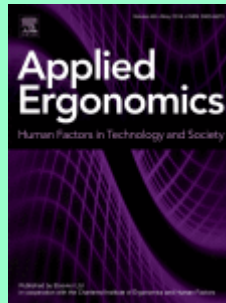


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T.L. Johnson, S.R. Fletcher, W. Baker, R.L. Charles. [How and why we need to capture tacit knowledge in manufacturing: Case studies of visual inspection](#). Pages 1-9.

Human visual inspection skills remain superior for ensuring product quality and conformance to standards in the manufacturing industry. However, at present these skills cannot be formally shared with other workers or used to develop and implement new solutions or assistive technologies because they involve a high level of tacit knowledge which only exists in skilled operators' internal cognitions. Industry needs reliable methods for the capture and analysis of this tacit knowledge so that it can be shared and not lost but also so that it can be best utilised in the transfer of manual work to automated systems and introduction of new technologies and processes. This paper describes two UK manufacturing case studies that applied systematic task analysis methods to capture and scrutinise the tacit knowledge and skills being applied in the visual inspection of aerospace components. Results reveal that the method was effective in eliciting tacit knowledge, and showed that tacit skills are particularly needed when visual inspection standards lack specification or the task requires greater subjective interpretation. The implications of these findings for future research and for developments in the manufacturing industry are discussed.

- **Keywords:** Tacit knowledge; Visual inspection; Task analysis

Kiana Kia, Jonathan Sisley, Peter W. Johnson, Jeong Ho Kim. [Differences in typing forces, muscle activity, wrist posture, typing performance, and self-reported comfort among conventional and ultra-low travel keyboards](#). Pages 10-16.

This study investigated the relative impact of ultra-low travel keyboards on typing force, muscle activity, wrist posture, typing performance, and self-reported comfort/preference as compared to a conventional keyboard. In a repeated-measures laboratory-based study, 20 subjects were invited to type for 10 min on each of five keyboards with different travel distances of 0.5, 0.7, 1.2, 1.6 (ultra-low travel keyboards), and 2.0 mm (a conventional keyboard). During the typing sessions, we measured typing force; muscle activity in extrinsic finger muscles (flexor digitorum superficialis and extensor digitorum communis), shoulder (trapezius) and neck (splenius capitis); wrist posture; typing performance; and self-reported comfort/preference. While using the ultra-low travel keyboards, subjects typed with less force and wrist extension, and had more ulnar deviation (p 's < 0.0001) compared with conventional keyboard. However, these

differences in typing forces were less than 0.5 N and less than 4° for both wrist extension and ulnar deviation. The general trend of data did not show any consistent or substantial differences in muscle activity (less than 2 %MVC) and typing performance (<5 WPM in speed; < 3% in accuracy), despite the observed statistical difference in the finger flexors and extensors muscle activity (p 's < 0.19) and typing performance (p < 0.0001). However, the subjects preferred using conventional keyboards in most of the investigated self-reported comfort and preference criteria (p 's < 0.4). In conclusion, these small differences indicate that using ultra-low travel keyboards may not have substantial differences in biomechanical exposures and typing performance compared to conventional keyboard; however, the subjective responses indicated that the ultra-low keyboards with the shortest key travel tended to be the least preferred.

- **Keywords:** Electromyography; Force-displacement characteristics; Key travel distance; Computer-related musculoskeletal disorders; Usability

Jacob J. Banks, Graham E. Caldwell. [Are psychophysically chosen lifting loads based on joint kinetics?](#) Pages 17-23.

Tables of maximal acceptable weight limits (MAWL) are used to select safe lifting loads and help reduce workplace injuries. However, their subjective basis provides little information on the underlying load selection rationale, and few studies have examined MAWLs in relation to full-body joint demands. Therefore, link-segment biomechanical modeling was applied for 18 participants during three sagittal 4.3 lifts/minute tasks at chosen MAWL levels. Each lift produced unique kinematics, kinetics, MAWL loads and most highly stressed joints. Lifting from the lowest starting position most heavily challenged the L5/S1 joint, whereas more upright starting postures stressed the shoulder. Lifting loads above and below MAWL level demonstrated consistent joint loading patterns. The normalized peak moments of the highest stressed joint were similar across the lifts at ~70–75% of the joint maximum. Our results suggest that MAWLs may be chosen based on perception of the most stressed joint for the specific lift.

- **Keywords:** Manual materials handling; Psychophysics; Link-segment model; Limiting joint

Emma C. Falkland, Mark W. Wiggins. [Cross-task cue utilisation and situational awareness in simulated air traffic control.](#) Pages 24-30.

