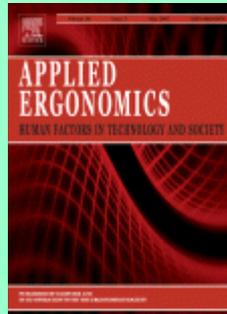


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**Jaume Gual, Marina Puyuelo, Joaquim Lloveras. *The effect of volumetric (3D) tactile symbols within inclusive tactile maps.* Pages 1-10.**

Point, linear and areal elements, which are two-dimensional and of a graphic nature, are the morphological elements employed when designing tactile maps and symbols for visually impaired users. However, beyond the two-dimensional domain, there is a fourth group of elements – volumetric elements – which mapmakers do not take sufficiently into account when it comes to designing tactile maps and symbols. This study analyses the effect of including volumetric, or 3D, symbols within a tactile map. In order to do so, the researchers compared two tactile maps. One of them uses only two-dimensional elements and is produced using thermoforming, one of the most popular systems in this field, while the other includes volumetric symbols, thus highlighting the possibilities opened up by 3D printing, a new area of production. The results of the study show that including 3D symbols improves the efficiency and autonomous use of these products.

- **Keywords:** Tactile symbols; Visually impaired; 3D printing

**Hwa S. Jung, Gemus Park, Young-Shim Kim, Hyung-Shik Jung. *Development and evaluation of one-hand drivable manual wheelchair device for hemiplegic patients.* Pages 11-21.**

This study was conducted for one-hand users including hemiplegic clients currently using standard manual wheelchairs, so as to analyze their specific problems and recommend solutions regarding usage. Thirty hemiplegic clients who were admitted to rehabilitation and convalescent hospitals participated as subjects. The research tools were standard manual wheelchairs commonly used by people with impaired gait and a “one-hand drivable manual wheelchair,” which was developed for this study. The Wheelchair Skills Test (WST) was adopted for the objective assessment tool, while drivability, convenience, difference, and acceptability were developed for the subjective evaluation tools. The assessment procedures comprise two phases of pre-assessment and post-assessment. In the pre-assessment phase, the WST and subjective evaluation (drivability, convenience) were conducted using the existing standard manual wheelchair and with/without use of a foot to control the wheelchair. In the post-assessment phase, the WST and subjective evaluation (drivability, convenience, difference, acceptability) were also carried out using the developed one-hand drivable manual wheelchair. The results showed that the highest pass rate recorded for the WST items was 3.3% when the participants drove standard manual wheelchairs without the use of either foot and 96.7% when using the manual wheelchairs equipped with developed device. As compared to the existing wheelchair,

statistical results showed significant effects on the WST, drivability, convenience, difference and acceptability when the participants drove wheelchairs equipped with the developed device. These findings imply that the one-hand drivable wheelchair equipped with the developed device can be an active and effective solution for hemiplegic clients using existing manual wheelchairs to increase their mobility and occupational performance.

- **Keywords:** Manual wheelchair; One-hand drivable wheelchair; Hemiplegia

**Mohammad Ali Rajaei, Navid Arjmand, Aboufazi Shirazi-Adl, André Plamondon, Hendrik Schmidt. *Comparative evaluation of six quantitative lifting tools to estimate spine loads during static activities. Pages 22-32.***

Different lifting analysis tools are commonly used to assess spinal loads and risk of injury. Distinct musculoskeletal models with various degrees of accuracy are employed in these tools affecting thus their relative accuracy in practical applications. The present study aims to compare predictions of six tools (HCBCF, LSBM, 3DSSPP, AnyBody, simple polynomial, and regression models) for the L4-L5 and L5-S1 compression and shear loads in twenty-six static activities with and without hand load. Significantly different spinal loads but relatively similar patterns for the compression ( $R^2 > 0.87$ ) were computed. Regression models and AnyBody predicted intradiscal pressures in closer agreement with available in vivo measurements ( $RMSE \approx 0.12$  MPa). Due to the differences in predicted spinal loads, the estimated risk of injury alters depending on the tool used. Each tool is evaluated to identify its shortcomings and preferred application domains.

