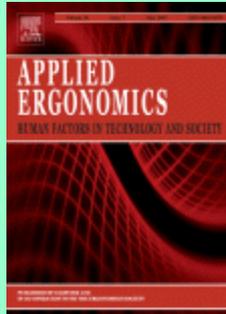


## **Applied Ergonomics - rok 2011, ročník 42**

### **Číslo 3 (March 2011)**



**Bülent Çakmak, Türker Saraçoğlu, Fazilet N. Alayunt, Cengiz Özarslan. *Vibration and noise characteristics of flap type olive harvesters. Pages 397-402.***

The object of this study was to measure and evaluate the vibration and noise characteristics of five flap type portable harvesters using for olive harvesting and their effect on operator health during harvesting time. The vibration and sound pressure levels of different harvesters were measured at both idling and full load conditions. The vibration values of harvesters were measured and analyzed for both right and left hands and the sound pressure level was measured at ear level of the operator. The vibration total value was expressed as the root-mean-squares (rms) of three component values. The results indicated that in 10% of the exposed population traumatic vasospastic disease (TVD) appeared after 0.7–7.1 years for the left hand, 1.0–4.7 years for the right hand of the operator in continuous use of these harvesters, under usual working conditions. The sound pressure values at operator's ear level of harvesters were found below risk levels when compared with ILO standards.

- **Keywords:** Vibration; Olive harvester; Tvd

**Katrina M. Simpson, Bridget J. Munro, Julie R. Steele. *Effect of load mass on posture, heart rate and subjective responses of recreational female hikers to prolonged load carriage. Pages 403-410.***

Load carriage has been associated with a risk of upper and lower limb musculoskeletal disorders with women suffering significantly higher injury rates than their male counterparts. Despite this injury risk, there are limited evidence-based guidelines for recreational hikers, particularly female recreational hikers, regarding safe backpack loads. The purpose of the present study was to determine how variations in load mass affected the heart rate, posture and subjective responses of women during prolonged walking to provide evidence for a load mass limit for female recreational hikers. Heart rate (HR), posture and ratings of perceived exertion (RPE) and discomfort were collected for 15 female experienced recreational hikers ( $22.3 \pm 3.9$  years) while they hiked for 8 km at a self-selected pace under four different load conditions (0%, 20%, 30% and 40% of body weight (BW)). Although HR was not significantly affected by load mass or walking distance, increasing load mass and distance significantly affected posture, RPE and discomfort of the upper body. Carrying a 20% BW load induced significant changes in trunk posture, RPE and reported shoulder discomfort compared to the unloaded condition. The 20% BW load also resulted in a mean RPE rating of 'fairly light', which

increased to 'hard' when carrying a 40% BW load. As load carriage distance increased participants reported significantly increased shoulder, neck and upper back discomfort. Based on the changes to posture, self-reported exertion and discomfort when carrying loads of 20%, 30% and 40% BW over 8 km, it was concluded that a backpack load limit of 30% BW should be recommended for female recreational hikers during prolonged walking.

- **Keywords:** Load carriage; Backpack; Gait; Walking; Discomfort; Exertion

**M. Phillips, A. Petersen, C.R. Abbiss, K. Netto, W. Payne, D. Nichols, B. Aisbett. *Pack Hike Test finishing time for Australian firefighters : pass rates and correlates of performance. Pages 411-418.***