Objective: To examine the role of cross-task cue utilisation in the acquisition of situational awareness during the initial stages of learning to operate an air traffic control simulation. **Background:** Cue-based associations are an important component of situational awareness, a construct that is necessary for skilled process control, where the location, movement, and direction of multiple targets needs to be managed. However, the potential for high levels of situational awareness is difficult to assess in the absence of exposure. Previous research suggests that cross-task cue utilisation predicts the acquisition of feature-event associations that form the basis of situational awareness. **Method:** Sixty university students undertook an assessment of cue utilisation in the context of motor vehicle driving and subsequently engaged in an air traffic control simulation task. During the air traffic control simulation task, situational awareness queries were introduced based on the Situation Awareness Global Assessment Test (SAGAT). **Results:** The analyses revealed that participants who demonstrated relatively higher levels of cross-task cue utilisation also demonstrated greater performance on the SAGAT and achieved greater performance during the simulated air traffic control task. **Conclusion:** The outcomes suggest a relationship between cross-task cue utilisation and situational awareness, particularly at the initial stages of skill acquisition. **Application:** Assessments of cross-task cue utilisation may be used to distinguish the propensity for prospective trainees to acquire the situational awareness necessary for complex, process control tasks such as air traffic control.

- **Keywords:** Cross-task cue utilisation; Situational awareness; Skill acquisition

David Rempel, Andrea Antonucci, Alan Barr, Michael R. Cooper, Bernard Martin, Richard L. Neitzel. [*Pneumatic rock drill vs. electric rotary hammer drill: Productivity, vibration, dust, and noise when drilling into concrete.*](#) Pages 31-36.

Objectives: Both pneumatic rock drills and electric rotary hammer drills are used for drilling large holes (e.g., 10–20 mm diameter) into concrete for structural upgrades to buildings, highways, bridges, and airport tarmacs. However, little is known about the differences in productivity, and exposures to noise, handle vibration, and dust between the two types of drills. The aim of this study was to compare these outcomes with similar mass electric rotary and pneumatic rock drills drilling into concrete block on a test bench system. **Method:** Three experiments were conducted on a test bench system to compare an electric (8.3 kg) and pneumatic drill (8.6 kg) on (1) noise and handle vibration, (2) respirable silica dust, and (3) drilling productivity. The test bench system repeatedly drilled 19 mm diameter x 100 mm depth holes into cured concrete block while the respective exposure levels were measured following ISO standards. **Results:** Productivity levels were similar between the electric and the pneumatic drill (9.09 mm/s vs. 8.69 mm/s ROP; $p=0.15$). However, peak noise (LPeak: 117.7 vs. 139.4 dBC; $p=0.001$), weighted total handle vibration (ahw: 7.15 vs. 39.14 m/s^2 ; $p=0.002$), and respirable silica dust levels (0.55 vs. 22.23 mg/m^3 ; $p=0.003$) were significantly lower for the electric than the pneumatic drill. **Discussion:** While there were no differences in drilling productivity between an electric and pneumatic drill of similar mass, there were substantial differences in exposure levels of noise, handle vibration, and respirable silica dust. Structural contractors should switch from pneumatic rock drills to electric rotary hammer drills for structural drilling into concrete in order to reduce worker exposures to the hazards of noise, hand vibration, and silica dust.

- **Keywords:** Masonry; Concrete; Hand-arm-vibration; Silicosis; Silica

Attilio Carraro, Catherine A. Elliot, Erica Gobbi. [*Perceived treadmill function is correlated with enjoyment of use in trained runners: A user-centred approach.*](#) Pages 37-40.

Physical inactivity, a primary cause of most chronic diseases, has been associated with low levels of physical activity enjoyment. Physical activity enjoyment can be impacted by an individual's experience with exercise equipment. The purpose of this study was to adopt a user-centred approach to determine the relationship between physical activity enjoyment and functionality and usability of four treadmills. A running protocol was completed by 57 trained runners (41 male) on four treadmills. Runners reported enjoyment levels as well as their perceptions about treadmill running surface, controls, safety and stability, physical interaction, learnability of data console and aesthetic appeal. Repeated measures ANOVAs showed significant differences between the treadmills for each variable. Multiple regression analysis reported aesthetic appeal significantly predicted enjoyment of use. Results suggest that adopting a user-centred approach to compare exercise equipment usability and features can correlate with enjoyment and further impact on physical activity adherence.

