Miyuki Morioka, Michael J. Griffin. Equivalent comfort contours for vertical vibration of steering wheels: effect of vibration magnitude, grip force, and hand position. S. 817-825.

Vehicle drivers receive tactile feedback from steering-wheel vibration that depends on the frequency and magnitude of the vibration. From an experiment with 12 subjects, equivalent comfort contours were determined for vertical vibration of the hands at two positions with three grip forces. The perceived intensity of the vibration was determined using the method of magnitude estimation over a range of frequencies (4–250 Hz) and magnitudes (0.1–1.58 ms$^{-2}$ r.m.s.). Absolute thresholds for vibration perception were also determined for the two hand positions over the same frequency range. The shapes of the comfort contours were strongly dependent on vibration magnitude and also influenced by grip force, indicating that the appropriate frequency weighting depends on vibration magnitude and grip force. There was only a small effect of hand position. The findings are explained by characteristics of the Pacinian and non-Pacinian tactile channels in the glabrous skin of the hand.

- **Keywords:** Absolute threshold; Equivalent comfort contour; Hand-transmitted vibration


A health and safety association collaborated with two research centres to examine the dissemination of knowledge of an ergonomic intervention by opinion leaders in the construction sector. The intervention was a hydraulic ladder lift that aided with loading and unloading of ladders off van roofs. Thirteen companies, with five to 900 employees, were involved. The van operators informed workmates not employed by their companies but who worked on the same site as them about the intervention. The opinion leaders informed decision makers within their companies which led to commitments to purchase similar units. They also gave presentations at prearranged health and safety meetings, where attendees indicated that they thought the intervention sounded like a good idea. In this way, knowledge of the innovation reached at least 32 more companies and potentially several thousand other employees. The study showed the potential for workplace change to be exponential.
**Keywords:** Diffusion of innovations; Prevention of musculoskeletal disorders; Workplace intervention research; Construction sector


The aim of this study was to identify the magnitude and characteristics of work-related musculoskeletal complaints among perioperative nurses and technicians (PNT) and determine the associated ergonomic risk factors in the operating room (OR) environment based on self-report and focus group discussion. The 50 PNTs who participated in the study completed a self-report survey for musculoskeletal symptoms, Job Description Questionnaire, and Psychometric Evaluation Questionnaire, and participated in focus groups to discuss potential OR ergonomic risk factors. The results of the study demonstrated a high prevalence of work-related musculoskeletal disorders (WMSD) among PNTs, with lower back pain the most prevalent (84%) complaint, followed by ankle/foot (74%) and shoulder (74%) pain. In addition, lower back pain (31%), followed by ankle/knee (24%) pain were found to be the main causes of absenteeism from work. Participants suggested simple ergonomic and engineering solutions can be adopted to improve the work environment of PNTs.

**Keywords:** Operating room; Ergonomics; Musculoskeletal symptoms; Perioperative nurses, Perioperative technicians


In this study, elderly persons' physical and spiritual necessities and their satisfaction in their residences are investigated by applying a comprehensive questionnaire on the residents of Trabzon Old Person's Home. By grouping the residents of the home according to their age, gender, marital status, occupation, health conditions, cultural status, and economic conditions, their expectations are determined. Physical conditions of the home are also examined in order to determine whether the necessities of the residents are met or not. The questionnaire consisting of 75 questions is applied to 60 people, and 4500 data points are analyzed by using SPSS software. In the results of this study, physical deficiencies that require elderly persons want to be in Trabzon Old Person's Home are determined. It is also determined that 86.7% of the residents are pleased with living in the old persons' home and they could get used to living in the old persons' home but 73.3% of the residents do not want to send someone in their family to the old person's home. These contradictory results show that residents do not want to live in old person's home but they adapt in there because of compulsoriness. This situation affects the residents' psychological well-being in a negative way.