- **Keywords:** Lifting tools; Biomechanical models; Spine loads

**John Elson, Steve Eckels. *An objective method for screening and selecting personal cooling systems based on cooling properties. Pages 33-41.***

A method is proposed for evaluation and selection of a personal cooling system (PCS) incorporating PCS, subject, and equipment weights; PCS run time; user task time; PCS cooling power; and average metabolic rate. The cooling effectiveness method presented is derived from first principles and allows those who select PCSs for specific applications to compare systems based on their projected use. This can lower testing costs by screening for the most applicable system. Methods to predict cooling power of PCSs are presented and are compared to data taken through standard manikin testing. The cooling effectiveness ranking is presented and validated against human subject test data. The proposed method provides significant insight into the application of PCS on humans. However, the interaction a humans with a PCS is complex, especially considering the range of clothing ensembles, physiological issues, and end use scenarios, and requires additional analysis.

- **Keywords:** Personal cooling system; Evaluation tool; Heat stress

**Huiju Park, Seonyoung Kim, Kristen Morris, Melissa Moukperian, Youngjin Moon, Jeffrey Stull. *Effect of firefighters' personal protective equipment on gait. Pages 42-48.***

The biomechanical experiment with eight male and four female firefighters demonstrates that the effect of adding essential equipment: turnout ensemble, self-contained breathing apparatus, and boots (leather and rubber boots), significantly restricts foot pronation. This finding is supported by a decrease in anterior-posterior and medial-lateral excursion of center of plantar pressure (COP) trajectory during walking. The accumulation of this

equipment decreases COP velocity and increases foot-ground contact time and stride time, indicating increased gait instability. An increase in the flexing resistance of the boots is the major contributor to restricted foot pronation and gait instability as evidenced by the greater decrease in excursion of COP in leather boots (greater flexing resistance) than in rubber boots (lower resistance). The leather boots also shows the greatest increase in foot contact time and stride time. These negative impacts can increase musculoskeletal injuries in unfavorable fire ground environments.

- **Keywords:** Firefighters; Foot; Gait

**Pilwon Hur, Kiwon Park, Karl S. Rosengren, Gavin P. Horn, Elizabeth T. Hsiao-Wecksler. *Effects of air bottle design on postural control of firefighters. Pages 49-55.***

The purpose of this study was to investigate the effect of firefighter's self-contained breathing apparatus (SCBA) air bottle design and vision on postural control of firefighters. Twenty-four firefighters were tested using four 30-minute SCBA bottle designs that varied by mass and size. Postural sway measures were collected using a forceplate under two visual conditions (eyes open and closed) and two stance conditions (quiet and perturbed stances). For perturbed stance, a mild backward impulsive pull at the waist was applied. In addition to examining center of pressure postural sway measures for both stance conditions, a robustness measure was assessed for the perturbation condition. The results suggest that wearing heavy bottles significantly increased excursion and randomness of postural sway only in medial-lateral direction but not in anterior-posterior direction. This result may be due to stiffening of plantar-flexor muscles. A significant interaction was obtained between SCBA bottle design and vision in anterior-posterior postural sway, suggesting that wearing heavy and large SCBA air bottles can significantly threaten postural stability in AP direction in the absence of vision. SCBA bottle should be redesigned with reduced weight, smaller height, and COM closer to the body of the firefighters. Firefighters should also widen their stance width when wearing heavy PPE with SCBA.

- **Keywords:** Self-contained breathing apparatus; Firefighting; Balance

**Laura Lewis, Sarah Sharples, Ed Chandler, John Worsfold. *Hearing the way: Requirements and preferences for technology-supported navigation aids. Pages 56-69.***

Many systems have been developed to assist wayfinding for people with sight problems. There is a need for user requirements for such systems to be defined. This paper presents a study which aimed to determine such user requirements. An experiment was also conducted to establish the best way of guiding users between locations. The focus group results indicated that users require systems to provide them with information about their surroundings, to guide them along their route and to provide progress information. They also showed that users with sight conditions interact with systems differently to sighted users, thereby highlighting the importance of designing systems for the needs of these users. Results of the experiment found that the preferred method of guiding users was a notification when they were both on and off track. However, performance was best when only provided with the off track notification, implying that this cue is particularly important. Technology has the potential to support navigation for people with sight problems. Users should have control over cues provided and for these cues should supplement environmental cues rather than replacing them.

