit changed. Results showed that leaving signs blank prior to the change instead of displaying speed limits continuously did not alter change detection, whereas flashers and waves eroded detection of the changed speed limit. This suggests that using flashers and waves to attract attention to electronic signs in fact decreases people's ability to process the information contained in the signs.

- **Keywords:** Change blindness; Variable speed limit; Flasher

Elise Jouanne, Camilo Charron, Christine Chauvin, Gaël Morel. *Correlates of team effectiveness: An exploratory study of firefighter's operations during emergency situations.* Pages 69-77.

This paper examines elements contributing to the effectiveness of firefighting teams carrying out typical tasks. Fourteen firefighter crews were filmed during nineteen real operations and answered questionnaires relating to psychosocial dimensions. Results have shown that "enriched closed-loops" of communication, positive emotional interactions and a "gamma" type of adaptation are positively related to team effectiveness. Conversely, open and incomplete loops of communication, negative emotional interactions, "beta" and "alpha" types of adaptation are negatively related to team effectiveness. Furthermore, there is a mediated link between organisational trust and motivation on the one hand and team effectiveness on the other. These findings highlight the necessity to consider both cognitive and psychosocial variables to account for team effectiveness in the firefighting profession. They also emphasize the need to expand firefighter training to the "non-technical" aspects of the competence.

- **Keywords:** Teamwork; Adaptation; Closed-loop communication; Emergency situations; Fire-fighters

Sandra D. Starke, Chris Baber, Neil J. Cooke, Andrew Howes. *Workflows and individual differences during visually guided routine tasks in a road traffic management control room.* Pages 79-89.

Road traffic control rooms rely on human operators to monitor and interact with information presented on multiple displays. Past studies have found inconsistent use of available visual information sources in such settings across different domains. In this study, we aimed to broaden the understanding of observer behaviour in control rooms by analysing a case study in road traffic control. We conducted a field study in a live road traffic control room where five operators responded to incidents while wearing a mobile eye tracker. Using qualitative and quantitative approaches, we investigated the operators' workflow using ergonomics methods and quantified visual information sampling. We found that individuals showed differing preferences for viewing modalities and weighting of task components, with a strong coupling between eye and head movement. For the quantitative analysis of the eye tracking data, we propose a number of metrics which may prove useful to compare visual sampling behaviour across domains in future.

- **Keywords:** Control room operations; Eye tracking; Information search

Ari Kolbeinsson, Jessica Lindblom, Peter Thorvald. *Missing mediated interruptions in manual assembly: Critical aspects of breakpoint selection.* Pages 90-101.

The factory of the future aims to make manufacturing more effective and easily customisable, using advanced sensors and communications to support information management. In this paper, we examine how breakpoint selection during interruption management can fail, even when using recommendations for interruption management from existing research. We present an experiment based on prior work where mediated interruptions (i.e. smart interruptions that should interrupt at opportune moments) were missed by participants when sent at one of two pre-defined breakpoints. These breakpoints were selected based on existing research to minimise the cost of interruption, which can involve longer times to complete tasks as well as making errors on tasks. Missing mediated interruptions in this way was unexpected, and the prior study was not configured to measure this effect, which has led to the experiment detailed here. We strive to explore whether there is a risk of missing notifications when mediated interruptions are used, and how this is affected by breakpoint selection. This was investigated through an experiment that uses tasks and environments that simulate a manufacturing assembly facility.

The results indicate that the effect exists, i.e. that participants miss significantly more notifications when interrupted at fine breakpoints than when interrupted at coarse breakpoints. An embodied cognition perspective was used for analysis of the tasks to understand the cause of the effect. This analysis shows that an overlap between "action" and "anticipation of action" can account for why participants miss notifications at fine breakpoints. Based on these findings, recommendations were developed for designing interruption systems that minimise the costs (errors and time) imposed by interruptions during assembly tasks in manufacturing.

- **Keywords:** Interruptions; Mediated interruptions; Breakpoint selection; Manual assembly; Manufacturing

Emilia Irzmańska, Tomasz Tokarski. A new method of ergonomic testing of gloves protecting against cuts and stabs during knife use. Pages 102-114.