**Keywords:** Elderly people; Ageing; Old person's home; Physical conditions; Psychological well-being


Desk design and computer display height can affect posture and muscle activation during computer use. Amplitudes of postural variables and muscle activity during computer use do not explain the results from epidemiological studies of musculoskeletal discomfort and disorders related to computer use. The purpose of this study was to assess variability of
posture and muscle activity during work with two computer display heights and book/paper, in conjunction with a curved desk designed to provide forearm support and a traditional, straight desk. 18 male and 18 female participants performed 10-min tasks involving keying, mousing, reading and writing in six desk/display conditions. 3D posture and surface emg were assessed for the final 2 min of each task. The curved desk resulted in greater postural and muscle activity variation, suggesting an advantage of this supportive surface over the straight desk. There was little difference in variability associated with the two display heights. However, greater variability of posture and muscle activity was evident with the book/paper condition. Non-touch typists had greater neck flexion variation. The design of information technology tasks and workstations can influence the short term variation in posture and muscle activity. Variation is influenced independently of mean postures and muscle amplitudes and therefore needs to be considered to adequately assess the risk of musculoskeletal disorders.

- **Keywords:** Computer; Musculoskeletal disorder; Variation; Posture; Muscle activity


Booming sound is one of the important sounds in a passenger car. The aim of the paper is to develop the objective evaluation method of interior booming sound. The development method is based on the sound metrics and ANN (artificial neural network). The developed method is called the booming index. Previous work maintained that booming sound quality is related to loudness and sharpness – the sound metrics used in psychoacoustics – and that the booming index is developed by using the loudness and sharpness for a signal within whole frequency between 20 Hz and 20 kHz. In the present paper, the booming sound quality was found to be effectively related to the loudness at frequencies below 200 Hz; thus the booming index is updated by using the loudness of the signal filtered by the low pass filter at frequency under 200 Hz. The relationship between the booming index and sound metric is identified by an ANN. The updated booming index has been successfully applied to the objective evaluation of the booming sound quality of mass-produced passenger cars.

- **Keywords:** Booming; Sound metrics; Neural network; Car; Acceleration; Subjective evaluation

**Elizabeth A. McCullough, Steve Eckels, Craig Harms. Determining temperature ratings for children’s cold weather clothing.** S. 870-877.

This study examined the physical and physiological differences between children and adults that affect body heat generation and losses and then developed a heat loss model for determining the temperature ratings of cold weather clothing designed for use by children of various ages. The thermal insulation values of selected jackets were measured using a heated manikin dressed in two base ensembles, and the temperature ratings were calculated using the model. The results indicated that the type of garments used in the base ensemble had a major effect on jacket ensemble insulation and the predicted comfort temperature. For a given level of insulation, the temperature rating decreased as the wearer's age and activity level increased. This is probably because children have a higher surface area per unit mass ratio than adults, and they lose heat faster. However, this effect is partially offset by their higher metabolic rates.

- **Keywords:** Clothing insulation; Temperature ratings; Thermal modeling
Fong-Gong Wu, Min-Yuan Ma, Ro-Han Chang. *A new user-centered design approach: a hair washing assistive device design for users with shoulder mobility restriction*. S. 878-886.

This study utilized a user-centered design approach as the foundation for a new Assistive Device (AD) design process. Observation and evaluation results from a Usability Context Analysis (UCA) was used to improve the analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT Analysis) and the matrix of Threats, Opportunities, Weaknesses, and Strengths (TOWS matrix), resulting in two assistive device design methods named AD-SWOT and AD-TOWS. Thus, an AD-design process, tailored for designing assistive devices, was both established and tested. Owing to the information gained from using the design processes and evaluating product efficiency with various cases in the early part of the research, it was decided to use the AD-design process for the entire design process. Using this process, an adjustable hair washer for physically disabled individuals to wash their hair using normal postures was developed. Furthermore, the method derived in this study can also be applied to users suffering from single-sided shoulder-joint mobility disabilities, such as frontal flexion, scapular plan elevation, and restricted abductors.

- **Keywords**: User-centered design; Design process; Assistive device


In this field study, the size and structure of kinematics variability were assessed in relation to experience and discomfort during a deboning task. Eighteen workers divided in groups with low/high experience and with/without neck–shoulder discomfort participated. Standard deviation and coefficient of variation (amount of variability), as well as approximate entropy and sample entropy (complexity) and, correlation dimension (dimensionality) were computed for head–shoulder, shoulder–hip and elbow–hip displacement in the vertical direction. A longer work experience was associated with shorter work cycle duration and decreased amount of variability while complexity increased for the head–shoulder displacement, \( P < 0.05 \). Shorter work cycle, lower amount of variability and, lower dimensionality for the head–shoulder displacement were found in relation to discomfort, \( P < 0.05 \). While the amount of variability, complexity and dimensionality increased for the elbow–hip displacement, \( P < 0.05 \). These findings suggest a functional role of experience via learning effects and discomfort through compensatory mechanisms on the size and structure of motor variability.

