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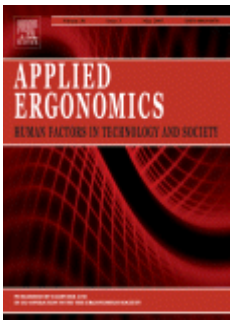

SPECIAL SECTION: Recycling centres and waste handling - a workplace for employees and users

Inga-Lill Engkvist. Waste and recycling : a challenge for society. *Page 335.*

- Bez abstraktu a klíčových slov

I.-L. Engkvist, J. Eklund, J. Krook, M. Björkman, E. Sundin, R. Svensson, M. Eklund. *Joint investigation of working conditions, environmental and system performance at recycling centres : development of instruments and their usage*. Pages 336-346.

Recycling is a new and developing industry, which has only been researched to a limited extent. This article describes the development and use of instruments for data collection within a multidisciplinary research programme "Recycling centres in Sweden – working conditions, environmental and system performance". The overall purpose of the programme was to form a basis for improving the function of recycling centres with respect to these three perspectives and the disciplines of: ergonomics, safety, external environment, and production systems. A total of 10 instruments were developed for collecting data from employees, managers and visitors at recycling centres, including one instrument for observing visitors. Validation tests were performed in several steps. This, along with the quality of the collected data, and experience from the data collection, showed that the instruments and methodology used were valid and suitable for their purpose.

- **Keywords:** Environment; Interview protocol; Methods; Questionnaire; Waste handling; Work environment

Inga-Lill Engkvist. *Working conditions at recycling centres in Sweden : physical and psychosocial work environment*. Pages 347-354.

The number of jobs at recycling centres are increasing, at the same time as there are indications of work environment problems. The aim of this paper was to investigate physical and psychosocial working conditions for employees at recycling centres in Sweden, to describe how they were perceived, to compare differences between subgroups, and further to identify proposals for improvement. Employees at 42 recycling

centres (n = 122) responded a postal questionnaire. Of these 32 employees from 16 recycling centres were interviewed, as also their employer (n = 16).

The work at recycling centres was reported to be a meaningful service job comprising many social interactions with users, but also substantial physical strain. There was a high frequency of injuries and minor injuries. Several risks were identified. There is a need for several preventive actions, e.g. better planning when building recycling centres, including better machines and equipment and more training, especially in handling hazardous waste.

- **Keywords:** Accident; Injury; Psychosocial conditions; Work environment; Waste management

Jörgen Eklund, Annika Kihlstedt, Inga-Lill Engkvist. *Sorting and disposing of waste at recycling centres : a users perspective*. Pages 355-361.

This paper investigates Swedish recycling centres from the users' perspective. The aim was to describe the characteristics and experiences of the users and their activities when sorting and disposing of waste, and to identify improvements for the users. The typical recycling centre user is a recently retired man, living in a house with a garden, having travelled 5 km alone in his own car. The users requested longer opening hours and better information available at home and at the recycling centre. The major difficulty for the users is to understand which fraction their waste belongs to, and consequently into which container they should throw it. The most important sources of sorting information, in addition to experience from earlier visits, are signs and asking the personnel. Although the service at recycling centres is perceived positively by a majority of users, substantial improvements can still be made, and a number of such suggestions are given.

- **Keywords:** Service; Information; Activity; Improvement; Signs

Joakim Krook, Mats Eklund. *The strategic role of recycling centres for environmental performance of waste management systems*. Pages 362-367.

This paper analyses how different actors influence the sorting quality of waste at recycling centres. Users (i.e. citizens) play an essential role since they conduct the actual sorting. They have difficulties sorting many of their discarded products, leading to decreased performance of the entire waste management system of which recycling centres are a part. Several measures addressing this problem are identified such as product design, improved terminology for labelling waste and increased manning at recycling centres. A fundamental task for managers and employees is to further develop information and guidance for users, both at home and at recycling centres. Several obstacles for improvements are also discussed, including working conditions and the economy of recycling centres, as well as the routines for communication and quality assurance among actors in the recycling business.

- **Keywords:** Actors; System performance; Sorting quality

Hillevi Hemphälä, Annika Kihlstedt, Jörgen Eklund. *Vision ergonomics at recycling centres*. Pages 368-375.