- **Keywords:** Analysis and evaluation; Exercise equipment; User-centred approach; Usability testing and evaluation

Gisele C. Gotardi, Paula F. Polastri, Paulo Schor, Raoul R.D. Oudejans, John van der Kamp, Geert J.P. Savelsbergh, Martina Navarro, Sérgio T. Rodrigues. [*Adverse effects of anxiety on attentional control differ as a function of experience: A simulated driving study.*](#) Pages 41-47.

This study tested whether adverse effects of state anxiety on attention and performance may be modulated by experience. Sixteen experienced and eleven inexperienced drivers drove in a simulator under low- and high-stress conditions. Anxiety was manipulated by competition, the presence of an evaluator, external video camera, and traffic noise. Most drivers showed greater anxiety scores and higher mean heart rates following manipulation. In both groups increased state anxiety decreased car speed control and caused more collisions, accompanied by fewer fixations of longer duration towards the driving lane across a horizontally narrower region. Inexperienced drivers increased the number of short fixations towards cars, while experienced drivers increased the number of short fixations on the speedometer. Although anxiety impairs processing efficiency and performance effectiveness for both groups, attentional changes differ as a function of experience. Inexperienced drivers tended to shift attention to threatening stimuli, while experienced drivers were more likely to consciously monitor task goal.

- **Keywords:** Anxiety; Driving experience; Gaze; Attentional control theory

Paul W. Richmond, Adam W. Potter, David P. Looney, William R. Santee. [*Terrain coefficients for predicting energy costs of walking over snow.*](#) **Pages 48-54.**

Background: Predicting the energy costs of human travel over snow can be of significant value to the military and other agencies planning work efforts when snow is present. The ability to quantify, and predict, those costs can help planners determine if snow will be a factor in the execution of dismounted tasks and operations. To adjust predictive models for the effect of terrain, and more specifically for surface conditions, on energy costs, terrain coefficients (η) have been developed. The physiological demands of foot travel over snow have been studied previously, and there are well established methods of predicting metabolic costs of locomotion. By applying knowledge gained from prior studies of the effects of terrain and snow, and by leveraging those existing dismounted locomotion models, this paper seeks to outline the steps in developing an improved terrain coefficient (η) for snow to be used in predictive modeling. **Methods:** Using published data, methods, and a well-informed understanding of the physical elements of terrain, e.g., characterization of snow sinkage (z), this study made adjustments to η -values specific to snow. **Results:** This review of published metabolic cost methods suggest that an improved η -value could be developed for use with the Pandolf equation, where $z = \text{depth} (h) * (1 - (\text{snow density} (\rho_0) / 1.186))$ and $\eta = 0.0005z^3 + 0.0001z^2 + 0.1072z + 1.2604$. **Conclusion:** While the complexity of variables related to characteristics of snow, speed of movement, and individuals confound efforts to develop a simple, predictive model, this paper provides data-driven improvements to models that are used to predict the energy costs of dismounted movements over snow.

- **Keywords:** Metabolic costs; Physiology; Military; Load carriage

Saad Alabdulkarim, Maury A. Nussbaum. [*Influences of different exoskeleton designs and tool mass on physical demands and performance in a simulated overhead drilling task.*](#) **Pages 55-66.**

We compared different passive exoskeletal designs in terms of physical demands (maximum acceptable frequency = MAF, perceived discomfort, and muscular loading) and quality in a simulated overhead drilling task, and the moderating influence of tool mass (~2 and ~5 kg). Three distinct designs were used: full-body and upper-body exoskeletons with attached mechanical arms; and an upper-body exoskeleton providing primarily shoulder support. Participants ($n = 16$, gender-balanced) simulated drilling for 15 min to determine their MAF, then maintained this pace for three additional minutes while the remaining outcome measures were obtained. The full-body/upper-body devices led to the

lowest/highest MAF for females and the lowest quality. The shoulder support design reduced peak shoulder muscle loading but did not significantly affect either quality or MAF. Differences between exoskeleton designs were largely consistent across the two tool masses. These results may be helpful to (re)design exoskeletons to help reduce injury risk and improve performance.

- **Keywords:** Exoskeleton; Wearable assistive device; Intervention

Menekse Salar Barim, Richard F. Sesek, M. Fehmi Capanoglu, Phil Drinkaus, Mark C. Schall, Sean Gallagher, Gerard A. Davis. [Improving the risk assessment capability of the revised NIOSH lifting equation by incorporating personal characteristics](#). Pages 67-73.

