

Ergonomics– rok 2010, ročník 53

Číslo 1



Daniel P. Jenkins ; Paul M. Salmon ; Neville A. Stanton ; Guy H. Walker. *A systemic approach to accident analysis : a case study of the Stockwell shooting.* Pages 1 – 17.

This paper uses a systemic approach to accident investigation, based upon AcciMaps, to model the events leading up to the shooting of Jean Charles de Menezes at Stockwell Underground station in July 2005. The model captures many of the findings of the Independent Police Complaints Commission's report in a single representation, modelling their interdependencies and the causal flow. Furthermore, by taking a systemic approach, the analysis identifies further considerations related to the suitability of the Metropolitan Police Service's organisational structure to support rapid-paced operations, where reliable identification of a suspect is not possible. Based upon the analysis, the paper questions the division of functions between teams and the suitability of an organisational structure that relies upon the complex flow of information between separate teams for surveillance and for controlling the suspect. A dynamic organisational structure is proposed that changes in response to operation type and unfolding events.

Statement of Relevance: This paper provides much needed and called for validation for a systemic approach to accident analysis. A widely reported case study is used to illustrate the process. The paper shows how such an approach can consolidate the key findings of much larger reports as well as draw out additional recommendations.

- **Keywords:** AcciMaps; accidents; error; police; command and contro

Allan B. Carman ; Sarah Gillespie ; Kathryn Jones ; Jessie Mackay ; Gena Wallis ;Stephan Milosavljevic. *All terrain vehicle loss of control events in agriculture : contribution of pitch, roll and velocity.* Pages 18 – 29.

All terrain vehicle (ATV) (i.e. quad bike) loss of control (LOC) events are a major cause of injury and death on New Zealand and Australian farms. ATV LOC history, work experience, anthropometric data and vehicle pitch, roll and velocity data were recorded from 30 farmers. The terrain induced 95th percentiles were forward pitch 27.8°, backward pitch 28.7° and 20.8° for left and right roll. Nineteen participants (mean 42.4 years) had experienced 53 LOC events and were on average 9.5 years younger than the 11 participants (mean 51.9 years) who had not previously experienced LOC. Peak pitch, roll and velocity were not associated with LOC; however, at peak left roll the non-LOC group had a pitch of 3.1° downhill, while the LOC group had a pitch of 2.1° uphill. Results

indicate ATV LOC prevalence is considerably underestimated, while increased risk for LOC may be influenced by a combination of personal, mechanical or terrain factors. The ATV pitch, roll and slope traverse data may help in the better understanding of why LOC events occur, may help in the development of safety equipment such as a tilt warning device and will contribute to national safety guidelines. **Statement of Relevance:** Approximately 80,000 ATVs are used in rural New Zealand and ATV accidents are the single most common cause of work-related fatalities, apart from road accidents. This fieldwork research provides pitch, roll and velocity data and considers how these data might contribute to risk of ATV accidents.

- **Keywords:** all terrain vehicle; loss of control; pitch; quad bike; roll; velocity

Dick de Waard ; Paul Schepers ; Wieke Ormel ;Karel Brookhuis. *Mobile phone use while cycling : incidence and effects on behaviour and safety.* Pages 30 – 42.

The effects of mobile phone use on cycling behaviour were studied. In study 1, the prevalence of mobile phone use while cycling was assessed. In Groningen 2.2% of cyclists were observed talking on their phone and 0.6% were text messaging or entering a phone number. In study 2, accident-involved cyclists responded to a questionnaire. Only 0.5% stated that they were using their phone at the time of the accident. In study 3, participants used a phone while cycling. The content of the conversation was manipulated and participants also had to enter a text message. Data were compared with just cycling and cycling while listening to music. Telephoning coincided with reduced speed, reduced peripheral vision performance and increased risk and mental effort ratings. Text messaging had the largest negative impact on cycling performance. Higher mental workload and lower speed may account for the relatively low number of people calling involved in accidents. **Statement of Relevance:** Although perhaps mainly restricted to flat countries with a large proportion of cyclists, mobile phone use while cycling has increased and may be a threat to traffic safety, similar to phone use while driving a car. In this study, the extent of the problem was assessed by observing the proportion of cyclists using mobile phones, sending questionnaires to accident-involved cyclists and an experimental study was conducted on the effects of mobile phone use while cycling.

