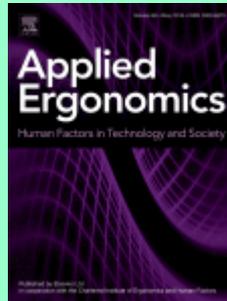


## **Applied Ergonomics - rok 2022, Volume 100**

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**Nima Ahmadi, Matthew Romoser, Christian Salmon. *Improving the tactical scanning of student pilots: A gaze-based training intervention for transition from visual flight into instrument meteorological conditions.* 103642.**

Eye tracking has been applied to train novice drivers and clinicians; however, such applications in aviation are limited. This study develops a gaze-based intervention using video-based, expert commentary, and 3M (Mistake, Mitigation, Mastery) training to instruct visual flight rule student pilots on an instrument cross-check to mitigate the risk of losing aircraft control when they inadvertently enter instrument meteorological conditions (IMC). Twenty general aviation student pilots were randomized into control and experimental groups. Dwell time, return time, entropy, Kullback-Leibler divergence, and deviations from flight paths were compared before and after training to straight-and-level-flight (LF) and standard left level turn (LT) scenarios. After the training, the experimental pilots significantly increased dwell time on primary instruments (PIs), reduced randomness in visual search, and fixated on the PIs in shorter times (in the scenario of LT). In terms of piloting, all experimental pilots successfully kept the aircraft control while five control pilots lost control in IMC; significant differences in altitude and rate of climb deviations were observed between groups (in the scenario of LF).

- **Keywords:** General aviation pilots; Gaze-based training intervention; Eye tracking technology

**Emily E. Meehan, Natasa Vidic, Kurt E. Beschorner. *In contrast to slip-resistant shoes, fluid drainage capacity explains friction performance across shoes that are not slip-resistant.* 103663.**

Slip and fall injuries can be prevented through footwear with good friction performance. The factors that contribute to friction in non-slip-resistant (NSR) shoes are not well understood. The purpose of this study was to determine whether predictive models for slip-resistant (SR) shoes also apply to NSR shoes. This study also quantified the contributions of under-shoe fluid drainage to friction in NSR shoes. The coefficient of friction (ACOF) and under-shoe fluid pressures of fifteen NSR shoes were measured. A previously developed ACOF prediction model based on measurable outsole features was applied to the NSR shoes. The previously developed model did not apply well (in trends, as indicated by interaction effects involving SR/NSR classification, or in magnitude,  $p < 0.001$ ) to NSR shoes. Instead, an increase in the fluid pressures were associated with a reduction in ACOF ( $p < 0.001$ ). This study demonstrates that fluid pressures dominate performance in NSR shoes in contrast to SR shoes.

- **Keywords:** Slips; Trips; And falls; Coefficient of friction; Footwear

**Zixian Yang, Ita Suzana Mat Jais, Therma Wai Chun Cheung. *Which is the most ergonomic mop? A comparison of three domestic mopping systems.* 103669.**

**Purpose:** To assess musculoskeletal risk factors (repetitions, posture, forces) of the upper limb during domestic floor mopping tasks. **Methods:** Two hundred women were surveyed to determine the most common mopping system, mopping patterns and type of flooring used in their homes. The biomechanical demands of the three most common mopping systems were then evaluated in the laboratory. Participants were also asked to rate their perceived levels of exertion and cleanliness of each mopping system. **Results:** The use of wet wipes had the highest repetition count and exertion rates during mopping and scrubbing tasks. Higher peak scrubbing forces were noted for the plunge mop. All participants found the cotton fibre mop to be the cleanest. All 3 mops had medium postural risk. **Conclusion:** The advantages and disadvantages of each mopping system were outlined and may be used by occupational therapists when providing ergonomic advice to patients with upper limb musculoskeletal conditions.

- **Keywords:** Occupational therapy; Housework; Musculoskeletal disorders

**Philipp Wolf, Nikica Hennes, Jessica Rausch, Wolfgang Potthast. *The effects of stature, age, gender, and posture preferences on preferred joint angles after real driving.* 103671.**

Few studies have investigated preferred driving posture involving real-world driving. For this purpose, seven preferred joint angles of 127 participants were recorded three times from sagittal plane photographs after a short, standardized drive on public roads. Participants' individual driving posture preferences were determined using a word-based questionnaire. The inter- and intraindividual joint angle differences were calculated and some significant effects of stature, age, and gender on these joint angle differences were found. Additionally, significant correlations were found between posture preferences and joint angles, except for the lower extremities. The results show that the factors stature, age, gender, and posture preferences have influence on the preferred joint angles. However, other human-, vehicle-, and context-related factors also seem relevant and should be considered in future studies. The results provide important field-based knowledge for an application-oriented understanding of driving posture and for the human-centered design process of future vehicle interior research and development.