The impact of manual material handling such as lifting, lowering, pushing, pulling and awkward postures have been studied, and models using these external demands to assess risk of injury have been developed and employed by safety and health professionals. However, ergonomic models incorporating personal characteristics into a comprehensive model are lacking. This study explores the utility of adding personal characteristics such as the estimated L5/S1 Intervertebral Disc (IVD) cross-sectional area, age, gender and Body Mass Index to the Revised NIOSH Lifting Equation (RNLE) with the goal to improve risk assessment. A dataset with known RNLE Cumulative Lifting Indices (CLIs) and related health outcomes was used to evaluate the impact of personal characteristics on RNLE performance. The dataset included 29 cases and 101 controls selected from a cohort of 1022 subjects performing 667 jobs. RNLE risk assessment was improved by incorporation of personal characteristics. Adding gender and intervertebral disc size multipliers to the RNLE raised the odds ratio for a CLI of 3.0 from 6.71 (CI: 2.2–20.9) to 24.75 (CI: 2.8–215.4). Similarly, performance was either unchanged or improved when some existing multipliers were removed. The most promising RNLE change involved incorporation of a multiplier based on the estimated IVD cross-sectional area (CSA). Results are promising, but confidence intervals are broad and additional, prospective research is warranted to validate findings.

- **Keywords:** Revised NIOSH lifting equation (RNLE); Personal characteristics; BMI; Age; Gender; Low back pain; Intervertebral disc cross sectional area; L5/S1; Risk assessment

Simon Lawry, Vesna Popovic, Alethea Blackler, Helen Thompson. [Age, familiarity, and intuitive use: An empirical investigation](#). Pages 74-84.

Research has shown that older adults interact with products less intuitively than younger adults, and that familiarity is an essential element of intuitive interaction. This paper reports on the findings of two empirical studies that examined familiarity in younger and older adults. Each study comprised 32 participants over four age groups. The first study required participants to use their own contemporary products in their homes in order to investigate older adults' familiarity with them, and how this familiarity differed from that of younger adults. Older people were less familiar with their own contemporary products than younger people. The second study aimed to investigate differences in familiarity between younger and older adults while using products that they did not own and were likely to be less familiar with. When using products not already familiar to them, both middle aged and older adults showed significantly lower familiarity than younger people. The significance of this research is in its empirical findings about familiarity differences between age groups. It has been recognised that the identification and understanding of differences in familiarity will enable designers to design more intuitive interfaces and systems for both younger and older cohorts. The implications of the findings from the two studies reported here are discussed in light of this recognition.

- **Keywords:** Human computer interaction; User knowledge; Familiarity; Intuitive interaction; Interface design

Juergen Sauer, Andreas Sonderegger, Klaus Heyden, Jasmin Biller, Julia Klotz, Andreas Uebelbacher. [Extra-laboratorial usability tests: An empirical comparison of remote and classical field testing with lab testing.](#) Pages 85-96.

The present article examined the effects of using different extra-laboratorial testing procedures in usability testing. Three experiments were conducted using different artefacts (website, computer-simulated mobile phone, fully operational smartphone) to compare different methodological approaches in field testing (synchronous and asynchronous remote testing, classical field testing) to lab-based testing under different operational conditions (dual task demands, poor product usability). Typical outcome variables of usability testing were measured, including task completion time, click rate, perceived usability and workload. Overall, the results showed no differences between field and lab-based testing under favourable operational conditions. However, under difficult operational conditions (i.e. dual task demands, poor product usability) differences between field and lab-based testing emerged (corresponding to small and medium effect sizes). The findings showed a complex pattern of effects, suggesting that there was no general advantage of one testing procedure over another.

- **Keywords:** Usability test; Remote testing; Field testing; Synchronous testing; Asynchronous testing

Sven Schmutz, Andreas Sonderegger, Juergen Sauer. [Easy-to-read language in disability-friendly web sites: Effects on nondisabled users.](#) Pages 97-106.

This article examines the influence of using easy-to-read language (as an important web accessibility criterion to support users with disabilities) on nondisabled users. A web site usability test was conducted with 128 nondisabled participants. Each participant evaluated one of two web site versions: conventional language vs. easy-to-read language. Measures of performance (e.g., recognition of content and reading time) and subjective user reactions (e.g., perceived usability and text liking) were taken. The results showed that easy-to-read language (compared to conventional language) led to improvements for some performance measures (e.g., recognition of content) but also to increased reading time, decreased text liking and reduced intention to revisit the web site. This article concludes that when implementing easy-to-read language in web sites, adverse as well as beneficial effects on nondisabled users need to be considered.