All municipalities in Sweden offer their inhabitants a service for disposing of large-size and hazardous waste at local recycling centres. Opening hours at these centres include hours of darkness. The aims of this study were to 1) describe user and employee experiences of lighting and signs at Swedish recycling centres, 2) measure and assess

the lighting system at the two recently built recycling centres in Linköping and to assess the legibility and visibility of the signs used and 3) propose recommendations regarding lighting and signs for recycling centres. Interviews and questionnaires were used to assess experiences of employees and users, and light measurements were performed. By observing users, activities with different visual demands at different areas within the recycling centres were identified. Based on the literature, standards and stakeholder experiences, recommendations regarding lighting systems and sign design, illuminance, luminance and uniformity are proposed for recycling centres.

- **Keywords:** Illuminance; Light recommendations; Lighting systems; Signs; Safety

REGULAR PAPERS

Heather E. Webb, David R. McMinn, Ryan S. Garten, Jamie L. Beckman, Gary H. Kamimori, Edmund O. Acevedo. *Cardiorespiratory responses of firefighters to a computerized fire strategies and tactics drill during physical activity*. Pages 376-381.

Firefighters are subjected to a combination of physical and mental challenges in the course of their occupational responsibilities. However, due to the ecological factors involved with firefighting, it makes it extremely difficult to examine physiological and psychological changes that occur as a result of these combined challenges. The purpose of this study was to examine the efficacy of a computer-based Fire Strategies and Tactics Drill (FSTD) in eliciting psychological and physiological measures of stress in professional firefighters. In one session, participants exercised at 60% VO_{2max} for 37 min (exercise alone condition, EAC), and in the other session the firefighter exercised for an equal amount of time and responded to the FSTD (dual challenge condition; DCC) while exercising. Cardiorespiratory (heart rate [HR], respiration rate [RR], minute ventilation [V_E], oxygen consumption [VO_2], ventilatory efficiency [V_E/VO_2], and respiratory exchange ratio [RER]) and psychometric measures (State Anxiety Inventory [SAI] and Ratings of Perceived Exertion [RPE]) were obtained throughout the experimental protocols. The NASA Task Load Index was used to assess perceived physical and mental load during each condition. The results demonstrated that the participants perceived overall workload to be higher in the DCC. Repeated measures ANOVAs revealed no differences between the EAC and DCC for VO_2 or RER, but the DCC did elicit significantly greater elevations in HR, RR, V_E, and V_E/VO_2 compared to the EAC. These results suggest that the FSTD utilized in this study provides an effective method for examining the physiological and psychological responses of firefighters in a research laboratory environment.

- **Keywords:** Stress; Occupational stress; Psychophysiology; Dual stress; Combined stress

Dan Lockton, David Harrison, Neville A. Stanton. *The Design with Intent Method : a design tool for influencing user behaviour*. Pages 382-392.

Using product and system design to influence user behaviour offers potential for improving performance and reducing user error, yet little guidance is available at the concept generation stage for design teams briefed with influencing user behaviour. This article presents the Design with Intent Method, an innovation tool for designers working in this area, illustrated via application to an everyday human–technology interaction problem: reducing the likelihood of a customer leaving his or her card in an automatic teller machine. The example application results in a range of feasible design concepts which are comparable to existing developments in ATM design, demonstrating that the method has potential for development and application as part of a user-centred design process.

- **Keywords:** Product design; Interaction design; User behaviour; Methods

Laura Pickup, John Wilson, Emma Lowe. *The Operational Demand Evaluation Checklist (ODEC) of workload for railway signalling*. Pages 393-402.

This paper is concerned with the interpretation and assessment of mental workload, and in particular assessment of the load imposed by the work system. It highlights a framework created to direct the development of workload assessment tools capable of assessing the dimensions most relevant to the population being studied, in our case railway signallers. A tool to capture the operational demands on the rail signaller was required to evaluate the load from the system they operated. This paper justifies the need for, and describes the development of, the Operational Demand Evaluation Checklist (ODEC), using techniques like repertory grid with active signallers. The practical experience of the development, evaluation, live use and validation of ODEC is discussed and the paper concludes by suggesting that the approach could be adopted to interpret the concept of workload in other work domains.

- **Keywords:** Mental workload; Railway; Signallers; Repertory Grid Technique; Operational demand

Andreas Sonderegger, Juergen Sauer. *The influence of design aesthetics in usability testing : effects on user performance and perceived usability*. Pages 403-410.