- **Keywords:** Automotive; Driving posture; Vehicle design

**Taylor B. Winberg, Michal N. Glinka, Kaitlin M. Gallagher, Tyler B. Weaver, Andrew C. Laing, Jack P. Callaghan. *Anti-fatigue mats can reduce low back discomfort in transient pain developers.* 103661.**

Complaints of musculoskeletal pain are common among employees who stand for prolonged periods. This study sought to determine if an anti-fatigue mat (AFM) could uniquely affect low back pain (LBP), low back posture, and foot-floor interface responses in individuals prone to developing LBP (termed pain developers (PDs)) during prolonged standing experiments compared to those who do not develop LBP under the same exposures (termed non pain developers (NPDs)). Sixteen volunteers (8 PDs and 8 NPDs) were recruited based on their pain-development tendencies, which were established in previous standing experiments. They visited the laboratory on two separate days for 60 min of light manual work while standing on either a rigid floor or AFM. All participants were asymptomatic at the beginning of each experimental session. The amount of LBP experienced during the standing exposure, measured via a visual analogue scale, was

reduced ( $p = 0.03$ ) in the PD group when on the AFM ( $3.6 \pm 6$  mm) compared to the rigid floor ( $6.8 \pm 7$  mm). LBP levels remained low and unchanged ( $p = 0.5$ ) between the AFM ( $2.4 \pm 5$  mm) and rigid floor ( $1.6 \pm 2$  mm) conditions for the NPD group. Neither postural nor foot-floor interface measures correlated with this unique reduction of LBP for the PD group when standing on the AFM. The AFM did, however, increase centre of pressure excursion (NPD 55% increase; PD 35% increase) and tended to increase the number of body weight shifts (NPD 116% increase; PD 54% increase) in both the PD and NPD groups. These findings suggest that AFMs may selectively benefit individuals prone to developing standing-induced back pain by facilitating subtle movements at the foot-floor interface.

- **Keywords:** Anti-fatigue mats; Low back pain; Prolonged standing

**Aditi Gupta, Harvey M. Edwards III, Aaron R. Rodriguez, Ryan J. McKindles, Leia A. Stirling. *Alternative cue and response modalities maintain the Simon effect but impact task performance.* 103648.**

Inhibitory control, the ability to inhibit impulsive responses and irrelevant stimuli, enables high level functioning and activities of daily living. The Simon task probes inhibition using interfering stimuli, i.e., cues spatially presented on the opposite side of the indicated response; incongruent response times (RT) are slower than congruent RTs. Operational applicability of the Simon task beyond finger/hand manipulations and visual/auditory cues is unclear, but important to consider as new technologies provide tactile cues and require motor responses from the lower extremity (e.g., exoskeletons). In this study, twenty participants completed the Simon task under four conditions, each combination of two cue (visual/tactile) and response (upper/lower-extremity) modalities. RT were significantly longer for incongruent than congruent cues across cue-response pairs. However, alternative cue-response pairs yielded slower RT and decreased accuracy for tactile cues and lower-extremity responses. Results support operational usage of the Simon task to probe inhibition using tactile cues and lower-extremity responses relevant for new technologies like exoskeletons and immersive environments.

- **Keywords:** Information processing; Tactile/haptic displays; Perception-action

**Jodi Oakman, Victoria Weale, Natasha Kinsman, Ha Nguyen, Rwth Stuckey. *Workplace physical and psychosocial hazards: A systematic review of evidence informed hazard identification tools.* 103614.**

Prevention of musculoskeletal disorders (MSDs) requires the identification of physical and psychosocial hazards. This systematic review aimed to identify accessible and validated tools, for the assessment of workplace physical and psychosocial hazards, and consolidate the results into a matrix for use by work health and safety (WHS) professionals. Web of Science, Medline, ProQuest Central, and PsychInfo electronic databases, along with grey literature, were searched (Jan 1990 to July 2020). Studies that included tools with evidence of validity for the identification of physical hazards, psychosocial hazards, or both were included. A total of 83 tools were identified and then reviewed to ensure the tools were accessible. The final matrix included a total of 26 tools (16 physical, 4 psychosocial, and 6 comprehensive [physical and psychosocial]). Evidence on best practice for MSD mitigation supports the need for a comprehensive approach; however, the current review identified limitations in the availability of such tools to support WHS professionals.