- **Keywords:** Web accessibility; Easy-to-read language; Nondisabled users

Myrte C. Alfred, David M. Neyens, Anand K. Gramopadhye. [Learning in simulated environments: An assessment of 4-week retention outcomes.](#) Pages 107-117.

Simulations offer the benefits of a safer and more accessible learning environment, where learners can practice until the point of proficiency. While research into the effectiveness of simulations as learning tools has found tangible benefits, fewer studies have examined retention and differences between high and low fidelity simulations. This research sought to supplement the literature in this domain by investigating whether participants who learned to construct an electrical circuit using a 2D or 3D breadboard simulation could achieve comparable learning, transfer, and retention outcomes to those who learned using a physical breadboard. The influence of learner characteristics - cognitive ability and goal orientation - were also evaluated. This study had two parts: a

cross-sectional portion that examined learning and transfer outcomes and a longitudinal portion that examined retention outcomes after a 2 and 4-week period. The cross-sectional analysis included 70 participants and the longitudinal analysis included 40 participants. The results found that the physical fidelity of the learning environment significantly impacted several transfer outcomes (construction and construction time) but not retention outcomes. Cognitive ability was a significant predictor of learning (gain score, circuit design score) and retention (posttest scores, construction time) outcomes. Learning goal orientation significantly predicted circuit construction over time and measurement occasion significantly predicted posttest scores and interacted with fidelity to predict circuit design score. The study demonstrated that simulated environments can lead to comparable, or better, proficiency than physical environments. These findings have implications for the design and implementation of simulated environments, specifically for courses delivered in an online setting.

- **Keywords:** Simulation; Learning; Fidelity

Steven A. Lavender, Zimei Wang, W. Gary Allread, Carolyn M. Sommerich. [*Quantifying the effectiveness of static and dynamic insoles in reducing the tibial shock experienced during walking.*](#) **Pages 118-123.**

Many individuals work in jobs that require them to spend much of their day walking. There is evidence to suggest that shoe insoles may reduce the lower extremity discomfort for these workers. This study compared the effects of static and dynamic shoe insoles on lower extremity forces when walking at different speeds. Tibial acceleration (a.k.a. tibial shock) was assessed bilaterally in 30 participants who walked in both athletic shoes and work boots without any additional insole, with additional static insoles, and with additional dynamic insoles. The participants walked a prescribed course at a "slow", "normal", and "fast" pace. With both shoe types, there were significant reductions in tibial shock values when insoles were used. With the work boots, the dynamic insole further reduced tibial shock relative to the static insole. The significant interactions show that the differences between insole conditions become greater with faster walking speeds.

- **Keywords:** Insoles; Tibial shock; Tibial acceleration; Distribution centers

Philippe Corbeil, André Plamondon, Grant Handrigan, Jasmin Vallée-Marcotte, Simon Laurendeau, Jasmin Ten Have, Nancy Manzerolle. [*Biomechanical analysis of manual material handling movement in healthy weight and obese workers.*](#) **Pages 124-133.**

The risk of back injury during work remains high today for manual materials handler. The purpose of this study is to identify the potential presence of compensatory strategies in obese and non-obese handlers and evaluate the impact these strategies have on trunk kinematics and kinetics. The biomechanical and ergonomic impacts in 17 obese and 20 healthy-weight handlers were evaluated. The task studied consisted in moving boxes from a conveyor to a hand trolley and back. The results show that the anthropometric characteristics of obese handlers are linked to a significant increase in peak lumbar loading during lifting and lowering of boxes. Few postural differences between the two groups were observed. These results suggest that the excess weight of an obese worker has a significant added effect on the musculoskeletal structures of the back, which exposes obese handlers to a higher risk of developing a musculoskeletal disorder during load handling.

- **Keywords:** Body weight; Lifting; Lowering; External loading; Lumbar moment; L5/S1 joint; Spinal loading; Obesity

Giulia Patelli, Michael J. Griffin. [*Effects of seating on the discomfort caused by mechanical shocks: Measurement and prediction of SEAT values.*](#) Pages 134-144.

Seat effective amplitude transmissibilities (SEAT values) quantify the influence of seats on discomfort caused by vibration. This study investigated SEAT values with vertical mechanical shocks at low, medium, and high magnitudes (0.5, 1.0, and 2.0 ms⁻¹–1.75) at frequencies between 1.0 and 16 Hz. With 18 subjects sitting on a rigid seat and two foam cushions, SEAT values were measured objectively (from the transmitted vibration), measured subjectively (by the responses of subjects), and predicted (using a model of the seat-passenger system). Except with high magnitude low frequency shocks, predicted SEAT values were similar to measured SEAT values. With shocks causing subjects to rise off a cushion and subsequently impact the cushion (low frequencies around 1g), subjective SEAT values were better estimated using predicted SEAT values than objectively measured SEAT values, because accelerometers on cushions exaggerated the impact of the falling subject. However, accelerometers on rigid seats will underestimate such impacts.

