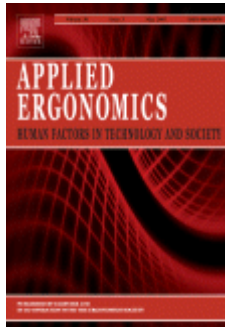


## **Applied Ergonomics - rok 2007, ročník 38**

### **Číslo 2 (March 2007)**



**David Gonzalez, Heather Carnahan, Monate Praamsma and Adam Dubrowski. *Control of laparoscopic instrument motion in an inanimate bench model : implications for the training and the evaluation of technical skills.* Pages 123-132.**

Computer-assisted analysis of wrist movement has recently emerged as an objective laparoscopic performance evaluation method. The first purpose of this study was to assess the differences in motion characteristics between the tip of the instrument and the wrist. The second purpose was to describe the control strategies used to move laparoscopic instruments. During a bead transfer task, motions of a laparoscopic needle driver's tip, heel, and the participants' wrist were monitored. Results showed that large amplitude movements were best described by movements of the wrist, and small amplitude movements were evidenced by motions of the instrument tip. Thus, for describing expertise, and for evaluation and feedback, motion of the tip of the laparoscopic instrument should be quantified, in addition to motion of the wrist. The motions of the instrument were controlled by utilizing the flexibility of the skin of the laparoscopic trainer in addition to using the fulcrum, and sliding through the trocar. In order to increase fidelity, virtual reality trainers should simulate the flexibility of the real structures around the insertion of the instrument.

**Min-Chi Chiu and Mao-Jiun J. Wang. *Professional footwear evaluation for clinical nurses.* Pages 133-141.**

Epidemiological investigations indicate that nursing professionals experience a higher prevalence of musculoskeletal disorders (MSDs) than most other occupational groups. Most nursing activities require standing and walking for prolonged periods. Such job requirements may contribute to MSD problems in the lower extremities. Thus, wearing comfortable nursing shoes is essential to reduce the lower-extremity discomfort for clinical nurses. The objectives of this study are: (1) to evaluate three brands of commercially available nursing footwear and identify the important shoe features for adequate shoe support during nursing activities, and (2) to assess the effect of wearing compression hosiery by measuring the biomechanical, physiological, and psychophysical responses of test participants. The method of this study involved two phases. First, field observations were conducted to collect job demand data, including walking speed, and the ratios of walking, standing, and sitting. Second, an experiment was conducted to evaluate the functions of professional nursing footwear and examine the influence of compression hosiery on lower extremity discomfort relief. Measurements included electromyography (EMG) of the lower leg, joint range of motion (ROM) in the lower

extremity, foot pressure, ground reaction force (GRF), and subjective discomfort ratings for the lower body and feet. Summarizing the findings of this study, comfortable footwear for nursing professionals should emphasize a footbed with arch support outside with 1.5 cm thickness of EVA materials in the metatarsal zone and heel height between 1.8 and 3.6 cm; this can minimize foot pressure distribution, impact force, and increase shin and ankle comfort. In addition, wearing compression hosiery is recommended to alleviate lower body and foot discomfort for clinical nurses.

**Sara Kraemer and Pascale Carayon. *Human errors and violations in computer and information security : the viewpoint of network administrators and security specialists. Pages 143-154.***

This paper describes human errors and violations of end users and network administration in computer and information security. This information is summarized in a conceptual framework for examining the human and organizational factors contributing to computer and information security. This framework includes human error taxonomies to describe the work conditions that contribute adversely to computer and information security, i.e. to security vulnerabilities and breaches. The issue of human error and violation in computer and information security was explored through a series of 16 interviews with network administrators and security specialists. The interviews were audio taped, transcribed, and analyzed by coding specific themes in a node structure. The result is an expanded framework that classifies types of human error and identifies specific human and organizational factors that contribute to computer and information security. Network administrators tended to view errors created by end users as more intentional than unintentional, while errors created by network administrators as more unintentional than intentional. Organizational factors, such as communication, security culture, policy, and organizational structure, were the most frequently cited factors associated with computer and information security.