- **Keywords:** Hazards; Risk assessment; Musculoskeletal disorders; Ergonomics; Tools

**Fang Fu, Yan Luximon. *Comfort and fit perception based on 3D anthropometry for ear-related product design.* 103640.**

Anthropometry and human perception lie at the core of the ergonomic design process. Until now, relevant studies have been quite restricted, being unable to provide a holistic view of the perceived comfort and fit for ear-related products. The study examined the perceived comfort and fit using factor analysis and established a linkage between anthropometry and human perception for design uses. A total of 30 participants (15 male, 15 female) were recruited in the within-subject experiment. The results showed that ear symmetry, gender, concha length, and cavum concha width had either insignificant or weak correlation with the perception scores. Use condition and product size significantly influenced the perceived comfort and fit for ear-related products. Users preferred a larger product size in the dynamic condition than in the static condition. Moreover, the study proposed a novel method to quantify the relationship between anthropometric data and human perception for the ear-related product. For an in-the-ear product, trendlines were generated to link the product size based on 3D anthropometry with the comfort and fit scores.

- **Keywords:** Comfort and fit; Human perception; 3D modeling; Ear-related product design

**Emmanuel Tetteh, M. Susan Hallbeck, Gary A. Mirka. *Effects of passive exoskeleton support on EMG measures of the neck, shoulder and trunk muscles while holding simulated surgical postures and performing a simulated surgical procedure.* 103646.**

Exoskeletons have shown significant impact at reducing the biomechanical demand on muscles during repetitive lifting and overhead tasks in non-healthcare industries. However, the benefits of exoskeletons are yet to be realized in the operating room, particularly as work-related musculoskeletal disorders continue to be a concern for surgeons. This study quantified the effect of using neck, arm, and trunk exoskeletons on muscle activity while assuming typical postures held in the operating room. Fourteen participants were recruited to participate in this study. In this two-part experiment participants were asked to 1) hold a series of neck flexion, arm abduction and trunk flexion postures seen in surgical procedures, and 2) perform a simulated surgical task requiring five different trunk flexion posture levels. Participants were required to complete these tasks with and without passive exoskeleton(s). This study showed that even for postures held short time periods, exoskeletons are beneficial at reducing the demand on muscles; however, the reduction in muscle demand depends on body segment and postural angle, as intended with these passive exoskeletons. Furthermore, for the simulated surgical task with awkward trunk flexion postures (10–65°), the trunk exoskeletons showed a significant reduction in the rate of rise in back muscle sEMG (+1.365%MVC/min vs. +0.769%MVC/min for non-dominant lumbar extensor muscles,  $p = 0.0108$ ; +1.377%MVC/min vs. +0.770%MVC/min for the dominant lumbar extensor muscles,  $p = 0.0196$ ) over 25 min, consequently resulting in improved trunk subjective discomfort scores (7.34 vs. 4.30,  $p < 0.05$ ), with no impact on the neck and shoulder biomechanical demand. The results from this study indicate that exoskeletons may be a potential intervention to reduce biomechanical loading during surgery.

- **Keywords:** sEMG; Musculoskeletal disorders; Passive exoskeleton

**Nathalie M.C.W. Oomen, Ryan B. Graham, Steven L. Fischer. *Exploring the role of task constraints on motor variability and assessing consistency in individual responses during repetitive lifting using linear variability of kinematics.* 103668.**

To better understand the assessment of motor variability (MV) in an occupational context, this study determined the role of task constraints on MV and consistency in individual MV responses. Twenty participants performed repetitive lifting under four constraints differing in restriction of foot movement and load weight. MV was assessed for three body regions and for the whole-body using linear variability of three-dimensional joint angles. Foot movement caused significant increases of lower body (11–17%), low back (318–439%) and a reduction in upper body variability (4%), whereas no effects of weight nor interaction of foot restriction and weight were found. Good individual consistency (ICC = 0.71–0.84) was demonstrated across constraints. Even though MV is affected by constraints, this study supports that MV is largely an individual trait independent of constraints. Future work should evaluate if MV remains an individual trait across different tasks, and if MV is confounded by other task constraints.

- **Keywords:** Motor variability; Task constraints; Individual consistency

**Omar Faruq Hamim, Shahnewaz Hasanat-E-Rabbi, Mithun Debnath, Md Shamsul Hoque, Rich C. McIlroy, Katherine L. Plant, Neville A. Stanton. *Taking a mixed-methods approach to collision investigation: AcciMap, STAMP-CAST and PCM. 103650.***

Recently, ergonomics and safety researchers have turned their attention towards applying combinations of sociotechnical methods rather than using single methods in isolation. In the current research, a mixed-method approach combining two systems-based methods, Accimaps and the Systems Theoretic Accident Model and Process - Causal Analysis using Systems Theory (STAMP-CAST), and one cognitive approach, the Perceptual Cycle Model (PCM), were employed in analysing a rail-level crossing incident in Bangladesh. Each method was applied individually to investigate the collision, and interventions were proposed corresponding to incident events at different risk management framework levels. The three methods provided different perspectives of the whole picture, together identifying an array of contributory factors. The complementary nature of these methods aided in proposing a comprehensive set of safety recommendations, thereby demonstrating the benefit of a mixed-method approach for collision investigation in low-income settings.