The pack hike test (PHT, 4.83 km hike wearing a 20.4-kg load) was devised to determine the job readiness of USA wildland firefighters. This study measured PHT performance in a sample of Australian firefighters who currently perform the PHT (career land management firefighters, LMFF) and those who do not (suburban/regional volunteer firefighters, VFF). The study also investigated the relationships between firefighters' PHT performance and their performance across a range of fitness tests for both groups. Twenty LMFF and eighteen age-, body mass-, and height-matched VFF attempted the PHT, and a series of muscular endurance, power, strength and cardiorespiratory fitness tests. Bivariate correlations between the participants' PHT finishing time and their performance in a suite of different fitness tests were determined using Pearson's product moment correlation coefficient. The mean PHT finishing time for LMFF ( $42.2 \pm 2.8$  min) was  $9 \pm 14\%$  faster ( $p = 0.001$ ) than for VFF ( $46.1 \pm 3.6$  min). The pass rate (the percentage of participants who completed the PHT in under 45 min) for LMFF (90%) was greater than that of VFF (39%,  $p = 0.001$ ). For LMFF,  $VO_{2peak}$  in  $L \cdot min^{-1}$  ( $r = -0.66$ ,  $p = 0.001$ ) and the duration they could sustain a grip 'force' of 25 kg ( $r = -0.69$ ,  $p = 0.001$ ) were strongly correlated with PHT finishing time. For VFF,  $VO_{2peak}$  in  $mL \cdot kg^{-1} \cdot min^{-1}$  ( $r = -0.75$ ,  $p = 0.002$ ) and the duration they could hold a 1.2-m bar attached to 45.5 kg in a 'hose spray position' ( $r = -0.69$ ,  $p = 0.004$ ) were strongly correlated with PHT finishing time. This study shows that PHT fitness-screening could severely limit the number of VFF eligible for duty, compromising workforce numbers and highlights the need for specific and valid firefighter fitness standards. The results also demonstrate the strong relationships between PHT performance and firefighters' cardiorespiratory fitness and local muscular endurance. Those preparing for the PHT should focus their training on these fitness components in the weeks and months prior to undertaking the PHT.

- **Keywords:** Wildland firefighter; Physical employment standards; Fitness

**Katherine J.C. Sang, Diane E. Gyi, Cheryl O. Haslam. *Stakeholder perspectives on managing the occupational health of UK business drivers : a qualitative approach. Pages 419-425.***

Musculoskeletal disorders are one of leading causes of work related ill health and sickness absence. Those drive as part of their job may be at particular risk, with evidence suggesting that prolonged exposure to driving is associated with increased absence from work due to low back pain. Business drivers often work away from a traditional office environment. Such mobile working may pose greater risks to occupational health due to increased ergonomic risks, for example working from the car, longer working hours and a lack of concern amongst drivers about health and safety. It has been suggested that occupational health practices have not adapted to meet the needs of peripatetic workers. The current study explored how occupational health services are delivered to business drivers. Semi-structured interviews were carried out with a sample of 31 stakeholders in 4 organisations. Respondents included, health and safety professionals, occupational health nurses, fleet managers and high mileage business drivers. The interviews were transcribed and analysed using 'Template Analysis'. The data revealed that, within these

organisations, the provision of occupational health services was often fragmented and drivers and other key stakeholders were often unaware of the existing systems within their organisations. The peripatetic nature of business drivers meant that they were difficult for occupational health teams to reach. The paper concludes by presenting recommendations for occupational health professionals and researchers engaged with improving the health of peripatetic workers, namely that occupational health policies should be integrated in company strategy and widely disseminated to drivers and those with responsibility for managing their occupational health provision.

- **Keywords:** Business drivers; Occupational health; Qualitative research; Musculoskeletal disorders

**Anna-Maria Teperi, Anneli Leppänen. *From crisis to development : analysis of air traffic control work processes.* Pages 426-436.**

In this study an intervention to improve work processes in air traffic control (ATC) is evaluated. The background was the Finnish air traffic controllers' strike of 1999. The old ways of thinking and acting did not support development of ATC prompting a need for a new kind of working culture in the organisation. Several actions were started. In one of these, ATC work processes were modelled by personnel and development plans concerning work were delivered to top management. Different actors (management, trade union, stakeholders) were interviewed before ( $n = 16$ ) and after the project ( $n = 7$ ). The intervention supported systematic co-operation between different actors in the organisation. However, a follow-up revealed that only a few participants had adopted the idea of continuous work development. Mastery of human factors is crucial in a high reliability work environment such as ATC. But how is the analytical and co-operative aspect kept alive in an organisation that is run by strict international regulation and has a strong technical competence, but is not that strong in collaborative and human aspects?