This article examined the effects of product aesthetics on several outcome variables in usability tests. Employing a computer simulation of a mobile phone, 60 adolescents (14–17 yrs) were asked to complete a number of typical tasks of mobile phone users. Two functionally identical mobile phones were manipulated with regard to their visual appearance (highly appealing vs not appealing) to determine the influence of appearance on perceived usability, performance measures and perceived attractiveness. The results showed that participants using the highly appealing phone rated their appliance as being more usable than participants operating the unappealing model. Furthermore, the visual appearance of the phone had a positive effect on performance, leading to reduced task completion times for the attractive model. The study discusses the implications for the use of adolescents in ergonomic research.

- **Keywords:** Usability test; Aesthetics; Adolescent; Performance; Mobile phone

William Porter, Sean Gallagher, Janet Torma-Krajewski. *Analysis of applied forces and electromyography of back and shoulders muscles when performing a simulated hand scaling task*. Pages 411-416.

Hand scaling is a physically demanding task responsible for numerous overexertion injuries in underground mining. Scaling requires the miner to use a long pry bar to remove loose rock, reducing the likelihood of rock fall injuries. The experiments described in this article simulated "rib" scaling (scaling a mine wall) from an elevated bucket to examine force generation and electromyographic responses using two types of scaling bars (steel and fiberglass-reinforced aluminum) at five target heights ranging from floor level to 176 cm. Ten male and six female subjects were tested in separate experiments. Peak and average force applied at the scaling bar tip and normalized electromyography (EMG) of the left and right pairs of the deltoid and erectores spinae muscles were obtained. Work height significantly affected peak prying force during scaling activities with highest force capacity at the lower levels. Bar type did not affect force generation. However, use of the lighter fiberglass bar required significantly more muscle activity to achieve the same force. Results of these studies suggest that miners

scale points on the rock face that are below their knees, and reposition the bucket as often as necessary to do so.

- **Keywords:** Scaling; Electromyography; Mining

Balmatee Bidassie, James D. McGlothlin, Alina Goh, Robert G. Feyen, James W. Barany. *Limited economic evaluation to assess the effectiveness of a university-wide office ergonomics program*. Pages 417-427.

The objective of this research was to evaluate the effectiveness and provide a limited economic evaluation of an office ergonomics program at a major university from 1995 to 2007. The relationship between office-related recordable injuries, reported lost time, severity of these injuries, and the Workers' Compensation (WC) paid was analyzed and the corresponding incident cost was calculated. Two major datasets analyzed were OSHA 200/300 logs (1991–2007) and WC claims paid (1999–2007). Since the beginning of the office ergonomics program in 1995 and through 2007 (13-year period), the number of office cumulative trauma disorder (CTD) cases decreased by 53%. Since the official start (in 1999) of a 50–50 cost share agreement for office equipment purchases between the university's Safety and Health Department (SHD) and the university departments evaluated, it was observed that the incident rate decreased by 63%, Total Days Away/restrict or Transfer (DART) rate decreased by 41%, Lost Time Case (LTC) rate decreased by 71% and office-related carpal tunnel syndrome decreased by almost 50%. The long-term goal of this research is to demonstrate the self-sustainability of an office ergonomics program by showing that equipment costs are eventually offset by a decrease in WC claims paid and lost time from office-related injuries and illnesses. While limited, this research helps in cost-justifying the implementation of future office ergonomics programs for large organizations.

- **Keywords:** Cost-justification analysis; Office ergonomics program; Cumulative trauma disorders; Workers' compensation; Incident cost

Lambros Laios, John Giannatsis. *Ergonomic evaluation and redesign of children bicycles based on anthropometric data*. Pages 428-435.

Proper bicycle fit is very important for cycling performance, efficiency, comfort and injury prevention. This is especially true in the case of children cyclists that do not have the necessary cycling experience, balance and the fully developed musculoskeletal system of the adults. Bicycle fit depends on both the design and dimensions of the bicycle as well as on the anthropometric dimensions of the cyclist. In the present paper a case study concerning the ergonomic evaluation and redesign of a series of bicycles for children and teenagers 7–14 years old is presented. The study has been commissioned by a major Greek bicycle manufacturer who wanted to gain competitive advantage by introducing new anthropometrically-designed bicycles. Employing virtual modelling techniques and the method of Principal Component Analysis, bicycle affordance for selected representative cases and various bicycle sizes has been examined. Based on the results of the study redesign recommendations that improved bicycle fit for specific groups were proposed and a formal bicycle size selection method has been defined. The redesigned bicycles are now in full production and distribution is underway in many commercial outlets in Greece.