- **Keywords:** Accimap; STAMP-CAST; PCM

**Yong-Ku Kong, Min-Uk Cho, Chae-Won Park, Seoung-Yeon Kim, Min-Jung Kim, Junpil Moon, Sungwon Lim, Byung-Mo Oh, Banseok Han, JunHee Choi, Kyeong-Hee Choi. *Quantification of physical stress experienced by obstetrics and gynecology sonographers: A comparative study of two ultrasound devices. 103665.***

This study aims to quantify the stresses of sonographers using two different ultrasound devices, one of conventional and one of ergonomic design. A total of 20 obstetricians and gynecologists participated in this study, and two types of tasks (scanning and positioning) were evaluated while using the two different devices. To quantify workload, four dependent variables (muscle activity, estimated grip force, subjective comfort rating, and task time) were measured. The muscular activity required while using the conventional device was 14.4% MVC (Maximum voluntary contraction) for the scanning task, which was significantly higher than that of the ergonomic device. The subjective comfort rating for the conventional design was lower than that of the ergonomic design. For the positioning task, the ergonomic device (33.2% MVC) resulted in significantly higher muscle activity in the extensor digitorum (ED) and flexor digitorum superficialis (FDS) than the conventional design (22.2% MVC), whereas the deltoid muscle showed significantly lower activity than in users of conventional design (4.5% MVC). Ergonomically-designed ultrasound devices improve ease of moving and the probe's

supporters, reduce physical load and increase ease of use for sonographers. Our results may be used as guidelines for usability testing of ultrasound devices.

- **Keywords:** Sonographer; Work-related musculoskeletal disorders (WMSDs); Ultrasound device; Scan stress; Ergonomic design

**Kaifeng Liu, Calvin Kalun Or, Mike So, Bernard Cheung, Bill Chan, Agnes Tiwari, Joseph Tan. *A longitudinal examination of tablet self-management technology acceptance by patients with chronic diseases: Integrating perceived hand function, perceived visual function, and perceived home space adequacy with the TAM and TPB.* 103667.**

**Background:** Health information technologies (HITs) are increasingly being used to support the self-management of chronic diseases. However, patients' initial or continued acceptance of such technologies is not always achieved. **Objective:** The aim of this study was to develop a theory-driven HIT acceptance model to examine factors affecting acceptance of HIT (measured by behavioral intention; BI) for disease self-management among patients with chronic diseases, in which we also focused on three additional, previously unexplored factors related to perceived hand function (PHF), perceived visual function (PVF), and perceived space adequacy (PSA) and a longitudinal scrutinization of changes in the effects of these factors on acceptance over time. **Methods:** The theoretical basis of our acceptance model was drawn from the technology acceptance model and the theory of planned behavior. The model was further extended by including patients' PHF, PVF (related to patients with chronic diseases who are mostly elderly), and PSA (related to the patients' home environment). The model was tested in the context of type 2 diabetes and hypertension self-management via a touchscreen tablet-based system over a 24-week period. A questionnaire was administered at four time points (baseline and 8, 16, and 24 weeks after implementation) to collect data from 151 patients with coexisting type 2 diabetes and hypertension. We tested the model at each time point using partial least squares structural equation modeling. **Results:** Perceived usefulness of the self-management system influenced BI directly at 8 and 24 weeks and indirectly at 8, 16, and 24 weeks. Perceived ease of use indirectly affected BI at 8, 16, and 24 weeks. Attitude directly affected BI at 8, 16, and 24 weeks. Perceived behavioral control directly influenced BI at baseline and 8 and 16 weeks. Subjective norms indirectly influenced BI at 8, 16, and 24 weeks. PHF and PVF indirectly influenced BI over the entire study period. PSA influenced BI directly at 16 weeks and indirectly at 8, 16, and 24 weeks. **Conclusion:** The effects of the proposed factors in our model on patient-focused HIT acceptance changed over a longer time period, emphasizing the importance of further investigation of the longitudinal mechanisms influencing technology acceptance behavior. It is recommended that healthcare practitioners consider such changes when implementing comparable technologies. Moreover, beyond technology attributes, the characteristics, needs, and limitations of older adults and elderly patient users and their home environments should also be considered in the design and implementation of patient-focused HIT systems for chronic disease self-management at home.

