

Ergonomics– rok 2018, ročník 61

Číslo 6



Brendan Ryan. *Developing a framework of behaviours before suicides at railway locations.* Pages: 605-626.

Better knowledge of behaviours of people at railway property could help with identifying those at risk of suicide. Literature has been reviewed from a range of disciplines on what is known about studying behaviour in this type of public location. Secondary analysis has been carried out on descriptions of behaviour from structured exercises with experts and other pre-existing sources. A framework has been produced with five main classes (display of emotion, appearance, posture/movements, activities and interactions) and associated sub-classes. Commentary has been provided on factors that influence identification of suspicious behaviours, how to distinguish these from normal behaviours and the circumstances that inhibit timely reactions to the behaviour amidst the complexity of the operational railway. Opportunities to develop and use the framework are discussed, including using this to prompt collection of additional behavioural data from wider resources, enhancing staff training and developing requirements for effective use of surveillance technologies. **Practitioner Summary:** Many railway suicides could be prevented with better understanding of behaviours before events. Pre-existing data sources have been analysed, producing a framework highlighting five aspects of behaviour. This can prompt the collection of better evidence on pre-suicidal behaviours, with future applications in developing surveillance technologies, training staff and public awareness.

- **Keywords:** Suicidal behaviour, railway, reporting, observation, surveillance technologies

Dominic Furniss, Paul Curzon & Ann Blandford. *Exploring organisational competences in Human Factors and UX project work: managing careers, project tactics and organisational strategy.* Pages: 739-761.

Organisational competence in Human Factors and UX (user experience) has not been looked at before despite its relevance to project success. We define organisational competence as the collective competence of the individuals, bringing together their

complementary abilities to deliver an outcome that is typically more than the sum of its parts. Twenty-two UX and Human Factors practitioners were interviewed about their project work in two contrasting domains: web design and safety-critical systems to explore organisational competences. Through doing a FRAM analysis, 29 functions and 6 main areas of competences were identified: the central project process; the process of learning about the problem; maintaining and developing client relations; staff development; evolving practices; and the management of documentation for audit and quality control. These dynamic and situated competences form a web of interactions. Managing competences is essential for project success. Implications for managing careers, project tactics and organisational strategy are discussed. **Practitioner Summary:** Organisational competences impact how routine and non-routine project work is performed, but these have received little attention in the literature. Six key areas of competences in Human Factors and UX project work were identified from practitioner interviews. Managing combinations of adaptive competences is important for developing careers, project tactics and organisational strategies.

- **Keywords:** FRAM, human factors, methods and approaches, usability practice, UX, resilience engineering

Graham K. Edgar, Di Catherwood, Steven Baker, Geoff Sallis, Michael Bertels, Helen E. Edgar, Dritan Nikolla, Susanna Buckle, Charlotte Goodwin & Allana Whelan. *Quantitative Analysis of Situation Awareness (QASA): modelling and measuring situation awareness using signal detection theory. Pages: 762-777.*

This paper presents a model of situation awareness (SA) that emphasises that SA is necessarily built using a subset of available information. A technique (Quantitative Analysis of Situation Awareness – QASA), based around signal detection theory, has been developed from this model that provides separate measures of actual SA (ASA) and perceived SA (PSA), together with a feature unique to QASA, a measure of bias (information acceptance). These measures allow the exploration of the relationship between actual SA, perceived SA and information acceptance. QASA can also be used for the measurement of dynamic ASA, PSA and bias. Example studies are presented and full details of the implementation of the QASA technique are provided. **Practitioner Summary:** This paper presents a new model of situation awareness (SA) together with an associated tool (Quantitative Analysis of Situation Awareness – QASA) that employs signal detection theory to measure several aspects of SA, including actual and perceived SA and information acceptance. Full details are given of the implementation of the tool.

- **Keywords:** Dynamic situation awareness, situational awareness, signal detection theory, bias, confidence, team situation awareness, situated situation awareness

Bernhard Schwartz, Jay M. Kapellusch, Andreas Schrempf, Kathrin Probst, Michael Haller & Arnold Baca. [*Effect of alternating postures on cognitive performance for healthy people performing sedentary work.*](#) Pages: 778-795.

Prolonged sitting is a risk factor for several diseases and the prevalence of worksite-based interventions such as sit-to-stand workstations is increasing. Although their impact on sedentary behaviour has been regularly investigated, the effect of working in alternating body postures on cognitive performance is unclear. To address this uncertainty, 45 students participated in a two-arm, randomised controlled cross-over trial under laboratory conditions. Subjects executed validated cognitive tests (working speed, reaction time, concentration performance) either in sitting or alternating working postures on two separate days (ClinicalTrials.gov Identifier: NCT02863731). MANOVA results showed no significant difference in cognitive performance between trials executed

in alternating, standing or sitting postures. Perceived workload did not differ between sitting and alternating days. Repeated measures ANOVA revealed significant learning effects regarding concentration performance and working speed for both days. These results suggest that working posture did not affect cognitive performance in the short term. **Practitioner Summary:** Prior reports indicated health-related benefits based on alternated (sit/stand) body postures. Nevertheless, their effect on cognitive performance is unknown. This randomised controlled trial showed that working in alternating body postures did not influence reaction time, concentration performance, working speed or workload perception in the short term.