The paper presents a new method of ergonomic evaluation of gloves protecting against cuts and stabs during knife use, consisting of five manual dexterity tests. Two of them were selected based on the available literature and relevant safety standards, and three were developed by the authors. All of the tests were designed to simulate occupational tasks associated with meat processing as performed by the gloved hand in actual workplaces. The tests involved the three most common types of protective gloves (knitted gloves made of a coverspun yarn, metal mesh gloves, and metal mesh gloves with an ergonomic polyurethane tightener) and were conducted on a group of 20 males. The loading on the muscles of the upper limb (adductor pollicis, flexor carpi ulnaris, flexor carpi radialis, and biceps brachii) was measured using surface electromyography. For the obtained muscle activity values, correlations were found between the glove type and loading of the upper limb. ANOVA showed that the activity of all muscles differed significantly between the five tests. A relationship between glove types and electromyographic results was confirmed at a significance level of $\alpha = 0.05$.

- **Keywords:** Manual dexterity tests; Protective gloves; Protection from cuts and stabs during knife use; Simulation of workplace conditions; EMG

Keenan R. May, Bruce N. Walker. The effects of distractor sounds presented through bone conduction headphones on the localization of critical environmental sounds. Pages 144-158.

Bone conduction headphones are devices that transmit sound through the bones of a listener's head rather than through the air in their outer ear. They have been marketed as a safer way to enjoy audio content while walking, jogging, or cycling. However,

listening to distracting sounds over bone conduction may still disrupt a listener's awareness of their auditory environment. The present study investigated the nature of this interference with the faculty of sound source localization-a key prerequisite for generating situation awareness through audio. Participants sat in the middle of a circle of loudspeakers and listened for target sounds played from different directions. Each time they heard a sound, they responded by indicating what direction they judged the sound to have come from. Meanwhile, participants listened to distractor sounds played through bone conduction headphones. Participants heard (1) no distractor sounds, (2) a spoken story that they were instructed to ignore, and (3) the same spoken story that they were instructed to attend to. For conditions (2) and (3), some participants heard a version of the story with background music, while others heard the spoken story without the music. Participants had greater localization error in the distractor-present conditions. Additionally, participants who heard the spoken story with music exhibited greater localization error. However, there was no effect of whether participants ignored or attended to distractors. This pattern was attributed to masking effects, and was more pronounced for narrow-band targets compared to broadband targets. Post-hoc analyses found evidence of a 'pulling' effect, in which localization judgments were systematically biased toward the apparent direction of the bone conducted distractors. These results indicate that using bone conduction headphones can be expected to cause a decline in a person's awareness of their environment, in a subtle way that a jogger or cyclist might not be actively aware of, even if their attention is directed to the environment and environmental sounds are readily detectable.

- **Keywords:** Bone conduction; Cycling; Distraction; Localization; Audio

Hwayeong Kang, Gwanseob Shin. *Effects of touch target location on performance and physical demands of computer touchscreen use. Pages 159-167.*

Touchscreen interfaces for computers are known to cause greater physical stress compared to traditional computer interfaces. The objective of this study was to evaluate how physical demands and task performance of a tap gesture on a computer touchscreen vary between target locations and display positions. Twenty-three healthy participants conducted reach-tap-return trials with touch targets at fifteen locations in three display positions. Mean completion time, touch accuracy and electromyography of the shoulder and neck extensor muscles were compared between the target locations and display positions. The results demonstrated that participants completed the trial 12%–27% faster with 13%–39% less muscle activity when interacting with targets in the lower area of the display compared to when tapping upper targets ($p < 0.05$). The findings suggest that proper target placement and display positioning can improve task performance and lessen physical demands of computer touchscreen interface use.