- **Keywords**: Variation; Compensatory mechanisms; Nonlinear analysis


This study aims to investigate the effects of shoe traction and obstacle height on lower extremity relative phase dynamics (analysis of intralimb coordination) during walking to better understand the mechanisms employed to avoid slippage following obstacle clearance. Ten participants walked at a self-selected pace during eight conditions: four obstacle heights (0%, 10%, 20%, and 40% of limb length) while wearing two pairs of shoes (low and high traction). A coordination analysis was used and phasing relationships between lower extremity segments were examined. The results demonstrated that significant behavioral changes were elicited under varied obstacle heights and frictional conditions. Both decreasing shoe traction and increasing obstacle height resulted in a more in-phase relationship between the interacting lower limb segments. The higher the
obstacle and the lower the shoe traction, the more unstable the system became. These changes in phasing relationship and variability are indicators of alterations in coordinative behavior, which if pushed further may have lead to falling.

- **Keywords:** Dynamical systems theory; Shoe traction; Obstacle clearance; Locomotion

Barbara M. Haward, Christopher H. Lewis, Michael J. Griffin. *Motions and crew responses on an offshore oil production and storage vessel*. S. 904-914.

The motions of vessels may interfere with crew activities and well-being, but the relationships between motion and the experiences of crew are not well-established. Crew responses to motions of a floating production and storage offshore vessel at a fixed location in the North Sea were studied over a 5-month period to identify any changes in crew difficulties and symptoms associated with changes in vessel motion. Ship motions in all six axes (fore-aft, lateral, vertical, roll, pitch, and yaw) were recorded continuously over the 5-month period while 47 crew completed a total of 1704 daily diary entries, a participation rate of 66–78% of the crew complement. The dominant oscillations had frequencies of around 0.1 Hz, producing magnitudes of translational oscillation in accommodation areas of up to about 0.7 m s\(^{-2}\) r.m.s., depending on the weather, and magnitudes up to three times greater in some other areas. The daily diaries gave ratings of difficulties with tasks, effort level, motion sickness, health symptoms, fatigue, and sleep. Problems most strongly associated with vessel motions were difficulties with physical tasks (balancing, moving and carrying), and sleep problems. Physical and mental tiredness, cognitive aspects of task performance, and stomach awareness and dizziness were also strongly associated with motion magnitude. There was a vomiting incidence of 3.1%, compared with a predicted mean vomiting incidence of 9.3% for a mixed population of unadapted adults. It is concluded that crew difficulties increase on days when vessel motions increase, with some activities and responses particularly influenced by vessel motions.

- **Keywords:** Ship motion; Crew response; Task difficulty; Crew performance; Motion sickness


Production in the automotive industry, based on assembly line work, is now characterized by lean manufacturing and customization. This results in greater flexibility and increased quality demands, including worker performance self-monitoring. The objectives of this study are to refine the concept of performance self-monitoring and to characterize the strategies developed by operators to achieve it. Data were collected based on the method of individual auto-confrontation, consisting of two steps: eleven assembly-line operators of a French automotive company were individually observed and video-taped while they were working; an interview then allowed each operator to discuss his/her activity based on the video-tape. This study expands the concept of performance self-monitoring by highlighting three types of strategies directly oriented toward quality: prevention, feedback control and control action strategies.

- **Keywords:** Performance self-monitoring; Lean manufacturing; Quality; Work strategies

Yu-Ting Lin, Po-Hung Lin, Sheue-Ling Hwang, Shie-Chang Jeng, Chi-Chang Liao. *Investigation of legibility and visual fatigue for simulated
This study employs simulated electronic paper to investigate critical issues and focuses on improving legibility of display and reducing users' visual fatigue. Three critical factors – choice of surface treatment, ambient illumination, and bending curvature – are evaluated through the method of a letter-search task. The results show that subjects performed better on legibility and felt less visual fatigue with an anti-glare treatment. Choosing the better anti-glare treatment instead of the anti-reflection series can save significant cost for manufacturers. In addition, ambient lighting of 1500 lux is more appropriate for reading on electronic paper than an environment with extreme illumination (e.g., 8000 lux). The present study also found that curvature had no impact on legibility or visual fatigue. These evaluations of simulated electronic paper may provide manufacturers useful information in fulfilling ergonomic requirements for product design.