**Jillian Dorrian, Gregory D. Roach, Adam Fletcher and Drew Dawson. *Simulated train driving: Fatigue, self-awareness and cognitive disengagement. Pages 155-166.***

Fatigue is a serious issue for the rail industry, increasing inefficiency and accident risk. The performance of 20 train drivers in a rail simulator was investigated at low, moderate and high fatigue levels. Psychomotor vigilance (PVT), self-rated performance and subjective alertness were also assessed. Alertness, PVT reaction times, extreme speed violations (>25% above the limit) and penalty brake applications increased with increasing fatigue level. In contrast, fuel use, draft (stretch) forces and braking errors were highest at moderate fatigue levels. Thus, at high fatigue levels, errors involving a failure to act (errors of omission) increased, whereas incorrect responses (errors of commission) decreased. The differential effect of fatigue on error types can be explained through a cognitive disengagement with the virtual train at high fatigue levels. Interaction with the train reduced dramatically, and accident risk increased. Awareness of fatigue-related performance changes was moderate at best. These findings are of operational concern.

**Angelo d'Errico, Rebecca Gore, Judith E. Gold, Jung-Soon Park and Laura Punnett. *Medium- and long-term reproducibility of self-reported exposure to physical ergonomics factors at work. Pages 167-175.***

**Introduction**

The literature is sparse on reproducibility of self-reported exposure to physical ergonomics risk factors for musculoskeletal disorders (MSDs). Aims of this study were to evaluate, in a cohort of workers interviewed up to three times: 1-year test-retest reliability; and 5- and 6-year recall of physical exposures. We also examined whether reproducibility was influenced by the presence of UE MSD or by technological changes introduced between the last two surveys.

### **Methods**

A cohort of automobile manufacturing employees was interviewed at baseline, one and six years later about work history, physical and psychosocial exposures at work, upper limb symptoms, injury and medical history, and demographics. Agreement between interviews was evaluated by intraclass correlation and Spearman coefficients. Differences in exposure between 1- and 6-year follow-up were analyzed by Wilcoxon matched-pairs signed-ranks test.

### **Results**

Large and significant decreases in work pace and physical effort were observed from baseline, although an upper extremity composite index was quite stable in the total population. One-year test-retest reliability was fair to good for the composite exposure index (ICC=0.58), whole-body vibration, handling parts, and tool use, but poor for the other variables considered. Long-term reproducibility, from baseline or 1-year follow-up to 6-year follow-up, was poor for the composite index and almost all single items. UE MSD case status influenced 1-year test-retest reliability, with subjects who changed case status from baseline displaying higher reliability, but not reproducibility of recalled exposures. A strong regression to the mean effect was observed on exposures reported at follow-up surveys.

### **Conclusions**

Recalled ergonomics exposures could be employed in retrospective cohort studies as a somewhat reliable and unbiased estimate of the self-reported exposures that would have been obtained up to one year earlier, but not over a longer period (5–6 years). These longer-term results may have been limited by difficulty in matching jobs between interviews; also the regression to the mean effect likely contributed to reduce agreement. Changes in production technology and work organization produced a decrease in physical workload intensity and job pace, but did not have a substantial impact on an exposure index for the upper limb.

### **Brendan Ryan and Christine M. Haslegrave. *Use of concurrent and retrospective verbal protocols to investigate workers' thoughts during a manual-handling task.* Pages 177-190.**

A manual handling task (an order picking task in a distribution warehouse) was investigated using concurrent verbal protocols and retrospective verbal protocols (applied at three different times after completion of the task). The study aimed to collect workers' thoughts during the task and to determine what workers are comfortable with reporting. Video recordings of the task were used as a means of investigating the accuracy of the information which was reported. The concurrent and retrospective verbal protocol methods were compared and it was found that concurrent reports could be used to collect a range of task related thoughts, although they only contained a proportion of the workers' thoughts during the task. Additional information could be obtained from retrospective reports, although these appeared to be vulnerable to bias and re-ordering of reported information. The retrospective reports produced whilst watching a video recording of the task were particularly vulnerable to bias from retrospective reasoning or the rationalisation of thoughts. Only one specific reference to posture or handling technique was made by any of the workers in their reports. There were also few references to load characteristics. Workers frequently reported aspects of the task that

were easier to verbalise, such as the counting or labelling of items. It is not known whether the workers were only aware of these limited details of their tasks or whether they were only able to report limited details of the tasks because of factors affecting verbal reporting. This was an exploratory study which has collected valuable information from a small sample of experienced workers in relation to a common task from industry, but further study is needed to investigate the effects of factors such as load weight, load position and task duration on awareness and reporting of thoughts.