- **Keywords:** Blind and partially sighted; Wayfinding; Navigation

**Daniël Lacko, Toon Huysmans, Paul M. Parizel, Guido De Bruyne, Stijn Verwulgen, Marc M. Van Hulle, Jan Sijbers. *Evaluation of an anthropometric shape model of the human scalp*. Pages 70-85.**

This paper presents the evaluation a 3D shape model of the human head. A statistical shape model of the head is created from a set of 100 MRI scans. The ability of the shape model to predict new head shapes is evaluated by considering the prediction error distributions. The effect of using intuitive anthropometric measurements as parameters is examined and the sensitivity to measurement errors is determined. Using all anthropometric measurements, the average prediction error is  $1.60 \pm 0.36$  mm, which shows the feasibility of the new parameters. The most sensitive measurement is the ear height, the least sensitive is the arc length. Finally, two applications of the anthropometric shape model are considered: the study of the male and female population and the design of a brain-computer interface headset. The results show that an anthropometric shape model can be a valuable tool for both research and design.

- **Keywords:** Computer-aided design; Shape modeling; Anthropometry

**Saija Mauno, Mervi Ruokolainen, Ulla Kinnunen. *Work–family conflict and enrichment from the perspective of psychosocial resources: Comparing Finnish healthcare workers by working schedules*. Pages 86-94.**

We examined work–family conflict (WFC) and work–family enrichment (WFE) by comparing Finnish nurses, working dayshifts (non-shiftworkers,  $n = 874$ ) and non-dayshifts. The non-dayshift employees worked either two different dayshifts (2-shiftworkers,  $n = 490$ ) or three different shifts including nightshifts (3-shiftworkers,  $n = 270$ ). Specifically, we investigated whether different resources, i.e. job control, managers' work–family support, co-workers' work–family support, control at home, personal coping strategies, and schedule satisfaction, predicted differently WFC and WFE in these three groups. Results showed that lower managers' work–family support predicted higher WFC only among 3-shiftworkers, whereas lower co-workers' support associated with increased WFC only in non-shiftworkers. In addition, shiftworkers reported higher WFC than non-shiftworkers. However, the level of WFE did not vary by schedule types. Moreover, the predictors of WFE varied only very little across schedule types. Shiftwork organizations should pay more attention to family–friendly management in order to reduce WFC among shiftworkers.

- **Keywords:** Work–family conflict; Work–family enrichment; Shiftwork

**Fatemeh Sadeghi, Adel Mazloumi, Zeinab Kazemi. *An anthropometric data bank for the Iranian working population with ethnic diversity*. Pages 95-103.**

This study constructed an anthropometric data bank for the Iranian working population. In total, thirty-seven body dimensions were measured among 3720 Iranian workers with different ethnicities (3000 male and 720 female; aged 20–60 years). Statistical analysis revealed significant differences for most of body dimensions among the ethnical groups. Moreover, the authors compared Iranian anthropometric characteristics with those of four Asian populations: Taiwanese, Chinese, Japanese, and Korean. Overall, 16 body dimensions for the five Asian populations were selected and compared. Accordingly, different morphological characteristics of these five populations were observed. The Iranian population showed wide shoulders and hips and long legs; the Chinese population showed narrow hips and shoulders and a short height relative to the other populations. The Korean sample recorded moderate body size comparing the other populations. The Taiwanese had large hands, relatively wide shoulders and short upper limbs. These

differences in population dimensions should be taken into consideration for product and process design when expanding regional markets.