**Keywords:** Air traffic control; Work process analysis; Work development

**C. Sutter, M. Oehl, C. Armbrüster. *Practice and carryover effects when using small interaction device.* Pages 437-444.**

The use of interaction devices in modern work often challenges the human motor system, especially when these devices introduce unfamiliar transformations to the user. In this paper we evaluated expert performance and skill differences between experts and novices when using small motion- and force-controlled interaction devices (touchpad and mini-joystick) in an applied text-editing task. Firstly, experts performed better with their familiar input device than with an unfamiliar one. Particularly touchpad experts operating the unfamiliar mini-joystick showed highly asymmetric carryover costs. Results showed that the efficient performance of experts depended on domain-specific skills, which were not transferable. Secondly, with considerable practice (more than observed for simple and short tasks) novices were brought up to higher levels of performance. The motion-transformation between hand and cursor action was easier in understanding and application than the force-transformation. Thus, the touchpad was used more efficiently than the mini-joystick. In conclusion, practice effects found so far are considerably underestimated when it comes to an applied task. The results give reason to develop and implement skill-sensitive training procedures, since the acquisition of domain-specific skills is critical for expert performance. As a consequence, training procedures might be essential for complex applications and/or unfamiliar device transformations.

- **Keywords:** Touchpad; Mini-joystick; Sensorimotor transformation; Tool use; Applied dragging task; Expert; Novice; Human-computer interaction

**Seungyeol Lee, Seungnam Yu, Junho Choi, Changsoo Han. *A methodology to quantitatively evaluate the safety of a glazing robot.* Pages 445-454.**

A new construction method using robots is spreading widely among construction sites in order to overcome labour shortages and frequent construction accidents. Along with economical efficiency, safety is a very important factor for evaluating the use of construction robots in construction sites. However, the quantitative evaluation of safety is difficult compared with that of economical efficiency. In this study, we suggested a safety evaluation methodology by defining the 'worker' and 'work conditions' as two risk factors, defining the 'worker' factor as posture load and the 'work conditions' factor as the work environment and the risk exposure time. The posture load evaluation reflects the risk of musculoskeletal disorders which can be caused by work posture and the risk of accidents which can be caused by reduced concentration. We evaluated the risk factors that may cause various accidents such as falling, colliding, capsizing, and squeezing in work environments, and evaluated the operational risk by considering worker exposure time to risky work environments. With the results of the evaluations for each factor, we calculated the general operational risk and deduced the improvement ratio in operational safety by introducing a construction robot. To verify these results, we compared the safety of the existing human manual labour and the proposed robotic labour construction methods for manipulating large glass panels.

- **Keywords:** Risk index; Safety evaluation; Large glass panels; Construction robots

**Kristina Kindblom-Rising, Rolf Wahlström, Lena Nilsson-Wikmar, Nina Buer. *Nursing staff's movement awareness, attitudes and reported behaviour in patient transfer before and after an educational intervention.* Pages 455-463.**

The objective was to evaluate changes after a two half-day patient transfer course regarding nursing staff's movement and body awareness, attitudes, reported behaviour, strain, disorder and sick leave. The course aimed at increasing staff's self-awareness of movements and body, and their communication competence, with the intention to promote the patient's independent mobility. Ninety-nine staff in an intervention group and 77 staff in two control groups answered a questionnaire before and after the intervention. After one year there was a significant increase in the number of instructions given and nursing staff's movement awareness in the intervention group compared to the control group. Reported physical disorders decreased significantly in the intervention group compared with both control groups. Increased movement awareness and frequent use of instructions during transfers may encourage patients to move independently and thereby reduce the strain in nursing staff.