**James P. Bliss, Corey K. Fallon and Nicolae Nica. *The role of alarm signal duration as a cue for alarm validity*. Pages 191-199.**

Researchers have isolated several variables that moderate the degrading effects of alarm mistrust on alarm reactions. We examined how alarm duration influences reactions to alarms of varying true alarm rates. In Experiment one, 45 psychology students performed a complex psychomotor task while reacting to an alarm system generating short- and long-duration signals. We predicted that participants would consider long-duration alarms more valid and would respond more to them despite the true alarm rate. Results supported both expectations. In addition to these findings, participants believed that true alarm rate influenced their response decisions more than duration even though true alarm rate did not affect actual response frequency. In Experiment two, 40 students reacted to short- and long-duration alarms originating from unique systems. Results showed some participants relied on duration, whereas others used true alarm rate, responded extremely, or combined strategies. Overall, results suggest signal duration is an important influence, but that increased task complexity may lead operators to adopt other reaction strategies.

**Ido Morag. *Intel's incident-free culture : a case study*. Pages 201-211.**

The occupational ergonomic program that Intel's newly established manufacturing plant in Israel implemented in 1997 helped prevent injuries and also marked the launch of a whole new approach to ergonomics. A key element in the success of the seven-point program was a strong commitment from management, which came to regard this plan as a vital strategic element in the new plant's success. Comprehensive, top-down planning imposed obligations on all elements in the manufacturing spectrum, from suppliers to contractors to employees. Work requirements were set; cooperation with the plant's occupational health professionals was established; and long-term reporting and instruction systems were developed. Extensive ergonomic training was a crucial factor in integrating ergonomic procedures into the organization's day-to-day activities. Along with this instructional program, ergonomic engineers implemented a strict measuring system to ensure that each ergonomic activity would be performed according to schedule. By the time the factory opened its gates and began to produce, a vigorous ergonomic environment had emerged and employees were displaying an ergonomic mindset that also impinged upon their non-work activities. As a result of the successful implementation of the program, Intel's ergonomic program has become a model for Israeli industry. This paper presents a full ergonomic program that besides supplying the Intel plant with solutions was unique enough to impact the whole Israeli industry.

**G. Flodgren, M. Heiden, E. Lyskov and A.G. Crenshaw. *Characterization of a laboratory model of computer mouse use : applications for studying risk factors for musculoskeletal disorders*. Pages 213-218.**

In the present study, we assessed the wrist kinetics (range of motion, mean position, velocity and mean power frequency in radial/ulnar deviation, flexion/extension, and

pronation/supination) associated with performing a mouse-operated computerized task involving painting rectangles on a computer screen. Furthermore, we evaluated the effects of the painting task on subjective perception of fatigue and wrist position sense. The results showed that the painting task required constrained wrist movements, and repetitive movements of about the same magnitude as those performed in mouse-operated design tasks. In addition, the painting task induced a perception of muscle fatigue in the upper extremity (Borg CR-scale: 3.5,  $p < 0.001$ ) and caused a reduction in the position sense accuracy of the wrist (error before:  $4.6^\circ$ , error after:  $5.6^\circ$ ,  $p < 0.05$ ). This standardized painting task appears suitable for studying relevant risk factors, and therefore it offers a potential for investigating the pathophysiological mechanisms behind musculoskeletal disorders related to computer mouse use.