- **Keywords:** Anthropometric characteristic; Bodily proportion; Ethnicity

**Yu-San Chang, Yu-Hsuan Wu, Mei Rou Lu, Chung-Yao Hsu, Ching-Kuan Liu, Chin Hsu. *Did a brief nap break have positive benefits on information processing among nurses working on the first 8-h night shift?* Pages 104-108.**

Shift workers frequently experience acute sleep deprivation on first night shift. This study compared the efficacy of 30-min nap (between 2 and 3 a.m.) on the visual attention ability of the nurses working at first 8-h night shift at the time of maximum fatigue (between 3 and 4 a.m.). In addition, we measured cognitive function (between 9 and 10 a.m.) in nurses working on daytime shift, which we defined as baseline wakefulness. The results showed that working on the night shift groups was associated with sleep loss, leading to a decrease in visual attention performance compared to the daytime shift group. There was no statistically significant difference in the visual attention performance between those taking and not taking a nap during the night shift, however the effect size was medium in the information process. It was still needed increase sample size to draw the conclusion regarding a 30-min nap break have positive benefits on perceptual speed during the first night shift.

- **Keywords:** Cognitive function; Nap; Night shift

**Maria Anna Nico, Stefania Liuzzi, Pietro Stefanizzi. *Evaluation of thermal comfort in university classrooms through objective approach and subjective preference analysis.* Pages 111-120.**

Assessing thermal comfort becomes more relevant when the aim is to maximise learning and productivity performances, as typically occurs in offices and schools. However, if, in the offices, the Fanger model well represents the thermal occupant response, then on the contrary, in schools, adaptive mechanisms significantly influence the occupants' thermal preference. In this study, an experimental approach was performed in the Polytechnic University of Bari, during the first days of March, in free running conditions. First, the results of questionnaires were compared according to the application of the Fanger model and the adaptive model; second, using a subjective scale, a complete analysis was performed on thermal preference in terms of acceptability, neutrality and preference, with particular focus on the influence of gender. The user possibility to control the indoor plant system produced a significant impact on the thermal sensation and the acceptability of the thermal environment. Gender was also demonstrated to greatly influence the thermal judgement of the thermal environment when an outdoor cold climate occurs.

- **Keywords:** Thermal comfort; Fanger's model; Adaptive model

**Timothy L. White, Andrea S. Krausman. *Effects of inter-stimulus interval and intensity on the perceived urgency of tactile patterns.* Pages 121-129.**

This research examines the feasibility of coding urgency into tactile patterns. Four tactile patterns were presented at either, 12 or 23.5 dB above mean threshold, with an ISI of either 0 (no interval) or 500 msec. Measures included pattern identification and urgency rating on a scale of 1 (least urgent) to 10 (most urgent). Two studies were conducted, a laboratory study and a field study. In the laboratory study, participants received the tactile patterns while seated in front of a computer. For the field study, participants

performed dismounted Soldier maneuvers while receiving the tactile patterns. Higher identification rates were found for the 23.5 dB intensity. Patterns presented at the 23.5 dB intensity and no ISI were rated most urgent. No differences in urgency ratings were found for 12 dB based on ISI. Findings support the notion of coding urgency into tactile patterns as a way of augmenting tactile communication.

- **Keywords:** Tactile; Perceived urgency; Dismounted maneuvers

**Jim Nixon, Andrew Leggatt, James Campbell. *The development and assessment of behavioural markers to support counter-IED training.* Pages 130-137.**

This article describes the method used to develop and test a checklist of behavioural markers designed to support UK military forces during Counter-Improvised Explosive Device (C-IED) training. IEDs represent a significant threat to UK and allied forces. Effective C-IED procedures and techniques are central to reducing risk to life in this safety critical role. Behavioural markers have been developed to characterise and assess non-technical skills which have been shown to be important in maintaining high performance in other safety critical domains. The aims of this study were two-fold. Firstly to develop a method which could be used to capture and assess operationally relevant behavioural markers for use in C-IED training relating primarily to non-technical skills. Secondly, to test the user acceptance of the behavioural marker checklist during military training activities. Through engagement with military subject matter experts, operationally relevant and observable behaviours seen in C-IED training have been identified and their links to stronger and weaker performance have been established. Using a card-sort technique, the content validity of each of the markers was assessed in addition to their detectability in an operational context. Following this assessment, a selection of the most operationally relevant and detectable behaviours were assimilated into a checklist and this checklist was tested in C-IED training activities. The results of the study show that the method used was effective in generating and assessing the behavioural markers using military subject matter experts. The study also broadly supports the utility and user-acceptance of the use of behavioural markers during training activities. The checklist developed using this methodology will provide those responsible for delivering instruction in C-IED techniques and procedures with a straightforward process for identifying good and poor performance with respect to non-technical skills. In addition it will provide a basis for the provision of focussed feedback to trainees during debrief.