- **Keywords:** Alternating body postures, cognitive performance, sit-to-stand workstation, randomised controlled trial

Yuxin Wu, Hong Liu, Baizhan Li, Yong Cheng, Daniel Mmerekki & Deyu Kong. *Behavioural, physiological and psychological responses of passengers to the thermal environment of boarding a flight in winter.* Pages: 796-805.

In practice, passengers actively respond to the thermal environment when they board an aircraft in winter, which is not considered in the current standards. In this study, the behavioural, physiological and psychological responses to the thermal environment were examined at 22 °C (with 68 subjects), 20 °C and 26 °C (with 32 subjects). The results showed that the three air temperature levels had significant effect on nozzle usage and clothing adjustment behaviours, surface skin temperature, and thermal sensation vote (TSV). The walking/waiting states prior to boarding the aircraft cabin had a significant effect on the proportion of jacket removal, TSV and thermal comfort vote. After 10 min in the aircraft cabin, the subjects maintained their comfort in a wider range of the thermal environment when the behavioural adjustments existed compared to when they did not. Thus, a suggestion was made for behavioural adjustments to be provided in aircraft cabins. **Practitioner Summary:** Experimental investigation of human responses was conducted in an aircraft cabin. Analysis showed that the subjects maintained their comfort in a wider range of the thermal environment when the behavioural adjustments existed compared to when they did not. Thus, a suggestion was made for behavioural adjustments to be provided in aircraft cabins.

- **Keywords:** Thermal environment, transport ergonomics, attitudes and behaviour, physiology, perception

Bin Liu, Liang Ma, Chi Chen & Zhanwu Zhang. *Experimental validation of a subject-specific maximum endurance time model.* Pages: 806-817.

This study aimed at experimentally validating a subject-specific maximum endurance time (MET) model. Thirty health participants (15 males and 15 females; Age: mean = 21.5 years, SD = 1.6 years) volunteered to conduct an isometric elbow flexion task until exhaustion. The endurance times of each participant were measured under relative exertion levels ranging from 30% MVC (Maximum Voluntary Contraction) to 70% MVC at 10% intervals. Assessment of the model showed that the intensity–endurance time relationship for each studied individual could be well fitted by the subject-specific MET model ($R^2 > 0.89$). The fatigue rates identified from the model fitting were normally distributed (Mean = 0.96 min^{-1} , SD = 0.29 min^{-1}). In addition, the fatigue rates of the male group were significantly higher than the female group. The subject-specific MET model can be used to predict the MET for individual workers, and further support physical task design, based on the fatigability data of a targeted worker population. **Practitioner Summary:** Ergonomists have extensively used MET models in physical fatigue assessment and physical task design. A subject-specific MET model could be used to predict the MET at individual levels, and also to support work design for a

target worker population, based on the fatigability data distribution obtained from sampled workers.

- **Keywords:** Maximum endurance time (MET), Subject-specific MET model, elbow flexion, fatigability, physical fatigue

Daniel Pan, Xueyan S. Xu, Daniel E. Welcome, Thomas W. McDowell, Christopher Warren, John Wu & Ren G. Dong. *The relationships between hand coupling force and vibration biodynamic responses of the hand-arm system.* Pages: 818-830.

This study conducted two series of experiments to investigate the relationships between hand coupling force and biodynamic responses of the hand–arm system. In the first experiment, the vibration transmissibility on the system was measured as a continuous function of grip force while the hand was subjected to discrete sinusoidal excitations. In the second experiment, the biodynamic responses of the system subjected to a broadband random vibration were measured under five levels of grip forces and a combination of grip and push forces. This study found that the transmissibility at each given frequency increased with the increase in the grip force before reaching a maximum level. The transmissibility then tended to plateau or decrease when the grip force was further increased. This threshold force increased with an increase in the vibration frequency. These relationships remained the same for both types of vibrations. The implications of the experimental results are discussed. **Practitioner Summary:** Shocks and vibrations transmitted to the hand–arm system may cause injuries and disorders of the system. How to take hand coupling force into account in the risk assessment of vibration exposure remains an important issue for further studies. This study is designed and conducted to help resolve this issue.

- **Keywords:** Hand force, hand–arm vibration, hand-transmitted vibration, vibration risk assessment

Saman Madinei & Xiaopeng Ning. *Effects of the weight configuration of hand load on trunk musculature during static weight holding.* Pages: 831-838.