- **Keywords:** Bicycle fit; Bicycle design; Anthropometric design

Paolo Pillastrini, Raffaele Mugnai, Lucia Bertozzi, Stefania Costi, Stefania Curti, Andrew Guccione, Stefano Mattioli, Francesco S. Violante. *Effectiveness of an ergonomic intervention on work-related posture and*

***low back pain in video display terminal operators : a 3 year cross-over trial*. Pages 436-443.**

This study investigated the effectiveness of a workstation ergonomic intervention for work-related posture and low back pain (LBP) in Video Display Terminal (VDT) workers. 100 VDT workers were selected to receive the ergonomic intervention, whereas 100 were assigned to a control group. The two groups were then crossed-over after 30 months from baseline. Follow-ups were repeated at 5, 12, and 30 months from baseline and then at 6 months following crossover. Outcomes: Work-related posture and LBP point-prevalence using the Rapid Entire Body Assessment method and a Pain Drawing, respectively. The ergonomic intervention at the workstation improved work-related posture and was effective in reducing LBP point-prevalence both in the first study period and after crossover, and these effects persisted for at least 30 months. In conclusion, our findings contribute to the evidence that individualized ergonomic interventions may be able to improve work-related posture and reduce LBP for VDT workers.

- **Keywords:** Low back pain; Posture; Video display terminal

Andrew M. Scuffham, Stephen J. Legg, Elwyn C. Firth, Mark A. Stevenson. *Prevalence and risk factors associated with musculoskeletal discomfort in New Zealand veterinarians*. Pages 444-453.

A cross-sectional study using a modified Nordic musculoskeletal questionnaire asked 867 New Zealand veterinarians about the presence or absence of musculoskeletal discomfort (MSD). Participants were asked if MSD affected their normal activities and if it required any period(s) of absence from work. Additional questions enquired about work activities, psychosocial factors and workload. A binary logistic regression analysis was used to quantify the association between identified risk factors and the presence of MSD requiring absence from work in the previous 12 months, controlling for the presence of known confounders. The overall period prevalence of MSD was 96%, 67% had normal activities being affected and 18% of participants reported that they had been absent from work due to MSD. The lower back was the body site most commonly reported for MSD (73%). Factors increasing the odds of MSD requiring time off work for clinical veterinarians were 10 year increases in age (OR 1.26, 95% CI 1.05–1.52), work involving awkward grip and hand movements 100% of time (OR 12.91, 95% CI 3.46–4.21) and those who were dissatisfied with the level and difficulty of their work (OR 2.27, 95% CI 1.11–6.56). These findings have implications for health, lifestyle and retention rates for veterinarians.

- **Keywords:** Neck shoulder back pain; Psychosocial factors; Veterinary procedures; Work activities; Nordic musculoskeletal questionnaire

Soon-Lae Kim, Jong-Eun Lee. *Development of an intervention to prevent work-related musculoskeletal disorders among hospital nurses based on the participatory approach*. Pages 454-460.

The participatory approach has been widely used to improve the work environment. The purpose of this study was to develop an intervention to prevent work-related musculoskeletal disorders in hospital nurses using the participatory approach. Based on the Participatory Action Oriented Training (PAOT) approach, the multidisciplinary team conducted the trainer workshop to develop a comprehensive intervention protocol, which yielded several practical and low-cost solutions to reduce the risk factors for musculoskeletal disorders. Structured tools that were focused on the hospital environment were developed. The developed action checklist consisted of 43 items that were focused on five areas of nursing tasks (i.e., patient care and treatment; safe handling of drugs, medical devices, and equipment; workstation design; physical

environment; and welfare facilities and administration). The final intervention protocol consisted of a series of structured participant workshop, follow-up visits, and presentation of achievements.

- **Keywords:** Work-related musculoskeletal disorders; Participatory approach; Hospital nurses; Action checklist

Anaïs Mayeur, Roland Brémond, J.M. Christian Bastien. *Effects of the viewing context on target detection : implications for road lighting design*. Pages 461-468.

The Small Target Visibility (STV) model is the main model used to assess the quality of road lighting installations (IESNA, 2000). However, this model is based on a simple detection task in foveal vision using psychophysical data from laboratory conditions. The purpose of this study was to evaluate the impact of a complex background and apparent motion on target detection performance in mesopic vision, for three luminance contrasts, with reference to the STV scenario. To do so, participants were invited to detect standard square targets varying in terms of contrast presented in three Conditions: a uniform background, still images, and a video. Luminance levels were chosen in the mesopic domain relevant for road lighting at night. Images and video were chosen in relation to a driving task at night. The results showed that both the spatial context and the apparent motion had a negative impact on peripheral target detection performance: contrasts which are easy to detect in conditions close to the STV reference data may lead to poor performance if one adds context variables. These results give evidence that the STV model used for road lighting design based on laboratory data is limited, which strengthens previous results (Mayeur et al., 2008). The results are discussed in relation to the field factor used by practitioners to compensate for the differences between the STV reference scenario (detection of a small square target on a lit road while driving) and the STV psychophysical reference data.