- **Keywords:** Seat vibration; Mechanical shocks; Biodynamic modelling

Wonjoon Kim, Taehoon Ko, Ilsun Rhiu, Myung Hwan Yun. [*Mining affective experience for a kansei design study on a recliner.*](#) Pages 145-153.

As the technical performance of products progresses, it is becoming more important to design products that satisfy customers' affective experiences. Hence, many studies about Kansei engineering or Kansei design have been conducted to develop products that can satisfy customers' affective experiences. In the Kansei design method, it is important to select affective variables related to the design elements of the product in order to accurately grasp the emotions of customers. Therefore, this study seeks to develop an affective variable extraction methodology that can reflect users' implicit needs effectively and efficiently. In this study, users' affective variables were extracted from online reviews and classified using a self-organizing map (SOM). For verification, the study selected the Amazon e-commerce service and performed a product experiment on recliners. The experimental results show that the most frequently used affective variable in the use of recliners is 'comfort', which is related to various affective variables. In addition, 15 clusters for affective experiences of recliners extracted from Amazon.com were classified through the SOM. The findings suggest that text mining techniques and the SOM can be used to gather and analyze customers' affective experiences effectively and efficiently. The results of this study can also enhance an understanding of customers' emotions regarding recliners.

- **Keywords:** Kansei engineering; Self-organizing map (SOM); Text-mining; User experience; Recliner

Jennifer F. Louie, Mustapha Mouloua. [*Predicting distracted driving: The role of individual differences in working memory.*](#) Pages 154-161.

The present study investigated the role of working memory capacity (WMC) in predicting distracted driving performance using a working memory distractor. Forty-nine participants (including one with missing data) completed four working memory complex spans prior to completing a distracted and non-distracted simulated driving trial. During the distracted driving trial, participants drove while simultaneously completing the grocery list task (GLT), a semi-naturalistic working memory task developed by the authors. Results showed that participants were significantly slower at braking when a yellow traffic light appeared and during sudden braking events when distracted.

Furthermore, the impairing effect of distraction on braking response time was partially mediated by WMC. There was also a trend towards a moderating effect of WMC, where the impairing effect of distraction was more pronounced for individuals with low WMC than high WMC. Theoretical and practical implications for the role of individual differences in cognition and driving, in-vehicle devices use and traffic safety, as well as semi-autonomous vehicle design are also discussed.

- **Keywords:** Working memory capacity; Driver cognition; Driver behavior; Distracted driving; Traffic safety

Paul M. Salmon, Gemma J.M. Read, Vanessa Beanland, Jason Thompson, Ashleigh J. Filtness, Adam Hulme, Rod McClure, Ian Johnston. [Bad behaviour or societal failure? Perceptions of the factors contributing to drivers' engagement in the fatal five driving behaviours](#). Pages 162-171.

The so-called 'fatal five' behaviours (drink and drug driving, distraction and inattention, speeding, fatigue, and failure to wear a seat belt) are known to be the major behavioural contributory factors to road trauma. However, little is known about the factors that lead to drivers engaging in each behaviour. This article presents the findings from a study which collected and analysed data on the factors that lead to drivers engaging in each behaviour. The study involved a survey of drivers' perceptions of the causes of each behaviour and a subject matter expert workshop to gain the views of road safety experts. The results were mapped onto a systems ergonomics model of the road transport system in Queensland, Australia, to show where in the system the factors reside. In addition to well-known factors relating to drivers' knowledge, experience and personality, additional factors at the higher levels of the road transport system related to road safety policy, transport system design, road rules and regulations, and societal issues were identified. It is concluded that the fatal five behaviours have a web of interacting contributory factors underpinning them and are systems problems rather than driver-centric problems. The implications for road safety interventions are discussed.

- **Keywords:** Road safety; Systems ergonomics; STAMP; Fatal five

S. Kratzenstein, M. Wanstrath, K. Behrenbruch. [Height adjustments on backpack-carrying systems and muscle activity](#). Pages 172-176.