- **Keywords:** Patient transfer; Movement awareness; Instruction

**Ole Broberg, Vibeke Andersen, Rikke Seim. *Participatory ergonomics in design processes : the role of boundary objects.* Pages 464-472.**

The aim of this paper is to introduce the concept of boundary objects in order to better understand the role of objects in participatory ergonomics (PE) design processes. The research question is: What characterizes boundary objects in PE processes? Based on two case studies, we identify eight characteristics of boundary objects and their use, which make them particularly useful in PE design processes. These characteristics go beyond the object itself and extend into the context of their use. We argue that the selection of boundary objects in PE processes is of great importance, since different objects enable workers' participation and collaborative design in different ways. The framework developed may serve to provide criteria to guide practitioners and

intervention researchers in the selection of objects to facilitate a PE process. The paper concludes with a list of recommendations for ergonomic practitioners that are based on the framework.

- **Keywords:** Participatory ergonomics; Design processes; Boundary objects

**Farrokh Janabi-Sharifi, Aleksandar Vakanski. *Analysis of visual acuity and motion resolvability as measures for optimal visual perception of the workspace.* Pages 473-486.**

For working tasks with high visual demand, ergonomic design of the working stations requires defining criteria for comparative evaluation and analysis of the visual perceptibility in different regions of the workspace. This paper provides kinematic models of visual acuity and motion resolvability as adopted measures of visual perceptibility of the workspace. The proposed models have been examined through two sets of experiments. The first experiment is designed to compare the models outputs with those from experiments. Time measurements of the participants' response to visual events are employed for calculation of the perceptibility measures. The overall comparison results show similar patterns and moderate statistical errors of the measured and kinematically modeled values of the parameters. In the second experiment, the proposed set of visual perceptibility measures are examined for a simulated industrial task of inserting electronic chips into slots of a working table, resembling a fine assembly line of transponders manufacturing. The results from ANOVA tests for the visual acuity and the motion resolvability justify the postures adopted by the participants using visual perceptibility measures for completing the insertion tasks.

- **Keywords:** Human visual system; Visual perceptibility; Acuity; Motion resolvability

**Juergen Sauer, Andreas Sonderegger. *Methodological issues in product evaluation : the influence of testing environment and task scenario.* Pages 487-494.**

This article examines the utility of two commonly used approaches in the evaluation of interactive consumer products: lab-based testing and single task scenarios. These are compared to two more complex and resource-demanding approaches (field-based testing and dual task scenarios) with regard to the test results they produce. An experiment with  $N = 80$  users was carried out, employing a 2 (laboratory vs. field) by 2 (single task vs. dual task scenario) by 2 (on-product information: present vs. absent) between-subjects design. On-product information (advising users to save water and electricity during kettle usage) represented the intervention, of which the effects on user behaviour were compared under the different experimental conditions. The main finding was that the impact of on-product information on user behaviour was strongest in the lab-based testing environment using a single task scenario (i.e., most economical testing condition), compared to the three other experimental conditions. The work found similar effects for self-report measures. The findings of the study point to the risk that the effects of system redesign on user behaviour may be overestimated if low-fidelity testing approaches are employed. The relevance of these findings for other application areas is also discussed (e.g., design of warnings).

- **Keywords:** Lab-based testing; On-product information; Warnings; Dual task

**Maranda McBride, Phuong Tran, Tomasz Letowski, Rafael Patrick. *The effect of bone conduction microphone locations on speech intelligibility and sound quality.* Pages 495-502.**

This paper presents the results of three studies of intelligibility and quality of speech recorded through a bone conduction microphone (BCM). All speech signals were captured and recorded using a Temco HG-17 BCM. Twelve locations on or close to the skull were selected for the BCM placement. In the first study, listeners evaluated the intelligibility and quality of the bone conducted speech signals presented through traditional earphones. Listeners in the second study evaluated the intelligibility and quality of signals presented through a loudspeaker. In the third study the signals were reproduced through a bone conduction headset; however, signal evaluation was limited to speech intelligibility only. In all three studies, the Forehead and Temple BCM locations yielded the highest intelligibility and quality rating scores. The Collarbone location produced the least intelligible and lowest quality signals across all tested BCM locations.