**Julia Faucett, James Meyers, John Miles, Ira Janowitz and Fadi Fathallah. *Rest break interventions in stoop labor tasks. Pages 219-226.***

Hand cultivation and harvest of agricultural products constitute strenuous physical tasks. Working with labor-management ergonomics committees in agricultural settings, the UC Agricultural Ergonomics Research Center (AERC) tested an experimental rest and recovery protocol for its impact on symptoms and productivity during two types of work tasks. The experimental condition consisted of adding a 5 min rest break to every working hour in which there was no other scheduled break (e.g., lunchtime). This resulted in an additional 20 min of rest per workday. We tested the intervention in two trials: Trial one compared workers ( $n=66$ ) randomly assigned to an experimental or a control group during the harvest of commercial strawberries. Trial two utilized a cross-over design ( $n=16$  pairs of workers) to compare experimental and control conditions while workers inserted bud grafts into young 18" high citrus trees. For both trials, workers under the experimental condition reported significantly less severe symptoms than workers under control conditions. The order in which the intervention was given, however, appeared to result in variations in productivity. We conclude that the introduction of frequent, brief rest breaks may improve symptoms for workers engaged in strenuous work tasks.

**Steven A. Lavender, Karen M. Conrad, Paul A. Reichelt, Aniruddha K. Kohok and Jessica Gacki-Smith. *Designing ergonomic interventions for EMS workers : part II : lateral transfers. Pages 227-236.***

The objective of the current work was to test ergonomic interventions aimed at reducing the low back musculoskeletal loads experienced by firefighters/paramedics (FFPs) providing emergency medical services (EMS) when performing lateral transfers between a bed and a stretcher or between a stretcher and a hospital gurney. The interventions, developed using focus groups, were a bridgeboard to reduce the frictional force resisting the lateral sliding of the patient, the use of rods along each side of the patient to facilitate the grasping and handling of the bedsheet on which the patient is typically transferred, and a single rod that, when rolled in the bedsheet, resulted in the task being changed from a lifting task to a pulling task. Eleven two-person teams laterally transferred a 75 kg dummy with each intervention between a bed and simulated stretcher. Two roles were defined. For the two-sided transfers, the FFP roles were termed "stretcher-side" and "bed-side." Surface electromyographic (EMG) data were collected from 8 trunk muscles from each participant along with spine kinematic data. Additionally, kinetic data were obtained for the FFP in the stretcher-side role. Trunk flexion moments and Erector Spinae activity were reduced for the FFP in the stretcher-side role when using the bridgeboard and the single rod both individually and in combination. The single rod reduced the Erector Spinae activity in the FFP who typically would have been on the bed. For FFPs in both roles the single rod increased Latissimus Dorsi activation relative to the standard bedsheet transfer condition, although, this effect was moderated when the

single rod was used in combination with the bridgeboard. Ratings of perceived exertion also supported the use of the single rod relative to the corresponding control condition.

**James F. Knight and Chris Baber. *Assessing the physical loading of wearable computers*. Pages 237-247.**

Wearable computers enable workers to interact with computer equipment in situations where previously they were unable. Attaching a computer to the body though has an unknown physical effect. This paper reports a methodology for addressing this, by assessing postural effects and the effect of added weight. Using the example of arm-mounted computers (AMCs), the paper shows that adopting a posture to interact with an AMC generates fatiguing levels of stress and a load of 0.54 kg results in increased level of stress and increased rate of fatigue. The paper shows that, due to poor postures adopted when wearing and interacting with computers and the weight of the device attached to the body, one possible outcome for prolonged exposure is the development of musculoskeletal disorders.

**E. Turpin-Legendre and J.P. Meyer. *Comparison of physiological and subjective strains of two protective coveralls in two short physically simulated demanding tasks*. Pages 249-252.**

A total of 15 physically active male students carried out a normalised task ( $T_N$ ) and a task of access by ladder and scaffolding ( $T_L$ ) in two impermeable protective coveralls and a reference sports wear to compare the physiological and subjective strains. Heart rate (HR) was recorded and sweat loss was checked. Subjective evaluations of comfort parameters, acceptable exposure durations and physical exhaustion were recorded at the end of the tasks. Results show that both protective clothing, compared to the sport wear, increase significantly HR, RPE and CR10 in both tasks. However the strains of both protective clothing are not significantly different except in sweat loss and cumbersomeness.

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