- **Keywords:** Road lighting design; Context; Visual performance; Target detection

Meredith A. Perry, Paul A. Hendrick, Leigh Hale, G. David Baxter, Stephan Milosavljevic, Sarah G. Dean, Suzanne M. McDonough, Deirdre A. Hurley. *Utility of the RT3 triaxial accelerometer in free living : an investigation of adherence and data loss*. Pages 469-476.

There is strong evidence for the protective effects of physical activity on chronic health problems. Activity monitors can objectively measure free living occupational and leisure time physical activity. Utility is an important consideration when determining the most appropriate monitor for specific populations and environments. Hours of activity data collected, the reasons for activity hours not being recorded, and how these two factors might change over time when using an activity monitor in free living are rarely reported. This study investigated user perceptions, adherence to minimal wear time and loss of data when using the RT3 activity monitor in 21 healthy adults, in a variety of occupations, over three (7 day) repeated weeks of measurement in free living. An activity diary verified each day of monitoring and a utility questionnaire explored participant perceptions on the usability of the RT3. The RT3 was worn for an average of 14 h daily with 90% of participants having complete data sets. In total 6535.8 and 6092.5 h of activity data were collected from the activity diary and the RT3 respectively. An estimated 443.3 h (6.7%) of activity data were not recorded by the RT3. Data loss was primarily due to battery malfunction (45.2%). Non-adherence to wear time accounted for 169.5 h (38.2%) of data loss, of which 14 h were due to occupational factors. The RT3 demonstrates good utility for free living activity measurement, however, technical issues and strategies to manage participant adherence require consideration with longitudinal and repeated measures studies.

- **Keywords:** Adherence; Usability; Physical activity; Data loss; Triaxial accelerometer

Jennifer A. Hess, Laurel Kincl, Tal Amasay, Peter Wolfe. *Ergonomic evaluation of masons laying concrete masonry units and autoclaved aerated concrete*. Pages 477-483.

Masons working with concrete masonry unit block have high rates of work-related musculoskeletal disorders to the low back and shoulders associated with repetitively lifting and buttering heavy block. A new material, autoclaved aerated concrete, may reduce the risk of shoulder and back injury but, ergonomic evaluation is needed. This study evaluated shoulder exposure parameters, low back stress, and worker perceptions in two groups of journey level masons, one using CMU and the other using AAC block. Results indicate that for the left arm AAC masons spent significantly more time than CMU masons in static (38.2% versus 31.1%, respectively), and less time in slow motions (48.2% versus 52.2%, respectively) and faster motions (13.6% versus 16.7%, respectively) ($p < 0.05$). CMU masons had significantly greater shoulder and low back pain ($p = 0.009$) and they held block significantly longer than AAC masons ($p < 0.001$). Low back compressive forces were high for both materials. Masons handling AAC demonstrated less left upper extremity stress but both materials were estimated to be hazardous to the low back.

- **Keywords:** Masonry; Construction; Ergonomics; Shoulder injury; Low back injury

Angela DiDomenico, Krystyna Gielo-Perczak, Raymond W. McGorry, Chien-Chi Chang. *Effects of simulated occupational task parameters on balance*. Pages 484-489.

The effects of single-handed load holding, length of the base of support, and standing surface condition (narrow and wide construction beams) on balance were investigated in twenty-three healthy men between the ages of 18 and 55 years old. Balance during quiet standing was evaluated from postural sway measurements derived from center of pressure (COP) displacement. These measurements included the range or maximal displacement of the COP in the anteroposterior (AP) and mediolateral (ML) directions, the elliptical area, and mean sway velocity. Holding a load in the hand did not significantly affect postural sway measures ($p > 0.05$), although the effect of surface condition was significant on all COP measures ($p < 0.001$). Lengthening the base of support did not affect the ranges or elliptical area, but increased the mean velocity of sway ($p = 0.001$). Changes in the dimensional characteristics of the surface condition and length of base of support affected postural sway, possibly by requiring adjustments to balance and motor control strategies. Further research is required to determine if these changes are detrimental to maintaining balance and increase the risk of falls for workers in similar environments.

- **Keywords:** Balance; Center of pressure; Falls; Construction