- **Keywords:** operator workload; transportation safety

Ludovic Le Bigot ; Patrice Terrier ; Eric Jamet ; Valérie Botharel ;Jean-François Rouet. *Does textual feedback hinder spoken interaction in natural language?* Pages 43 – 55.

The aim of the study was to determine the influence of textual feedback on the content and outcome of spoken interaction with a natural language dialogue system. More specifically, the assumption that textual feedback could disrupt spoken interaction was tested in a human-computer dialogue situation. In total, 48 adult participants, familiar with the system, had to find restaurants based on simple or difficult scenarios using a real natural language service system in a speech-only (phone), speech plus textual dialogue history (multimodal) or text-only (web) modality. The linguistic contents of the dialogues differed as a function of modality, but were similar whether the textual feedback was included in the spoken condition or not. These results add to burgeoning research efforts on multimodal feedback, in suggesting that textual feedback may have little or no detrimental effect on information searching with a real system. **Statement of Relevance:** The results suggest that adding textual feedback to interfaces for human-computer dialogue could enhance spoken interaction rather than create interference. The literature currently suggests that adding textual feedback to tasks that depend on the visual sense benefits human-computer interaction. The addition of textual output when the spoken modality is heavily taxed by the task was investigated.

- **Keywords:** multimodality; dialogue; speech; feedback; information search; natural language

D. H. K. Chow ; Z. Y. Ou ; X. G. Wang ; A. Lai. *Short-term effects of backpack load placement on spine deformation and repositioning error in schoolchildren. Pages 56 – 64.*

Backpack weight of 10-15% has been recommended as an acceptable limit for schoolchildren. However, there is still no clear guideline regarding where the backpack centre of gravity (CG) should be positioned. The changes of spinal curvature and repositioning error when carrying a backpack loaded at 15% of body weight at different CG locations (anterior or posterior at T7, T12 or L3) in schoolchildren were analysed. Both spinal curvature and repositioning error were found to be affected by backpack anterior-posterior position and CG level. A relatively smaller change was observed during anterior carriage with the least change when the backpack CG was positioned at T12. The results also suggested that alternative carriage by changing the backpack position occasionally between anterior and posterior positions might help to relieve the effects of backpack on spine. However, future study is recommended to further substantiate the beneficial effects of alternative carriage on children. **Statement of Relevance:** Anteriorly carried backpack with centre of gravity positioned at T12 was shown to induce relatively less effect on spinal deformation and repositioning error in schoolchildren. Changing backpack carriage position occasionally may help to relieve its effects on spinal deformation. The findings are important for ergonomic schoolbag design and determining a proper load carriage method.

- **Keywords:** backpack; load carriage; spinal deformation; repositioning ability; children

Poonam Pal ; Stephan Milosavljevic ; Diane E. Gregory ; Allan B. Carman ; Jack P. Callaghan. *The influence of skill and low back pain on trunk postures and low back loads of shearers. Pages 65 – 73.*

Shearing is a rural occupation developing considerable spinal loads and carrying a high risk of low back pain (LBP). Although the workforce has a skill structure, interaction between skill, spinal loads and LBP is unknown. We examined whether skill and LBP influenced trunk postures and loads within a sample of 80 shearers representing shear skill levels. A progression from junior to open class demonstrated a 100% increase in productivity, less time in severe flexion, more time in neutral lateral bend, and more time in axially twisted postures, with no increase in cumulative compressive and anterior shear forces. LBP prevalence increased linearly from 10% for junior through to 76% for open class shearers. Shearers with a history of LBP generated greater cumulative right medio-lateral shear forces, greater left lateral bend and left axial twist moments. Skill-based training that reduces asymmetric forces may help reduce such high prevalence levels of LBP. **Statement of Relevance:** Shearing is an important and physically demanding rural occupation. It requires sustained flexed postures that generate considerable spinal loads and a high risk of LBP. This research examines how skill and a history of LBP it carries interact to influence trunk postures and spinal loads within a sample of shearers.