- **Keywords:** Behavioural marker; Non-technical skills; Improvised explosive device

**Chao Sun, Joe Sau-chuen Au, Jintu Fan, Rong Zheng. *Novel ventilation design of combining spacer and mesh structure in sports T-shirt significantly improves thermal comfort.* Pages 138-147.**

This paper reports on novel ventilation design in sports T-shirt, which combines spacer and mesh structure, and experimental evidence on the advantages of design in improving thermal comfort. Evaporative resistance ( $R_e$ ) and thermal insulation ( $R_c$ ) of T-shirts were measured using a sweating thermal manikin under three different air velocities. Moisture permeability index ( $im$ ) was calculated to compare the different designed T-shirts. The T-shirts of new and conventional designs were also compared by wearer trials, which were comprised of 30 min treadmill running followed by 10 min rest. Skin temperature, skin relative humidity, heart rate, oxygen inhalation and energy expenditure were monitored, and subjective sensations were asked. Results demonstrated that novel T-shirt has 11.1% significant lower  $im$  than control sample under windy condition. The novel T-shirt contributes to reduce the variation of skin temperature and relative humidity up to 37% and 32%, as well as decrease 3.3% energy consumption during exercise.

- **Keywords:** Ventilation design; Thermal comfort; Sports T-shirt

**Kihyo Jung, Jinah Jang. *Development of a two-step touch method for website navigation on smartphones. Pages 148-153.***

The touch method for hyperlink selection in smartphones can often create usability problems because a hyperlink is universally smaller than a finger contact area as well as visually occluded by a finger while pressing. In this study, we developed a two-step touch method (called Press and Flick method) and comprehensively examined its effectiveness using the goals, operators, methods, and selection rules (GOMS) model and user testing. The two-step touch method consisted of finger press and flick motions; a target hyperlink was selected by a finger press motion, and a finger flick method was subsequently conducted for error correction if the initial interaction (press) failed. We compared the two-step touch method with the current touch method through the GOMS model and user testing. As a result, the two-step touch method was significantly superior to the current touch method in terms of error rate and subjective satisfaction score; however, its superiority in terms of number of interactions and touch time was vulnerably affected by error rate. The two-step touch method developed in this study can improve the usability and user experience of website navigation using smartphones.

- **Keywords:** Mobile website navigation; Press and flick; Smartphone interaction

**Chiuhsiang Joe Lin, Sui-Hua Ho, Yan-Jyun Chen. *An investigation of pointing postures in a 3D stereoscopic environment. Pages 154-163.***

Many object pointing and selecting techniques for large screens have been proposed in the literature. There is a lack of quantitative evidence suggesting proper pointing postures for interacting with stereoscopic targets in immersive virtual environments. The objective of this study was to explore users' performances and experiences of using different postures while interacting with 3D targets remotely in an immersive stereoscopic environment. Two postures, hand-directed and gaze-directed pointing methods, were compared in order to investigate the postural influences. Two stereo parallaxes, negative and positive parallaxes, were compared for exploring how target depth variances would impact users' performances and experiences. Fifteen participants were recruited to perform two interactive tasks, tapping and tracking tasks, to simulate interaction behaviors in the stereoscopic environment. Hand-directed pointing is suggested for both tapping and tracking tasks due to its significantly better overall performance, less muscle fatigue, and better usability. However, a gaze-directed posture is probably a better alternative than hand-directed pointing for tasks with high accuracy requirements in home-in phases. Additionally, it is easier for users to interact with targets with negative parallax than with targets with positive parallax. Based on the findings of this research, future applications involving different pointing techniques should consider both pointing performances and postural effects as a result of pointing task precision requirements and potential postural fatigue.