The aim of this study is to investigate the neuromuscular response of shoulder muscles at different attachment heights of a carrying system during arm movement. It was hypothesized that (1) different height adjustments lead to changes in muscle activity and (2) the shoulder horizontal provides a benchmark for the optimal attachment height of the shoulder belts. The musculus deltoideus was significantly relieved after the elevation of the shoulder belt for subjects with an initial attachment height of 2 cm below the shoulder. The musculus trapezius was relieved with the elevation above the shoulder. At a height of more than 2 cm above the shoulder, no further muscle unloading was achieved. These findings prove that a height adjustment can provide a systematic unloading or deloading of the shoulder musculature. Despite the fact that the magnitude and direction of changes in muscle activity lead to rather individual responses, the intra-individual responses are consistent. Therefore, support systems should provide the range of individual requirements.

- **Keywords:** Electromyography; Height adjustment; Carriage system

Dominique Larouche, Marie Bellemare, Jérôme Prairie, Sandrine Hegg-Deloye, Philippe Corbeil. [Overall risk index for patient transfers in total assistance mode executed by emergency medical technician-paramedics in real work situations](#). Pages 177-185.

Few studies have quantified the risk of musculoskeletal disorders during patient transfers in total assistance mode in real-life prehospital emergency care situations. An index to assess the overall risk of patient transfers was created; it makes it possible to quantify risk based on the patient's position and the height of the patient's location. An analysis of 71 transfers executed by paramedics in actual work situations showed that moving a patient from the ground was characterized by acute sagittal flexions and axial rotations, respectively, 42% and 12% of the time. When the patient was lying on a raised surface, the lifting index and perceived exertion were the lowest (2.55; easy). According to the overall risk index, patient transfers from the ground are the riskiest. Paramedics execute many risky lifts even in favorable patient handling contexts.

- **Keywords:** Emergency medical service (EMS); Patient transfers; Field study; Lifting; NIOSH lifting equation; Exposure variation analysis

Sunwook Kim, Maury A. Nussbaum, Joseph L. Gabbard. [Influences of augmented reality head-worn display type and user interface design on performance and usability in simulated warehouse order picking.](#) Pages 186-193.

Limited information is available regarding the effective use of workplace head-worn displays (HWD), especially the choices of HWD types and user interface (UI) designs. We explored how different HWD types and UI designs affect perceived workload, usability, visual discomfort, and job performance during a simulated warehouse job involving order picking and part assembly. Sixteen gender-balanced participants completed the simulated job in all combinations of two HWD types (binocular vs. monocular) and four UIs, the latter of which manipulated information mode (text-vs. graphic-based) and information availability (always-on vs. on-demand); a baseline condition was also completed (paper pick list). Job performance, workload, and usability were more affected by UI designs than HWD type. For example, the graphic-based UI reduced job completion time and number of errors by ~13% and ~59%, respectively. Participants had no strong preference for either of the HWD types, suggesting that the physical HWD designs tested are suboptimal.

- **Keywords:** Head-worn display; Augmented reality; User interface; Performance

Alessandro Naddeo, Rosaria Califano, Mariarosaria Vallone, Arianna Cicalese, Chiara Coccaro, Federica Marcone, Ervis Shullazi. [The effect of spine discomfort on the overall postural \(dis\)comfort.](#) Pages 194-205.

Currently, the word 'comfort' is often used in relation to the marketing of products such as chairs, cars interiors, clothing, hand tools and even airplane tickets. In this field of research, the aim of this study is to investigate the influence of spinal posture on postural (dis)comfort perception; the test case is the analysis of the interaction between humans and vending machines for purchasing food or beverages. A statistical sample of 20 healthy students (subjects) performed the required tests, with each participant asked to take a product from three different vending machines (snacks, drinks and coffee). The subjects' postures were acquired non-invasively using cameras; software and instruments for virtual prototyping were used for posture analysis and interaction modelling, both questionnaires (subjective) and comfort-analysis software (objective) were used to rate the perceived (dis)comfort. The results obtained from simulations and questionnaires were compared, and a method to weigh the effect of the perceived spinal discomfort on overall postural (dis)comfort was proposed. These results reveal a good correlation between subjective perception and objective evaluation obtained through simulations, confirming the validity of the proposed method.

- **Keywords:** Comfort evaluation; Non-invasive postural analysis; Vending machines; Spine discomfort; Information fusion

Mengli Yu, Ronggang Zhou, Huiwen Wang, Weihua Zhao. [An evaluation for VR glasses system user experience: The influence factors of interactive operation and motion sickness](#). Pages 206-213.