- **Keywords:** Health information technology; Self-management; Technology acceptance; Longitudinal examination

**Joel G. Brawner, Gregory A. Harris, Gerard A. Davis. *Will the real relationship between lean and safety/ergonomics please stand up?* 103673.**

This paper provides a review of studies containing safety and ergonomic outcomes in lean manufacturing (LM) environments over the past 40 years. The aim is to identify effects from specific LM methods on specific safety/ergonomic outcomes, to understand the relationship in greater detail. One hundred and one studies containing one hundred

and seventy outcomes were identified. Thirty-seven outcomes pertained to just-in-time (JIT) production, which contained twenty-three negative, eleven neutral, and three positive safety/ergonomic outcomes. Conversely, twenty-six outcomes pertained to 5S and consisted of twenty-four positive, two negative, and no neutral outcomes. The most common negative JIT outcome was stress and mental strain, while the most common positive 5S outcome was a tie between safety performance and hazard exposure. Studies containing other methods were fewer in number with more mixed outcomes. These findings suggest that individual LM methods, especially JIT and 5S, uniquely contribute to the safety/ergonomic outcomes attributed to LM.

- **Keywords:** Toyota production system; Occupational safety

**Donya Dalirnaghadeh, Semiha Yilmazer. *The effect of sound environment on spatial knowledge acquisition in a virtual outpatient polyclinic.* 103672.**

This study examines the impact of the sound environment on spatial knowledge acquisition in a virtual outpatient polyclinic. Outpatient polyclinics have a salient role in determining early outpatient treatments of COVID-19 to prevent hospitalization or death and reduce the burden on hospitals. However, they have not been widely investigated in the literature. The studies on spatial knowledge have identified environmental elements mainly related to vision with no focus on sound. Currently, there is limited research on the effect of sound environment on spatial knowledge acquisition in virtual outpatient polyclinics. In this study, a virtual simulated outpatient polyclinic has been created with varying levels of visual and audio cues. Eighty participants were assigned to one of the four groups: a control (no visual signage), a visual (visual signage), an only audio (no landmarks and no visual signage), and an audio-visual group. The virtual environment was presented as a video walkthrough with passive exploration to test spatial knowledge acquisition with tasks based on the landmark-route-survey model. The results showed that a combination of visual signage and sound environment resulted in higher spatial knowledge acquisition. No significant difference was found between the performance of the visual group and the control group that shows that signage alone cannot aid spatial knowledge in virtual outpatient polyclinics. Data from the only audio group suggests that landmarks associated with sound can compensate for the lack of visual landmarks that may help design a wayfinding system for users with visual disabilities.

- **Keywords:** Landmark-route-survey model; Outpatient polyclinics; Sound environment; Spatial knowledge; Virtual environments

**Nastja Podrekar Loredan, Dean Lipovac, Sabina Jordan, Michael David Burnard, Nejc Šarabon. *Thermal effusivity of different tabletop materials in relation to users' perception.* 103664.**

Tactile interaction between humans and elements in the built environment, such as furniture, is often underappreciated. The aim of this study was to objectively evaluate thermal properties of ten tabletop materials as well as user perceptions of those materials after use. Sixteen participants tested ten materials in a randomised order. Infrared thermography was used to determine tabletop temperature distribution and change. Materials with lower thermal effusivity (wood-based materials) in general reached higher surface temperature differences after 15 min of contact and were rated as more pleasant to touch, more suitable for writing, and more liked for everyday use. Participants' sex and forearm mass had no effect on the temperature after contact. Participants gave the highest ratings to the appearance of oak-based materials. Surface treatment affected subjective evaluation of the materials. The tabletop made of lacquered solid wood had the most favourable thermal and user-rated characteristics.

- **Keywords:** School desk; Office desk; Ergonomics; Thermal comfort

**Bart Accou, Fabrice Carpinelli. *Systematically investigating human and organisational factors in complex socio-technical systems by using the "SAFety FRactal ANalysis" method.* 103662.**

In order to manage the performance of socio-technical systems in a safe and sustainable way, the importance of looking at human and organisational factors (HOF) and their contribution to adverse events is widely recognised. In reality, however, the scope of accident and incident investigations stays usually limited to investigating the immediate causes and decision-making processes related to the accident sequence (e.g. Antonsen, 2009). Important factors, including design and planning decisions, contributing to accidents are hereby often overlooked and the weaknesses in the Safety Management System are hardly ever analysed. The SAFety FRactal ANalysis (SAFRAN) method (Accou and Reniers, 2019) can guide investigators in an intuitive and logic way, to ask questions that help to gain deeper understanding of the capability of organisations to monitor and manage safety critical variability. The essence of using the SAFRAN method for evaluating the performance of the different processes in a socio-technical system, is to approach them in a similar way, building on the generic elements that compose a SMS and systematically looking at the HOF that influenced actions and decision making, regardless of the hierarchical level they are situated at. This paper presents the SAFRAN method, specifying its HOF taxonomy and sharing examples of supporting HOF questions. The approach enables non-experts in HOF to systematically identify the different elements that introduce critical variability in performance and to recognise what additional expertise can be called upon when needed.