- **Keywords:** Bone conduction microphone; Communication; Speech intelligibility; Sound quality

**Yung-Chin Tsao, Shaio-Chung Chan. *A study on embarrassment associated with product use.* Pages 503-510.**

User interactions with products or systems can produce positive feelings, e.g. pleasing, encouraging or challenging; or negative ones, e.g. annoying, depressing or even abusive. This study attempted to explore reasons for negative emotions associated with product use by probing into the embarrassing emotions aroused in a product-use situation. The results showed that the embarrassment associated with product use was caused by two constructs: losing control of the product and inappropriate operation. Both of the two constructs have impacts on embarrassing emotions; however, the structural model showed that for the embarrassment associated with product use, inappropriate operation stands out as a more significant construct than losing control of the product. Users tended to blame themselves for the embarrassing situation, believing that the embarrassment was a result of their improper use of the product or carelessness.

- **Keywords:** Negative emotions; Use behavior; Structural equation modeling

**Rosemary R. Seva, Katherine Grace T. Gosiaco, Ma. Crea Eurice D. Santos, Denise Mae L. Pangilinan. *Product design enhancement using apparent usability and affective quality.* Pages 511-517.**

In this study, apparent usability and affective quality were integrated in a design framework called the Usability Perception and Emotion Enhancement Model (UPEEM). The UPEEM was validated using structural equation modeling (SEM). The methodology consists of four phases namely product selection, attribute identification, design alternative generation, and design alternative evaluation. The first stage involved the selection of a product that highly involves the consumer. In the attribute identification stage, design elements of the product were identified. The possible values of these elements were also determined for use in the experimentation process. Design of experiments was used to identify how the attributes will be varied in the design alternative stage and which of the attributes significantly contribute to affective quality, apparent usability, and desirability in the design evaluation stage. Results suggest that product attributes related to form are relevant in eliciting intense affect and perception of usability in mobile phones especially those directly related to functionality and aesthetics. This study considered only four product attributes among so many due to the constraints of the research design employed. Attributes related to aesthetic perception of a product enhance apparent usability such as those related to dimensional ratios.

- **Keywords:** Apparent usability; Product design; Affective product design; Structural equation modeling

**Makiko Kouchi, Masaaki Mochimaru. *Errors in landmarking and the evaluation of the accuracy of traditional and 3D anthropometry.* Pages 518-527.**

Body dimensions are based on landmarks of the body, but the magnitude of error in landmark determination is not well known. Therefore, a study was performed in which 40 subjects were marked five times in total by one highly skilled marker and a novice marker. Immediately after marking, a skilled measurer determined 34 body dimensions that were based on the mark locations. Intra- and inter-observer errors in landmarking of 35 landmarks, as well as those in 34 body dimensions were quantified. The error in landmarking was defined as the distance between two marks made on the same landmark by the same marker (intra-observer error) or by two different markers (inter-observer error). To make the first mark invisible when the second mark was made, the first mark was made using an invisible ink pen under black light. Landmarks with large intra-observer errors also had large inter-observer errors. Errors in body dimensions were smaller than landmarking errors in 23 measurements, which suggested that the magnitude of landmarking error would be underestimated from errors in body dimensions. In 15 body dimensions, measurements based on marks made by two different markers were not comparable according to the ISO 20685 criterion. Examination of body dimensions and landmarks with large inter-observer errors suggested that reducing inter-observer landmarking errors was necessary to reduce inter-observer measurement errors, and that a possible solution was to explicitly define landmarks with large errors in more detail so that anthropometrists can pinpoint them on the skin. Quantitative data on the intra- and inter-observer landmarking errors in the present study may be useful as a reference when evaluating and comparing the performance of software for calculating landmark locations for 3D anthropometry.

- **Keywords:** Body scanner; Accuracy; Evaluation protocol; Landmark; Body dimensions; Anthropometric survey