The performance of manual material handling tasks is one major cause of lower back injuries. In the current study, we investigated the influence of the weight configuration of hand loads on trunk muscle activities and the associated spinal stability. Thirteen volunteers each performed static weight-holding tasks using two different 9 kg weight bars (with medial and lateral weight configurations) at two levels of height (low and high) and one fixed horizontal distance (which resulted in constant spinal joint moment across conditions). Results of the current study demonstrated that holding the laterally distributed load significantly reduced activation levels of lumbar and abdominal muscles by 9–13% as compared with holding the medially distributed load. We believe such an effect is due to an elevated rotational moment of inertia when the weight of the load is laterally distributed. These findings suggest that during the design and assessment of manual material handling tasks, such as lifting and carrying, the weight configuration of the hand load should be considered. **Practitioner summary:** Elevated trunk muscle activities were found when holding a medially distributed load vs. a laterally distributed load (with an equivalent external moment to the spine), indicating a reduced spinal stability due to the reduced rotational moment of inertia. The configuration of the hand load should be considered when evaluating manual material handling tasks.

- **Keywords:** Trunk biomechanics, spinal stability, weight configuration, manual material handling, electromyography

Liana Michele Tennant, Helen Christina Chong & Stacey Marie Acker. *The effects of a simulated occupational kneeling exposure on squat mechanics and knee joint load during gait.* Pages: 839-852.

Occupational kneeling is associated with an increased risk for tibiofemoral knee osteoarthritis. Forces on the knee in the kneeling posture, as well as the greater incidence of meniscus tears among workers, likely contribute to the increased risk. We hypothesise that an additional mechanism may contribute – altered neuromuscular control due to prolonged high knee flexion. Forty participants (20 male, 20 female) completed an evaluation of gait and squatting before, immediately following, and 30 min following a 30 min simulated occupational kneeling exposure. An increase in the peak external knee adduction moment and a delay in vastus medialis activation onset during walking were observed post-kneeling, as well as increased frontal plane knee motion during squatting. This was the first investigation to find changes in high flexion transitions as a result of kneeling. Greater frontal plane knee motion may increase the risk for meniscal tears, and subsequently, knee osteoarthritis. **Practitioner Summary:** A 30 min simulated occupational kneeling exposure resulted in small but significant gait changes. The greatest effect was on frontal plane knee movement during squatting, which is especially relevant to occupations requiring frequent kneeling/squatting. This increased motion may indicate an increased risk of injury, which supports a link to knee osteoarthritis.

- **Keywords:** Biomechanics, ergonomics, musculoskeletal disorders, knee, osteoarthritis

Eric B. Weston, Alexander Aurand, Jonathan S. Dufour, Gregory G. Knapik & William S. Marras. *Biomechanically determined hand force limits protecting the low back during occupational pushing and pulling tasks.* Pages: 853-865.

Though biomechanically determined guidelines exist for lifting, existing recommendations for pushing and pulling were developed using a psychophysical approach. The current study aimed to establish objective hand force limits based on the results of a biomechanical assessment of the forces on the lumbar spine during occupational pushing and pulling activities. Sixty-two subjects performed pushing and pulling tasks in a laboratory setting. An electromyography-assisted biomechanical model estimated spinal loads, while hand force and turning torque were measured via hand transducers. Mixed modelling techniques correlated spinal load with hand force or torque throughout a wide range of exposures in order to develop biomechanically determined hand force and torque limits. Exertion type, exertion direction, handle height and their interactions significantly influenced dependent measures of spinal load, hand force and turning torque. The biomechanically determined guidelines presented herein are up to 30% lower than comparable psychophysically derived limits and particularly more protective for straight pushing. **Practitioner Summary:** This study utilises a biomechanical model to develop objective biomechanically determined push/pull risk limits assessed via hand forces and turning torque. These limits can be up to 30% lower than existing psychophysically determined pushing and pulling recommendations. Practitioners should consider implementing these guidelines in both risk assessment and workplace design moving forward.

- **Keywords:** Force limit, turn, psychophysical, lumbar spine

Leigh J. Allin, Maury A. Nussbaum & Michael L. Madigan. *Feet kinematics upon slipping discriminate between recoveries and three types of slip-induced falls.* Pages: 866-876.

This study investigated the relationship between feet kinematics upon slipping while walking and the outcome of the slip. Seventy-one slips (induced by walking over an unexpectedly slippery surface) were analysed, which included 37 recoveries, 16 feet-split falls, 11 feet-forward falls and seven lateral falls. Feet kinematics differed between recoveries and three types of slip-induced falls, and a discriminant model including six measures of feet kinematics correctly predicted 87% of slip outcomes. Two potentially modifiable characteristics of the feet kinematics upon slipping that can improve the likelihood of successfully averting a fall were identified: (1) quickly arresting the motion of the slipping foot and (2) a recovery step that places the trailing toe approximately 0–10% body height anterior to the sacrum. These results may inform the development of task-specific balance training interventions that promote favourable recovery responses to slipping. **Practitioner Summary:** This study investigated the relationship between feet movements upon slipping and outcomes of the slip. Potentially modifiable characteristics that can reduce the likelihood of falling were: (1) quickly arresting slipping foot motion and (2) a recovery step that places the trailing toe approximately 0–10% body height anterior to the sacrum.

- **Keywords:** Slips, falls, balance, training, biomechanics