- **Keywords:** Human and organizational factors; Safety management systems; Accident investigation

**Richard J. Simonson, Joseph R. Keebler, Elizabeth L. Blickensderfer, Ron Besuijen. *Impact of alarm management and automation on abnormal operations: A human-in-the-loop simulation study.* 103670.**

Process control consists of complex states of performance that require a significant amount of operator attention and skill to manage. Automation and smart alarms can enhance these processes. This study investigated the effects of alarm management and automation on process control operator workload (NASA-TLX) and performance via material lost through flaring outcomes. Eleven console qualified operators participated in a human-in-the-loop, high-fidelity simulation-based training exercise. Three levels of alarm management (no rationalization, rationalization, and state-based smart alarm) and two levels of automation (no automation and automation) conditions were implemented using six scenarios. A repeated measures two-way MANOVA indicated that both alarm management schema and automation significantly affected operator workload and performance. These results indicate that state-based smart alarm management and automation schemas may assist operators in reducing workload and material lost through flare release during abnormal operating conditions.

- **Keywords:** Process control; Workload; Flare; Alarm rationalization; Automation

**Anjum Naweed, Lorelle Bowditch, Joshua Trigg, Carolyn Unsworth. *Injury by design: A thematic networks and system dynamics analysis of work-related musculoskeletal disorders in tram drivers.* 103644.**

Tram driving is a safety critical task where work-related musculoskeletal disorders (WRMSDs) and injuries are associated with interacting occupational design factors over time. These interactions then carry implications for workforce retention, public safety, workplace relations and supports. To better understand such interactions, this study used thematic networks and system dynamics (causal loop diagrams) analysis with the aim to

unearth a global theme underscoring occurrence of WRMSDs, and describe the factors influencing the system dynamics of WRMSD occurrence in tram drivers. Building on earlier work focused on occupational participation, secondary analysis of driver interviews (n = 13) and driving observations (n = 11) produced thematic network and causal loop models of risk factors that highlighted an Injury by Design problem structure as a global theme. Research targeting organisational culture, human factors, and design standards is needed to minimise WRMSDs risk in tram drivers.

- **Keywords:** Rail; Systems dynamics; Risk perception; Occupational injury; Organisation behaviour

Amany Farag, L.D. Scott, Y. Perkhounkova, S. Saeidzadeh, M. Hein. A human factors approach to evaluate predictors of acute care nurse occupational fatigue. 103647.

Nurses function at the point of care and assume a significant role in intercepting errors. They work in a mentally and physically demanding profession that is comprised of shift-work, subjecting nurses to considerable fatigue. Yet, few studies constructed a comprehensive model that integrates personal and occupational factors to explore their relationship with various types of fatigue (acute, chronic, physical, mental, and total). Here, we examine this type of comprehensive fatigue-model, in a report that represents one aim of a larger, mixed-methods study. The study sample comprised of 1137 registered nurses working in eight hospitals in a Midwestern state. Nurses reported higher levels of acute and total fatigue than chronic and physical fatigue. Staffing and resource adequacy, exercise, and sleep were among the strongest predictors. Since fatigue is a multi-faceted construct, a comprehensive fatigue-management strategy that targets both day and night-shift nurses is the optimal way to manage nurse fatigue.

- **Keywords:** Occupational fatigue; Nurses; Shift-work; Sleep

**Kyung Hun Jung, Jack T. Labriola, Jack Krebs, Tiara Sawyer. *Usability enhancement based on usability heuristics: An examination of the underlying mechanism utilizing the psychological-refractory-period paradigm.* 103649.**

User Interface (UI) design practices often abide by popular usability heuristics such as Nielsen's (1994) "10 usability heuristics for user interface design" or Gerhardt-Powals' (1996) cognitive engineering principles. To examine the underlying mechanism of user performance enhancement by following some of these usability heuristics, we compared user performance between two device conditions: one representing design practices following two selected sets of usability heuristics (experimental condition) and the other without following them (control condition). As a research framework, we adopted the psychological-refractory-period (PRP) paradigm along with the locus-of-slack logic, a well-established dual-task paradigm for examining the nature of cognitive benefits caused by experimental manipulations. Results showed that the experimental-device condition that followed the usability heuristics yielded faster performance than the control condition, especially when the stimulus-onset-asynchrony between the two tasks was long than when it was short. According to the locus-of-slack logic, these results suggest that the nature of cognitive benefits caused by following the usability heuristics is more likely to be due to shortening of the response-activation stage (rather than the response-selection stage). These findings suggest that following the two usability heuristics tends to facilitate a specific stage of the information processes more than other stages.