- **Keywords:** Electronic paper; Legibility; Visual fatigue

**Daniel Baldauf, Esther Burgard, Marc Wittmann. Time perception as a workload measure in simulated car driving.** S. 929-935.

In experimental studies using flight simulations subjects’ duration estimates have shown to be an effective indicator of cognitive task demands. In this study we wanted to find out whether subjective time perception could serve as a measure of cognitive workload during simulated car driving. Participants drove on a round course of a driving simulator consisting of three different environments with different levels of task demands. Drivers were required to perform a time-production task while driving the vehicle. Electrodermal activity and subjective ratings of mental workload (SWAT) were recorded simultaneously. The length of produced intervals increased significantly in more complex driving situations, as did electrodermal activity and subjective ratings of mental workload. Thus, time production is a valid indicator of cognitive involvement in simulated driving and could become a valid method to measure the current mental workload of car drivers in various traffic situations.

- **Keywords:** Mental workload; Time perception; Duration production; Driving simulator


The purpose of this study was to investigate the effectiveness and user acceptability of a Personal Lift-Assist Device (PLAD) at an automotive manufacturing facility, with operators who perform an on-line assembly process requiring forward bending and static holding. Surface EMG data were collected at six sites on the low back and abdomen, and an accelerometer was used to measure trunk inclination. Use of the PLAD significantly reduced the thoracic and lumbar erector spinae activity and EMG-predicted compression at the 10th, 50th, and 90th APDF percentile levels ($p \leq 0.05$), without significantly increasing rectus abdominus activity or trunk flexion. Similarly, ratings of perceived exertion were found to be significantly lower when wearing the PLAD ($p = 0.006$). Subjective opinions were positive, with 8/10 subjects indicating they would wear the device everyday. With slight changes, workers felt that the PLAD could be beneficial at reducing forces and discomfort in similar industrial or manual materials handling tasks that place excessive physical demands on the low back.
**Keywords:** Ergonomic aid; Electromyography; Manual materials handling


As the population of many industrialized countries ages, the number of older drivers on the roads increases. Statistics show that older drivers are at increased risk for involvement in fatal accidents. One explanation for this is the cognitive and motor declines associated with the aging process. As we age, performance on attention, memory and motor control tasks, three important components of driving, declines. In the present study we examined the relationship between performance on component cognitive tasks and the influence of training on these tasks on the simulated driving performance of older adults. More specifically, we assessed performance on and trained older adults on single and dual tasks of attention, working memory and manual control. Regression analyses demonstrated that performance on the single and dual cognitive tasks and improvements in these computer-based tasks with training were predictive of improvements in driving simulator performance across the course of the study. These data suggest that relatively simple single and dual computer-based tasks and modest amounts of training on these tasks can improve driving performance in older adults, thereby extending functional independence.

**Keywords:** Aging; Training; Driving; Cognitive assessment


There is increasing momentum towards international harmonization of warning standards. Therefore, it is critical to determine the applicability of existing standards across different cultures. Perceived hazard in response to isolated warning components (colors, signal words and symbols) and warning configurations was examined as a function of culture of the product-user (US vs. China) to determine the extent to which ANSI (American National Standards Institute)-recommended components/configurations communicate the expected level of hazard across cultures. 40 college students in the US and 43 in China rated colors, signal words, symbols, and complex configurations on a scale from 1 (not at all hazardous) to 9 (extremely hazardous). US participants consistently provided higher ratings of perceived hazard than Chinese participants. Cross-cultural differences were also observed in the relative levels of perceived hazard assigned to different levels of a label component, particularly in response to colors. However, relative levels of perceived hazard among more complex configurations were similar across culture, even though Chinese participants continued to provide lower absolute ratings of perceived hazard. These results have important implications – if it is assumed that perceived hazard-level must attain some threshold value in order to trigger compliance, then differences in perception could result in a failure of product-users to take appropriate precautions.

**Keywords:** Hazard perception; Warning labels; China; Cultural differences