- **Keywords:** shearing; low back pain; skill, forces; posture; cumulative loading

Krishna Asundi ; Dan Odell ; Adam Luce ; Jack T. Dennerlein. *Notebook computer use on a desk, lap and lap support : effects on posture, performance and comfort. Pages 74 – 82.*

This study quantified postures of users working on a notebook computer situated in their lap and tested the effect of using a device designed to increase the height of the notebook when placed on the lap. A motion analysis system measured head, neck and upper extremity postures of 15 adults as they worked on a notebook computer placed on a desk (DESK), the lap (LAP) and a commercially available lapdesk (LAPDESK). Compared with the DESK, the LAP increased downwards head tilt 6° and wrist extension 8°. Shoulder flexion and ulnar deviation decreased 13° and 9°, respectively. Compared with the LAP, the LAPDESK decreased downwards head tilt 4°, neck flexion 2°, and wrist extension 9°. Users reported less discomfort and difficulty in the DESK configuration. Use of the lapdesk improved postures compared with the lap; however, all configurations resulted in high values of wrist extension, wrist deviation and downwards head tilt. **Statement of Relevance:** This study quantifies postures of users working with a notebook computer in typical portable configurations. A better understanding of the postures assumed during notebook computer use can improve usage guidelines to reduce the risk of musculoskeletal injuries

- **Keywords:** lapdesk; laptop; musculoskeletal disorder; posture; upper extremity

Jaclyn N. Chopp ; Steven L. Fischer ;Clark R. Dickerson. *The impact of work configuration, target angle and hand force direction on upper extremity muscle activity during sub-maximal overhead work. Pages 83 – 91.*

Overhead work has established links to upper extremity discomfort and disorders. As many jobs incorporate working overhead, this study aimed to identify working conditions requiring relatively lower muscular shoulder load. Eleven upper extremity muscles were monitored with electromyography during laboratory simulations of overhead work tasks. Tasks were defined with three criteria: work configuration (fixed, stature-specific); target angle (-15°, 0°, 15°, 30° from vertical); direction of applied hand force (pulling backwards, pushing forwards, downwards, sideways, upwards). Normalised electromyographic activity was greater for fixed configurations, particularly when pulling in a backward direction (total activity = 108.3% maximum voluntary exertion (MVE)) compared to pushing down or forward (total activity ranging from 10.5 to 17.3%MVE). Further, pulling backwards at angles of -15° and 0° showed the highest muscular demand ($p < 0.05$). These results suggest that, if possible, positioning overhead work in front of the body with exertions directed forwards will result in the lowest upper extremity muscle demand. **Statement of Relevance:** Overhead work pervades occupational settings and is associated with risk of upper extremity musculoskeletal disorders. The muscular intensity associated with performing overhead work was assessed in several combinations of work placement and hand force direction. These findings should have utility for designing overhead work tasks that reduce muscular exposure.

- **Keywords:** electromyography; overhead work; work design; muscle demand

Na Jin Seo ; Thomas J. Armstrong ;Justin G. Young. *Effects of handle orientation, gloves, handle friction and elbow posture on maximum horizontal pull and push forces. Pages 92 – 101.*

Biomechanical models were evaluated for effects of handle orientation, handle material, gloves and arm posture on maximal pull/push force. Eight healthy subjects performed maximum pull/push exertions on handles with two different orientations and two different surface materials, using bare hand and two types of glove as well as two arm postures. The empirical data supported the proposed biomechanical models: Pull/push forces for the bare hand on a rubber handle decreased 10% when the handle was parallel to the pull/push direction, compared with when perpendicular to it. For parallel handles,

pull/push forces further decreased with decreasing hand-handle friction coefficient (simulated by different handle materials and gloves). Pull force exerted by the bare hand was 29% greater when the elbow was extended than when flexed. Pull force was greater than push force (with bare hand and flexed elbow). The biomechanical models suggest that friction between the hand and handle limits pull/push forces for parallel handles. Elbow strength may be responsible for decreased pull force for the flexed elbow posture and decreased force for pull compared with push in the postures examined. **Statement of Relevance:** Biomechanical models presented in this paper provide insights for causes of upper extremity strength limitations during pull/push tasks. Findings in this paper can be used directly in the design of workstation and objects to reduce fatigue and risk of musculoskeletal disorders.