- **Keywords:** Usability heuristics; Interface design; User-interface (UI) design; Psychological-refractory-period paradigm; Locus-of-slack logic

**Shirley A. Elprama, Bram Vanderborght, An Jacobs. *An industrial exoskeleton user acceptance framework based on a literature review of empirical studies.* 103615.**

Studying the acceptance of exoskeletons in industry has gained increased attention. Exoskeletons (wearable support devices) are envisioned to alleviate heavy work. Examining what factors influence the use of exoskeletons is important, because influencing these factors could positively contribute to the adoption of industrial exoskeletons. The factors identified in this paper have been systematically derived from empirical research with (potential future) end users, most of whom have tried on an exoskeleton. Our framework with factors influencing the acceptance of industrial exoskeletons can be used during the (ideally iterative) design, (re)development and evaluation phase of new or existing exoskeletons. This could improve the quality of exoskeletons since this allows designers to already consider acceptance factors early in the design process instead of finding out what is important late in the design process during (field) testing. In turn, this might accelerate the adoption of exoskeletons. Also, our framework can be used to study the ongoing introduction of exoskeletons at work since it also addresses policy decisions companies interested in implementing exoskeletons should consider.

- **Keywords:** Acceptance; Industrial exoskeletons; Use; Usage; Comfort; Technology acceptance; Discomfort; Human-machine interaction

**Kim Buchmüller, Angela Bearth, Michael Siegrist. *The influence of packaging on consumers' risk perception of chemical household products.* 103676.**

Chemical household products are found in most households. If consumers are to safely handle such products, they need to be aware of the risks posed by the particular product they are using. Although most countries require that chemical household products feature warning labels (e.g. the Globally Harmonized System of Classification and Labelling of Chemicals), consumers appear to also use other cues to determine the risks associated with a specific product. Thus, we studied the influence of packaging on consumers' risk perception of chemical household products. More specifically, we examined the effect of the colour of the packaging (black or pink packaging versus the original packaging) as well as the presence of images of flowers or food-imitating elements on the packaging. Significant differences with regard to consumer's risk perception were found in terms of all four studied manipulations. Therefore, we conclude that consumers' risk perception can be influenced by the packaging design. In particular, if elements that lower consumer's risk perception (e.g. featuring flowers on the label and food-imitating elements on the packaging) are omitted from the packaging, consumers might be able to more accurately judge the risks associated with a product and so take appropriate safety precautions.

- **Keywords:** Risk perception; Chemical household products; Packaging design

**Vera JMP. Verstappen, Elise N. Pikaar, Rolf GD. Zon. *Assessing the impact of driver advisory systems on train driver workload, attention allocation and safety performance.* 103645.**

Netherlands Railways has developed driver advisory systems (DAS) to provide the train driver with route context information and coasting advice in order to benefit punctuality and energy efficiency. However, the impact of these DAS on human factors aspects and safety performance is unclear. The current study assesses the impact of two DAS levels (route context information and coasting advice) on mental workload, attention allocation and safety performance, using eye tracking, a subjective mental workload rating scale

(RSME) and simulator data. The overall findings suggest that the application of DAS levels has no negative impact on safety performance and attention allocation towards the trackside compared to a control condition with static timetable information. Furthermore, safety performance benefits significantly from DAS with route context information. DAS were originally developed to benefit punctuality and energy efficiency goals. This study implicates that DAS can also benefit safety performance. The current study found that DAS could decrease workload when the functionalities meet the requirements of the situation. The possible presence of mental underload and its effect on driving performance should be taken into consideration when implementing DAS. It is essential in the development of DAS that it meaningfully enriches the train driving task in stead of simply increasing mental workload.