- **Keywords:** Stereoscopic parallax; Pointing technique; 3D virtual environment

**Uzeyir Pala, H. Ridvan Oz. *An investigation of thermal comfort inside a bus during heating period within a climatic chambre. Pages 164-176.***

By this study, it was aimed to define a testing and calculation model for thermal comfort assessment of a bus HVAC design and to compare effects of changing parameters on passenger's thermal comfort. For this purpose, a combined theoretical and experimental work during heating period inside a coach was carried out. The bus was left under 20 °C for more than 7 h within a climatic chamber and all heat sources were started at the beginning of a standard test. To investigate effects of fast transient conditions on passengers' physiology and thermal comfort, temperatures, air humidity and air

velocities were measured. Human body was considered as one complete piece composed of core and skin compartments and the Transient Energy Balance Model developed by Gagge et al. in 1971 was used to calculate changes in thermal parameters between passenger bodies and bus interior environment. Depending on the given initial and environmental conditions, the graphs of passengers Thermal Sensation and Thermal Discomfort Level were found. At the end, a general mathematical model supported with a related experimental procedure was developed for the use of automotive HVAC engineers and scientists working on thermal comfort as a human dimension.

- **Keywords:** Thermal comfort; Bus; Heating period

**Kimberly Myles, Joel T. Kalb, Janea Lowery, Bheem P. Kattel. *The effect of hair density on the coupling between the tactor and the skin of the human head.* Pages 177-185.**

The purpose of this study was to determine the effect of hair density on vibration detection thresholds associated with the perception of low frequency vibration stimuli applied to the head. A host of tactile sensitivity information exists for other parts of the body, however the same information is lacking for the head. Thirty-three college students, age 18-35, were recruited for the study. A mixed design was used to evaluate the effect of hair density, head location, and frequency on vibration detection thresholds. Results suggest that hair density might slightly impede vibration signals from reaching the scalp and reduce vibration sensitivity, for the least sensitive locations on the head. This research provides design recommendations for head-mounted tactile displays for women and those with hair that can be used to convey directional cues for navigation and as alerts to critical events in the environment.

- **Keywords:** Tactile sensitivity; Head tactile display; Vibrotactile detection on scalp

**Jiyoung Choi, Kyunghi Hong. *3D skin length deformation of lower body during knee joint flexion for the practical application of functional sportswear.* Pages 186-201.**

With the advent of 3D technology in the design process, a tremendous amount of scanned data is available. However, it is difficult to trace the quantitative skin deformation of a designated location on the 3D body surface data during movement. Without identical landmarks or reflective markers, tracing the same reference points on the different body postures is not easy because of the complex shape change of the body. To find the least deformed location on the body, which is regarded as the optimal position of seams for the various lengths of functional compression pants, landmarks were directly marked on the skin of six subjects and scanned during knee joint flexion. Lines of non-extension (LoNE) and maximum stretch (LoMS) were searched for, both by tracing landmarks and newly drawn guidelines based on ratio division in various directions. Considering the waist as the anchoring position of the pants, holistic changes were quantified and visualized from the waistline in lengthwise and curvilinear deformation along the dermatomes of the lower body for various lengths of pants. Widthwise and unit area skin deformation data of the skin were also provided as guidelines for further use such as streamlined pants or design of other local wearing devices.

- **Keywords:** Skin length deformation; Line of non-extension; Functional compression pants

**Carlo Giaconia, Aldo Orioli, Alessandra Di Gangi. *A correlation linking the predicted mean vote and the mean thermal vote based on an***