- **Keywords:** EMG; Touch gesture; Muscle activity

Jie Yang, Wenguo Weng, Faming Wang, Guowen Song. *Integrating a human thermoregulatory model with a clothing model to predict core and skin temperatures. Pages 168-177.*

This paper aims to integrate a human thermoregulatory model with a clothing model to predict core and skin temperatures. The human thermoregulatory model, consisting of an active system and a passive system, was used to determine the thermoregulation and heat exchanges within the body. The clothing model simulated heat and moisture transfer from the human skin to the environment through the microenvironment and fabric. In this clothing model, the air gap between skin and clothing, as well as clothing properties such as thickness, thermal conductivity, density, porosity, and tortuosity were taken into consideration. The simulated core and mean skin temperatures were compared to the published experimental results of subject tests at three levels of

ambient temperatures of 20 °C, 30 °C, and 40 °C. Although lower signal-to-noise-ratio was observed, the developed model demonstrated positive performance at predicting core temperatures with a maximum difference between the simulations and measurements of no more than 0.43 °C. Generally, the current model predicted the mean skin temperatures with reasonable accuracy. It could be applied to predict human physiological responses and assess thermal comfort and heat stress.

- **Keywords:** Human thermoregulatory model; Clothing model; Human physiological responses; Core temperature; Skin temperature

Alexander Kalloniatis, Irena Ali, Timothy Neville, Phuong La, Iain Macleod, Mathew Zuparic, Elizabeth Kohn. *The Situation Awareness Weighted Network (SAWN) model and method: Theory and application.* Pages 178-196.

We introduce a novel model and associated data collection method to examine how a distributed organisation of military staff who feed a Common Operating Picture (COP) generates Situation Awareness (SA), a critical component in organisational performance. The proposed empirically derived Situation Awareness Weighted Network (SAWN) model draws on two scientific models of SA, by Endsley involving perception, comprehension and projection, and by Stanton et al. positing that SA exists across a social and semantic network of people and information objects in activities connected across a set of tasks. The output of SAWN is a representation as a weighted semi-bipartite network of the interaction between people ('human nodes') and information artefacts such as documents and system displays ('product nodes'); link weights represent the Endsley levels of SA that individuals acquire from or provide to information objects and other individuals. The SAWN method is illustrated with aggregated empirical data from a case study of Australian military staff undertaking their work during two very different scenarios, during steady-state operations and in a crisis threat context. A key outcome of analysis of the weighted networks is that we are able to quantify flow of SA through an organisation as staff seek to "value-add" in the conduct of their work.

- **Keywords:** Situation awareness; Empirical model; Case studies; Network analysis

Jessica A. Dobson, Diane L. Riddiford-Harland, Alison F. Bell, Julie R. Steele. *Work boot design affects the way workers walk: A systematic review of the literature.* Pages 53-68.

Safety boots are compulsory in many occupations to protect the feet of workers from undesirable external stimuli, particularly in harsh work environments. The unique environmental conditions and varying tasks performed in different occupations necessitate a variety of boot designs to match each worker's occupational safety and functional requirements. Unfortunately, safety boots are often designed more for occupational safety at the expense of functionality and comfort. In fact, there is a paucity of published research investigating the influence that specific variations in work boot design have on fundamental tasks common to many occupations, such as walking. This literature review aimed to collate and examine what is currently known about the influence of boot design on walking in order to identify gaps in the literature and develop evidence-based recommendations upon which to design future research studies investigating work boot design.

- **Keywords:** Work boot design; Walking; Gait; Biomechanics

Andreas K. Orphanides, Chang S. Nam. *Touchscreen interfaces in context: A systematic review of research into touchscreens across settings, populations, and implementations.* Pages 116-143.

Although many studies have been conducted on the human factors and ergonomics (HFE) of touchscreens, no comprehensive review has summarized the findings of these studies. Based on a schema (three dimensions of understanding critical for successful display selection) presented by Wickens et al. (2004), we identified three dimensions of analysis for touchscreen implementations: touchscreen technology, setting and environment of implementation, and user population. We conducted a systematic review based on the PRISMA protocol (Moher et al., 2009), searching five article databases for relevant quantitative literature on touchscreens. We found that all three dimensions of analysis have a significant effect on the HFE of touchscreens, and that a selection for or against touchscreens must take into consideration the specific context of system interaction in order to maximize safety, performance, and user satisfaction. Our report concludes with a set of specific recommendations for systems designers considering touchscreens as input/output devices, and suggestions for future study into the HFE of touchscreens.

- **Keywords:** Touchscreen interface; Human factors and ergonomics; User-centered design