- **Keywords:** Driver advisory system; Workload; Attention allocation; Train driver performance; Railway safety; Simulator; Eye tracker; Human factors

**Scott McLean, Lauren Coventon, Caroline F. Finch, Clare Dallat, Tony Carden, Paul M. Salmon. *Evaluation of a systems ergonomics-based incident reporting system.* 103651.**

**Introduction:** Incident reporting and learning systems are a fundamental component of safety management. The purpose of this study was to evaluate a novel incident reporting system specific to the Australian Led Outdoor Activity (LOA) sector. The Understanding and Preventing Led Outdoor Accidents Data System (UPLOADS), is a recently introduced systems thinking-based incident reporting and learning system that utilises contemporary safety theory and methods. **Method:** The implementation of UPLOADS was evaluated using the RE-AIM framework based on the following dimensions: Reach, Efficacy, Adoption, Implementation, and Maintenance. A pragmatic evaluation approach was used in which evaluation data were collected through the triangulation of multiple sources including different LOA stakeholders from both the individual organisational level (LOA providers) and LOA sector governance level (LOA industry representatives), incident data collected through the UPLOADS National Incident Dataset, and the online and physical presence of UPLOADS. **Results:** The findings show that a key strength of UPLOADS is its effectiveness as incident reporting tool for improving safety in the LOA sector. However, a weakness of UPLOADS is that it is not being implemented appropriately by the LOA providers. **Conclusion:** Overall, the current findings suggest that UPLOADS incident reporting tool is perceived by SMEs as an effective tool for improving safety in LOA. However, further work is required for UPLOADS to have a greater impact on the LOA sector. Specifically, Implementation of the UPLOADS system requires improvement, as well as additional training and education may be required to upskill and empower LOA providers to improve reporting and enhance the value placed on safety by LOA stakeholders. The RE-AIM framework was an appropriate evaluation framework for understanding the effectiveness of UPLOADS as a LOA sector specific incident reporting and learning system. **Practical applications:** The current findings have practical implications for ergonomics researchers applying evaluation frameworks in the real world, and LOA providers for implementing safety interventions. Lastly, contemporary systems-based incident reporting and learning systems have the capability to enhance the safety practices of the LOA sector.

- **Keywords:** RE-AIM; Led outdoor activity; Incident reporting; Systems analysis; AcciMap

**Pascaline Lantoine, Mathieu Lecocq, Clément Bougard, Erick Dousset, Tanguy Marqueste, Christophe Bourdin, Jean-Marc Allègre, Laurent Bauvineau, Serge Mesure. *Influence of car seat firmness on seat pressure profiles and perceived discomfort during prolonged simulated driving.* 103666.**

During a driving task, the seat-driver interface is particularly influenced by the external environment and seat features. This study compares the effect of two different seats (S1 – soft & S2 – firm) and the effect of visual simulation of different road types (city, highway, mountain, country), on pressure distribution and perceived discomfort during prolonged driving. Twenty participants drove two 3-h sessions (one per seat) on a static simulator. Contact Pressure (CP), Contact Surface (CS), and Seat Pressure Distribution Percentage (SPD%) were analyzed throughout, using two pressure mats positioned on seat cushion and backrest. Whole-body and local discomfort for each body part were rated every 20 min. The softer seat, S1, induced a greater contact surface on cushion and backrest and a lower SPD%, reflecting better pressure distribution. Pressure profiles were asymmetrical for both S1 and S2, with higher CP under left buttock (LBu) and right lower back (RLb) and greater CS under thighs and RLb. Pressure distribution was less homogeneous on mountain and city roads than on monotonous roads (highway and country). Despite the pressure differences between the seats, however, both led to similar increases in perceived whole-body discomfort throughout the driving session. Moreover, the highest discomfort scores were in the neck and the lower back areas, whatever the seat. These findings on pressure variables may have implications for the design of backrests and cushions to ensure more homogeneous pressure distribution, even though this is not shown to minimize perceived driver discomfort.

- **Keywords:** Prolonged driving; Discomfort; Seat design; Interface pressure

**Shelby K. Long, Jieun Lee, Yusuke Yamani, James Unverricht, Makoto Itoh. *Does automation trust evolve from a leap of faith? An analysis using a reprogrammed pasteurizer simulation task.* 103674.**

Trust is a critical factor that drives successful human-automation interaction in a myriad of modern professional environments. One seminal work on human-automation trust is Muir and Moray (1996) showing that human-machine trust evolves from faith, then dependability, and finally predictability in a simulated supervisory control task. However, our recent work failed to replicate the finding of the original study, calling for further replication efforts. Experiment 1 aimed to fully replicate Muir and Moray (1996) where participants performed a simulated pasteurizer task. Experiment 2 attempted to replicate Experiment 1 using participants who major in Engineering as used in the original study. Both experiments showed that dependability was the best initial predictor of trust, building later to predictability and faith. Two experiments consistently failed to support both the hypothesis proposed by Muir and Moray (1996), that trust develops from predictability to dependability to faith, and their original findings that trust develops initially from faith. The results of the current experiments challenge this widely cited view of how human-machine trust develops. Modern automation designers should be aware that dependability might control initial trust development for general users and incorporate dependability information into their designs.

- **Keywords:** Human-machine trust; Human-machine system; Supervisory control