- **Keywords:** friction; glove; handle; push; pull

Woojin Park ; Jaiganesh Ramachandran ; Paul Weisman ; Eui S. Jung. *Obesity effect on male active joint range of motion. Pages 102 – 108.*

Despite the prevalence of obesity, how obesity affects human physical capabilities is not well documented. As an effort toward addressing this, the current study investigated the obesity effect on joint range of motion (RoM) based on data collected from 20 obese and 20 non-obese males. In total, 30 inter-segmental motions occurring at the shoulder, elbow, knee and ankle joints and lumbar and cervical spine areas were examined. The obesity effect was found to be non-uniform across the joint motions. Obesity significantly reduced RoM for nine of the 30 motions: shoulder extensions and adductions, lumbar spine extension and lateral flexions and knee flexions. The largest significant RoM reduction was 38.9% for the left shoulder adduction. The smallest was 11.1% for the right knee flexion. The obesity-associated RoM reductions appear to be mainly due to the mechanical interposition and obstruction of inter-segmental motions caused by excess fat in the obese body. **Statement of Relevance:** Currently, obesity is prevalent worldwide and its prevalence is expected to increase continually in the near future. This study empirically characterised the obesity effects on joint RoM to provide better understanding of the physical capabilities of the obese. The study findings will facilitate designing man-artefact systems that accommodate obese individuals.

- **Keywords:** obesity; fatness; body joint motions; range of motion

Laura A. Frey Law ; Keith G. Avin. *Endurance time is joint-specific : a modelling and meta-analysis investigation. Pages 109 – 129.*

Static task intensity-endurance time (ET) relationships (e.g. Rohmert's curve) were first reported decades ago. However, a comprehensive meta-analysis to compare experimentally-observed ETs across bodily regions has not been reported. We performed a systematic literature review of ETs for static contractions, developed joint-specific power and exponential models of the intensity-ET relationships, and compared these models between each joint (ankle, trunk, hand/grip, elbow, knee, and shoulder) and the pooled data (generalised curve). 194 publications were found, representing a total of 369 data points. The power model provided the best fit to the experimental data. Significant intensity-dependent ET differences were predicted between each pair of joints. Overall, the ankle was most fatigue-resistant, followed by the trunk, hand/grip, elbow, knee and finally the shoulder was most fatigable. We conclude ET varies systematically between joints, in some cases with large effect sizes. Thus, a single generalised ET model does not adequately represent fatigue across joints. **Statement of Relevance:** Rohmert curves have been used in ergonomic analyses of fatigue, as there are limited tools available to accurately predict force decrements. This study provides updated endurance time-intensity curves using a large meta-analysis of fatigue data. Specific models derived for five distinct joint regions should further increase prediction accuracy.

- **Keywords:** holding time; fatigue; isometric; muscle; references; elbow; knee; shoulder; ankle; trunk; grip

W. P. Neumann ; J. Eklund ; B. Hansson ;L. Lindbeck. *Effect assessment in work environment interventions : a methodological reflection. Pages 130 – 137.*

This paper addresses a number of issues for work environment intervention (WEI) researchers in light of the mixed results reported in the literature. If researchers emphasise study quality over intervention quality, reviews that exclude case studies with high quality and multifactorial interventions may be vulnerable to 'quality criteria selection bias'. Learning from 'failed' interventions is inhibited by both publication bias and reporting lengths that limit information on relevant contextual and implementation factors. The authors argue for the need to develop evaluation approaches consistent with the complexity of multifactorial WEIs that: a) are owned by and aimed at the whole organisation; and b) include intervention in early design stages where potential impact is highest. Context variety, complexity and instability in and around organisations suggest that attention might usefully shift from generalisable 'proof of effectiveness' to a more nuanced identification of intervention elements and the situations in which they are more likely to work as intended. **Statement of Relevance:** This paper considers ergonomics interventions from perspectives of what constitutes quality and 'proof'. It points to limitations of traditional experimental intervention designs and argues that the complexity of organisational change, and the need for multifactorial interventions that reach deep into work processes for greater impact, should be recognised.

- **Keywords:** ergonomics intervention; macroergonomics; musculoskeletal disorders; research methodology