As a new type of Virtual Reality (VR) headset, VR glasses rise rapidly in a number of areas. It's essential to understand the importance of user experience (UX) on VR glasses design. This study aimed to develop questionnaires for evaluating VR glasses' UX, as well as to investigate the relationship between various UX variables. With using lab-based usability tests, this study analyzed participants' self-reports and performance based on testing eight VR glasses and seven mobile applications. A nine-item questionnaire and a ten-item questionnaire were successfully developed to measure VR glasses systems' UX quality in terms of hardware and application, respectively. Within a proposed UX evaluation framework, the perceived UX quality relative to VR glasses hardware emerged as a core predictor in predicting interactive operation performance, whereas the application UX perception was a significant predictor of motion sickness.

- **Keywords:** VR glasses system; User experience evaluation; Interactive operation; Motion sickness

Maria Varela, Diane Gyi, Neil Mansfield, Richard Picton, Akinari Hirao, Tomokazu Furuya. [Engineering movement into automotive seating: Does the driver feel more comfortable and refreshed?](#) Pages 214-220.

The concept of introducing movement in automotive seating was investigated. Three seat conditions, a control (no movement) and two movement conditions (fore-aft and cushion-backrest) were compared. Movement was introduced at a fixed speed, slow, smooth and within a small range. Ten participants took part in a 60 min simulated drive for each condition - single blind, repeated measures, and balanced order. Discomfort ratings were collected for six body areas and overall discomfort, together with a wellbeing questionnaire. Driver posture and Seat Fidgets and Movements (SFMs) were captured. There was a trend for lower ratings of discomfort, overall and in the neck, shoulders, lower back, buttocks, and ankles with both seat movement conditions. Wellbeing ratings were also better with movement. Significant differences were found at minute 60 for buttock discomfort - less discomfort with seat movement. Overall discomfort and SFMs frequency increased with time driving. Generally, passive seat movement was well received.

- **Keywords:** Driving; Comfort; Car seat design; Musculoskeletal; Ergonomics methods

Rebecca L. Charles, Jim Nixon. [Measuring mental workload using physiological measures: A systematic review](#). Pages 221-232.

Technological advances have led to physiological measurement being increasingly used to measure and predict operator states. Mental workload (MWL) in particular has been characterised using a variety of physiological sensor data. This systematic review contributes a synthesis of the literature summarising key findings to assist practitioners to select measures for use in evaluation of MWL. We also describe limitations of the methods to assist selection when being deployed in applied or laboratory settings. We detail fifty-eight peer reviewed journal articles which present original data using physiological measures to include electrocardiographic, respiratory, dermal, blood pressure and ocular. Electroencephalographic measures have been included if they are presented with another measure to constrain scope. The literature reviewed covers a

range of applied and experimental studies across various domains, safety-critical applications being highly represented in the sample of applied literature reviewed. We present a summary of the six measures and provide an evidence base which includes how to deploy each measure, and characteristics that can affect or preclude the use of a measure in research. Measures can be used to discriminate differences in MWL caused by task type, task load, and in some cases task difficulty. Varying ranges of sensitivity to sudden or gradual changes in taskload are also evident across the six measures. We conclude that there is no single measure that clearly discriminates mental workload but there is a growing empirical basis with which to inform both science and practice.

- **Keywords:** Mental workload; Taskload; Physiological measures; Systematic review

Luisa Fasulo, Alessandro Naddeo, Nicola Cappetti. [A study of classroom seat \(dis\)comfort: Relationships between body movements, center of pressure on the seat, and lower limbs' sensations](#). Pages 233-240.

The aim of this work is to define a new method that helps researchers to analyze perceptions of (dis)comfort in dynamic conditions. Recent studies pay considerable attention to body movements, mobility, and stability to measure comfort or discomfort when seated. Most of these discuss the relations between subjective comfort/discomfort and objective measurements (e.g. body pressure distribution, body movement and EMG) for short- and medium-term sitting. The present analysis took place in a classroom of the Industrial Engineering Department at the University of Salerno. The participants included 25 students (12 females and 13 males), who were observed during classroom hours. The students were invited to sit at a combo-desk and were free to perform different combinations of movements while writing and listening. These activities required that they adapt their body movements, as the combo-desk was fixed to the floor. A pressure pad was used to detect pressure at interface and center of pressure's changes, allowing for the bodies' motion data to be recorded. The aim was to identify the correct threshold to be used for movement detection and to investigate correlations between the number of movements and the perceived (dis)comfort. The study also identifies those body parts that have the greatest effect on (dis)comfort perception.

- **Keywords:** Comfort; Discomfort; Center of pressure; Pressure map; Body movements; Classroom seat; School furniture