***investigation on the human thermal comfort in short-haul domestic flights. Pages 202-213.***

The results of an experimental investigation on the human thermal comfort inside the cabin of some Airbus A319 aircrafts during 14 short-haul domestic flights, linking various Italian cities, are presented and used to define a correlation among the predicted mean vote (PMV), a procedure which is commonly used to assess the thermal comfort in inhabited environments, and the equivalent temperature and mean thermal vote (MTV), which are the parameters suggested by the European Standard EN ISO 14505-2 for the evaluation of the thermal environment in vehicles. The measurements of the radiant temperature, air temperature and relative humidity during flights were performed. The air temperature varied between 22.2 °C and 26.0 °C; the relative humidity ranged from 8.7% to 59.2%. The calculated values of the PMV varied from -0.16 to 0.90 and were confirmed by the answers of the passengers. The equivalent temperature was evaluated using the equations of Fanger or on the basis of the values of the skin temperature measured on some volunteers. The correlation linking the thermal sensation scales and zones used by the PMV and the MTV resulted quite accurate because the minimum value of the absolute difference between such environmental indexes equalled 0.0073 and the maximum difference did not exceed the value of 0.0589. Even though the equivalent temperature and the MTV were specifically proposed to evaluate the thermal sensation in vehicles, their use may be effectively extended to the assessment of the thermal comfort in airplanes or other occupied places.

- **Keywords:** Thermal comfort; Aircraft cabins; Air conditioning

***M. Oehl, C. Sutter. Age-related differences in processing visual device and task characteristics when using technical devices. Pages 214-223.***

With aging visual feedback becomes increasingly relevant in action control. Consequently, visual device and task characteristics should more and more affect tool use. Focussing on late working age, the present study aims to investigate age-related differences in processing task irrelevant (display size) and task relevant visual information (task difficulty). Young and middle-aged participants (20–35 and 36–64 years of age, respectively) sat in front of a touch screen with differently sized active touch areas (4" to 12") and performed pointing tasks with differing task difficulties (1.8–5 bits). Both display size and age affected pointing performance, but the two variables did not interact and aiming duration moderated both effects. Furthermore, task difficulty affected the pointing durations of middle-aged adults moreso than those of young adults. Again, aiming duration accounted for the variance in the data. The onset of an age-related decline in aiming duration can be clearly located in middle adulthood. Thus, the fine psychomotor ability "aiming" is a moderator and predictor for age-related differences in pointing tasks. The results support a user-specific design for small technical devices with touch interfaces.

- **Keywords:** Age; Display size; Tool use

***Mark C. Schall Jr., Nathan B. Fethke, Howard Chen, Fred Gerr. A comparison of instrumentation methods to estimate thoracolumbar motion in field-based occupational studies. Pages 224-231.***

The performance of an inertial measurement unit (IMU) system for directly measuring thoracolumbar trunk motion was compared to that of the Lumbar Motion Monitor (LMM). Thirty-six male participants completed a simulated material handling task with both systems deployed simultaneously. Estimates of thoracolumbar trunk motion obtained with the IMU system were processed using five common methods for estimating trunk motion characteristics. Results of measurements obtained from IMUs secured to the sternum and pelvis had smaller root-mean-square differences and mean bias estimates

in comparison to results obtained with the LMM than results of measurements obtained solely from a sternum mounted IMU. Fusion of IMU accelerometer measurements with IMU gyroscope and/or magnetometer measurements was observed to increase comparability to the LMM. Results suggest investigators should consider computing thoracolumbar trunk motion as a function of estimates from multiple IMUs using fusion algorithms rather than using a single accelerometer secured to the sternum in field-based studies.

- **Keywords:** Musculoskeletal disorders; Manual handling; Inertial measurement

**Katharine R. Parkes. *Sleep patterns of offshore day-workers in relation to overtime work and age. Pages 232-239.***

In addition to long contractual hours during offshore weeks (14 × 12 h shifts), many personnel on North Sea oil/gas installations also work overtime, but little is known about the implications of overtime for sleep patterns offshore. In this study, the additive and interactive effects of overtime and age were analysed as predictors of sleep duration and sleep quality among offshore day-workers (N = 551), 54% of whom reported overtime. Sleep duration and quality were impaired among personnel who worked overtime, relative to those who worked only standard shifts; there was also an inverse dose-response relationship between overtime hours and sleep duration. Although the sleep measures were more favourable during shore leave than during offshore weeks, there was little evidence of compensatory sleep patterns. These findings are discussed with reference to known performance and health effects of short sleep hours; formal guidance on overtime work offshore is noted; and methodological issues are considered.

- **Keywords:** Work hours; Shift work; Health and safety

**Glyn Lawson, Paul Herriotts, Louise Malcolm, Katharina Gabrecht, Setia Hermawati. *The use of virtual reality and physical tools in the development and validation of ease of entry and exit in passenger vehicles. Pages 240-251.***

Ease of entry and exit is important for creating a positive first impression of a car and increasing customer satisfaction. Several methods are used within vehicle development to optimise ease of entry and exit, including CAD reviews, benchmarking and buck trials. However, there is an industry trend towards digital methods to reduce the costs and time associated with developing physical prototypes. This paper reports on a study of entry strategy in three properties (buck, car, CAVE) in which inconsistencies were demonstrated by people entering a vehicle representation in the CAVE. In a second study industry practitioners rated the CAVE as worse than physical methods for identifying entry and exit issues, and having lower perceived validity and reliability. However, the resource issues associated with building bucks were recognised. Recommendations are made for developing the CAVE and for combinations of methods for use at different stages of a vehicle's development.

- **Keywords:** Entry exit; Automotive

**Judy Edworthy, Elizabeth Hellier, Lex Newbold, Kirsteen Titchener. *Passing crisis and emergency risk communications: The effects of communication channel, information type, and repetition. Pages 252-262.***

Three experiments explore several factors which influence information transmission when warning messages are passed from person to person. In Experiment 1, messages were passed down chains of participants using five different modes of communication. Written

communication channels resulted in more accurate message transmission than verbal. In addition, some elements of the message endured further down the chain than others. Experiment 2 largely replicated these effects and also demonstrated that simple repetition of a message eliminated differences between written and spoken communication. In a final field experiment, chains of participants passed information however they wanted to, with the proviso that half of the chains could not use telephones. Here, the lack of ability to use a telephone did not affect accuracy, but did slow down the speed of transmission from the recipient of the message to the last person in the chain. Implications of the findings for crisis and emergency risk communication are discussed.

- **Keywords:** Communication channel; Warning design; Crisis and emergency risk communications

**Arne Nieuwenhuys, Geert J.P. Savelsbergh, Raoul R.D. Oudejans.** *Persistence of threat-induced errors in police officers' shooting decisions.* Pages 263-272.

This study tested whether threat-induced errors in police officers' shooting decisions may be prevented through practice. Using a video-based test, 57 Police officers executed shooting responses against a suspect who rapidly appeared with (shoot) or without (don't shoot) a firearm. Threat was manipulated by switching on (high-threat) or switching off (low-threat) a "shootback canon" that could fire small plastic bullets at the officers. After an initial pretest, officers were divided over four different practice groups and practiced their shooting decisions for three consecutive weeks. Effects of practice were evaluated on a posttest. On the pretest, all groups experienced more anxiety and executed more false-positive responses under high-threat. Despite practice, these effects persisted on the posttest and remained equally strong for all practice groups. It is concluded that the impact of threat on police officers' shooting decisions is robust and may be hard to prevent within the limits of available practice.

- **Keywords:** Anxiety; Decision making; Representative practice

**Roland Zemp, William R. Taylor, Silvio Lorenzetti.** *Are pressure measurements effective in the assessment of office chair comfort/discomfort? A review.* Pages 273-282.

Nowadays, the majority of jobs in the western world involves sitting in an office chair. As a result, a comfortable and supported sitting position is essential for employees. In the literature, various objective methods (e.g. pressure measurements, measurements of posture, EMG etc.) have been used to assess sitting comfort/discomfort, but their validity remains unknown. This review therefore examines the relationship between subjective comfort/discomfort and pressure measurements while sitting in office chairs. The literature search resulted in eight papers that met all our requirements. Four studies identified a relationship between subjective comfort/discomfort and pressure distribution parameters (including correlations of up to  $r = 0.7 \pm 0.13$ ). However, the technique for evaluating subjective comfort/discomfort seems to play an important role on the results achieved, therefore placing their validity into question. The peak pressure on the seat pan, the pressure distribution on the backrest and the pressure pattern changes (seat pan and backrest) all appear to be reliable measures for quantifying comfort or discomfort.

- **Keywords:** Office chair; Comfort; Pressure measurements